Poverty Alleviation and Biodiversity Conservation in Rural Brazil: A Case Study of the Cananéia Oyster Producers Cooperative

by
Dean Medeiros

A Thesis Submitted to the Faculty of Graduate Studies of
The University of Manitoba
in Partial Fulfillment of the Requirement for the Degree,

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

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THE UNIVERSITY OF MANITOBA
FACULTY OF GRADUATE STUDIES

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ABSTRACT

The Cananéia Oyster Producers' Cooperative (Cooperostra) was awarded the 2002 Equator Prize by the United Nations Development Programme for simultaneous biodiversity conservation and poverty alleviation. In light of this achievement, the main goal of this thesis was to determine lessons learned by examining Cooperostra's successes and remaining challenges. Research specifically focused on how Cooperostra was initiated and evolved (self-organization) along with Cooperostra's institutional dynamics (cross-scale linkages) [Chapter 4]. Research also focused on the impact Cooperostra has had on livelihood improvement [Chapter 5] and conservation [Chapter 6].

Fieldwork for this interdisciplinary study was carried out during September 2003 to February 2004 as well as April to May 2005. A variety of Rapid Rural Appraisal tools was employed which were supplemented with archival reviews at Brazilian government agencies and universities. Numerous interviews were conducted with Cooperostra members, support staff, private oyster aquaculture enterprises. A technical understanding of oyster aquaculture was obtained from a three-day oyster aquaculture seminar. Additional data were collected at Cooperative meetings.

Research revealed that government interventions were partially responsible for triggering overexploitation of oyster stocks. In response to conservation threats and development needs, Cooperostra was initiated by a series of government technicians. The technicians provided critical leadership for the development of Cooperostra. Active participation of Cooperostra members was facilitated by the development of a mutual platform of respect among Cooperostra members and technicians. The technicians were well connected to diverse, cross-scale institutions which provided critical technical and financial support to capacitate Cooperostra. The Forest Foundation and Fisheries Institute played key roles in ensuring Cooperostra members were well-connected to supporting institutions.

With the assistance of a safety web of institutions, Cooperostra to triple the value its members obtained for their oysters. Oyster value increased with the use of rearing beds, attainment of health certification with the construction of a depuration station, and by forgoing middlemen. With the greater value obtained from oysters, Cooperostra members harvest fewer oysters and generally earn greater wages.

Despite some key administrative and economic challenges, Cooperostra members are committed to the process. Public recognition from local, national, and international media has instilled a sense of pride for the cooperative members. Before oyster harvesters were ashamed of their work, but belonging to Cooperostra has granted them dignity and cooperative members feel that they are now better respected.

Conservation goals have been aided with environmental education offered by governmental institutions. Cooperostra members now attempt to minimize their environmental impact the best they can, particularly when harvesting oysters. Reductions in extractive pressure could best be achieved by collecting oyster larvae from the ocean and rearing the larvae to market size. However, local knowledge, along with molecular and cytological analysis strongly suggest the presence of diverse species of oyster within the region. The rearing of oyster seeds would thus likely be confounded by the coexistence of more than one oyster species. It is difficult to distinguish between different oyster species which have different physiological preferences and rearing needs.

Cooperostra has also played a vital role in the development of the Mandira Extractive Reserve. Both projects were executed in parallel by the Forest Foundation and Fisheries Institute. The establishment of the 1, 700 hectare Mandira Extractive Reserve has granted exclusive access rights to the inhabitants. The ecological integrity of this mangrove and Atlantic forest fragment will be secured if effective monitoring and enforcement of reserve regulations and sustainable livelihood development are provided.

Through various coordinated endeavours such as the adoption of oyster rearing beds, depuration station, education, and designation of an extractive reserve, Cooperostra has helped cooperative members earn greater economic returns for their oysters while reducing enviornmental impact. Such a favorable resolution was made possible with the assistance of diverse, cross-scale insitutions. Cooperostra's achievements also set an example that helped the women of the Mandira community to organize themselves to create a Seamstresses Cooperative (*Corte Costura*), which produces and sells clothing and handicrafts. The Mandira community is also currently organizing themselves to capitalize on eco-tourism within their region. Consequently, the success of the Cooperative has empowered the community, both psychologically and technically, to seek further development opportunities in accordance with conservation regulations.

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Dedicado aos meus avos /
Dedicated to my grandparents:
Henrique Medeiros
Maria Sousa
José Carvalho Chaves
Filomena Puim Chaves

e meus pais /
and my parents:
Silvino da Conçeição Sousa Medeiros
Ermelinda Maria Puim Chaves Medeiros

Muito obrigado por me ajudarem a desenvolver a minha fascinação pela natureza./
Thank you for nurturing my fascination with nature.

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Acronyms

APTA - São Paulo Agency of Technology and Agrobusiness

CNPT - National Center for Sustainable Development of Traditional Communities

FINNIDA – Finnish Institute for International Development

IBAMA – Brazilian Institute of Environment and Renewable Natural Resources

MMA – Brazilian Ministry of the Environment

NUPAUB – Nucleus of Support for Research on Populations in Brazilian Wetlands

PD/A - Program for Demonstrative Projects – Type A [Fund from MMA]

PED - Program for Projects of Decentralized Execution [Fund from MMA]

SAA – São Paulo State Secretariat of Agriculture and Supply

SMA – São Paulo State Secretariat of the Environment

SIF – Federal Inspection Service [key institution for oyster consumption certification]

CHAPTER 1
INTRODUCTION

The Context and Statement of the Problem

Our planet is losing biodiversity at an alarming rate. Anthropogenic pressures are accelerating extinction rates by one to ten thousand times greater than natural extinction rates (Koziell 2001). Accelerating extinction rates are partly attributed to socio-economic pressures as countries strive for economic development. Compounded with a growing global economy and the potential alteration of ecosystems, biodiversity conservation is facing an uncertain future.

Biodiversity loss threatens the sustainability of our world since biodiversity maintains ecosystem health and confers ecosystem resilience to change (e.g. climate, pests, and disease) (Holling 2001). When change occurs, socio-economic flexibility and security can be maintained with access to a rich biodiversity. The full potential of biological resources has not been thoroughly investigated; potentially invaluable species may be lost forever without conservation efforts.

Because natural systems are complex, non-linear, and poorly understood (Holling and Meffe 1996), conservation efforts need to account for such complexity and uncertainty. Natural systems will never be perfectly understood since controlled and replicated experiments are impossible to perform on large-scale systems and large natural variations present numerous confounding variables (Ludwig et al. 1993). Moreover, conservation does not imply stasis; conservation must maintain the diversity of the ever-evolving variety of life on Earth (Knapp 2003). Consequently, a very high level of uncertainty and complexity in natural systems makes managing for the conservation of biodiversity difficult (Ludwig et al. 1993).

However, our attention to only complex natural systems is not adequate for conservation goals; social contexts and elements are equally or often more important in such efforts. For example, conservation dilemmas cannot be separated from problems of equity and governance. Ethics and social justice are needed to solve environmental problems (Ludwig 2001; Costanza 1996). Environmental degradation is generally viewed as the direct consequence of increasing human population and economic development. However, over consumption, use of inappropriate technologies, unequal access to resources and poverty are the underlying forces of the environmental crisis (Landa 1997; Folke et al. 1996).

Disciplinary approaches to environmental problems and crises have serious shortcomings because of their narrow, reductionist focus and coverage (Costanza 1996). To adequately address the environmental crisis, research endeavours must adopt a multidisciplinary, systems approach (Berkes et al. 1998; Gunderson and Holling 2002). A systems approach considers how each part interacts with every other part. Ignoring important interactions by simply understanding how each part functions independently may lead to false conclusions on natural and social systems (Dobson et al. 1997; Capra 1996). An interdisciplinary approach linking both natural and social systems is crucial.

In order to link social systems with natural systems, application of resilience thinking has proved to be very significant (Berkes and Folke, 1998). As defined by the Resilience Alliance (2002), resilience is the ability of a system to absorb perturbations and to build capacity for self-organization, learning, and adaptation. Learning and adaptation are possible through adaptive management, which is crucial for maintaining sustainability. Sustainability is attainable with adaptive management, since modifications

in resource use are made based on monitoring socio-economic and ecological systems responses to management decisions. Thus, management is treated like an experiment and refinements may be made to account for changing ecological conditions and socio-economic demands (Walters 1986).

Consequently, institutions that are closer to the resource, flexible, diverse, and open to feedback from the environment are more likely to achieve sustainable natural resource management (Berkes 1999). Natural resource management cannot be done only at the local or national level. There is a need for a diversity of institutional scales including community, municipal, state, national, and international levels (Brown and Rosendo 2000). Natural resource management is a cross-scale issue with larger scale institutions hindering or supporting smaller scale institutions through various mechanisms (Berkes 2002). If the management is too centralized, there is a delay or no feedback about the resource base (Berkes 2002). However, if the management is too decentralized, feedback between user groups of different resources or of adjacent areas may be lost (Berkes 2002). Thus, successful cross-scale linkages at various hierarchical levels of ecological, economic, and social systems are necessary to achieve environmental and socio-economic justice across different scales (Ludwig 2001, Holling 2001).

Moreover, new institutions need to evolve or be developed to achieve justice across ecological and socio-economic scales and thereby manage the simultaneous task of achieving both the conservation of biodiversity and alleviation of poverty. An examination of institutions that have already achieved success in the reconciliation of development goals with conservation goals may provide valuable lessons on how

successful institutions develop and are aided or hindered by other institutions. Research on the adaptive and coping capacity of successful institutions may also provide valuable lessons, and thus help contribute to achieving and perpetuating sustainability.

Reconciliation of Development Goals with Conservation Goals

A reconciliation of development goals with conservation goals is required to achieve sustainability. The compatibility of development goals with conservation goals is currently being debated in the conservation literature (Hackel 1999; Redford and Sanderson 2000). Development and biodiversity conservation are commonly thought of as being antagonistic (Clark 1995). Rapid human population growth has led to the destruction of "pristine" habitats through urban sprawl and the destruction of grasslands and forests for agriculture (Dobson et al. 1997). Thus to conserve biodiversity, it would appear that we must protect it from use by humans.

Humans are an active part of this biosphere and our traditional practices have shaped the evolution of biodiversity for numerous years (Striplen and DeWeerdt 2002). Some researchers (i.e. Diegues 1998) consider "untouched" wilderness to be a myth and that conservation through exclusion of people is not always a suitable solution for the conservation of biodiversity.

Conservation through exclusion is not very effective in Brazil (Diegues 1998) and elsewhere (Brown 2002). Most habitats are already populated with people that need to earn a living so it is difficult to obtain local support for conservation through exclusion. This lack of local support makes enforcement of exclusion difficult and requires costly measures for monitoring and enforcement (Diegues 2002). The displaced individuals are

left with limited options for survival and are often forced to move to crowded slums in larger cities.

Maintaining people on the land may actually help to conserve biodiversity since it is assumed that they have a genuine concern for the land (Diegues 1998). Rural populations in Brazil may help prevent unscrupulous logging and mining industries from taking over, claiming short-term benefits and leaving long-term ecological degradation (Diegues 1999). Thus the most valuable instrument for conservation is not the park fence in isolation but policies and reforms that also achieve environmental and social justice (Folke et al. 1996).

There has been a paradigm shift in biodiversity conservation from exclusive protected areas towards people-centered conservation, known as ‘new conservation’ (Brown 2002). New conservation adopts an understanding of the dynamics and disequilibria of ecological systems and rejects the myth of wilderness and pristine areas, and includes integrated conservation and development projects, extractive reserves, wildlife utilization, and community-based natural resource management (Brown 2002).

Community-based natural resource management (CBNRM) involves (1) incorporating local residents into land-use policy and management decisions, (2) giving people ownership of biological resources, and (3) returning economic benefits of conservation to local people (Hackel 1999). However, it is difficult to integrate conservation with economic needs. Traditional options conducive for conservation may not be flexible enough for demographic and economic developments and changing values. Furthermore, community aspirations may differ as a result of breakdown of traditional authority, commercialization, modernity, social change and new urban

aspirations, immigration of different people and/or intrusion of unsuitable state policies (Leach et al. 1999). Impoverished communities may overlook conservation goals in pursuit of short-term economic gain (Hackel 1999). Intense demand for short-term economic gain constrains sustainable alternatives, which are more beneficial in the long-term but less lucrative for immediate needs. Furthermore, Hardin's (1968) "Tragedy of the Commons" predicts that most individuals usually selfishly seek short-term gains, resulting in the inevitable decimation of common property resources from overexploitation.

Nevertheless, evidence from recent work suggests that organized communities, with access to favourable resource networks, have succeeded in managing common property resources, ensuring the sustainability of the resource and the conservation of biodiversity (Timmer and Juma 2005). A number of initiatives have been taken recently in this regard in Brazil and other developing countries. The Cananéia Oyster Producers Cooperative (Cooperostra), located just south of the Tropic of Capricorn on the coast of São Paulo State, Brazil (Schaeffer-Novelli et al.1990), is one of such initiative. The Cooperostra seems to have succeeded in ensuring the sustainability of a common property resource, the mangrove oyster (*Crassostrea spp.*), while conserving the region's highly biodiverse mangrove estuary. Cooperostra works within the Mandira Extractive Reserve and was founded in 1996 by the Forest Foundation of São Paulo. Cooperostra members are primarily *quilomobos* (descendents of freed slaves) with little financial resources. Yet even with such constraints, the community has achieved remarkable success, particularly in the conservation of mangrove ecosystems.

Mangrove conservation is important for several reasons. Mangroves serve as important nesting and rookery sites for various species of birds (Olmos and Silva, 2002). Interlocking mangrove roots help protect the shoreline from erosion (Kairo et al. 2001). Dense mangrove roots also provide shelter for small organisms and are known to serve as nurseries for various organisms, some of which are important renewable resources (Blankensteyn et al. 1997; Glaser and Grasso, 1998). Mangroves are also the basis for a complex marine food chain, thereby providing food for fish stocks in the open ocean (Schwamborn et al. 1999, Medeiros et al. 1999). The livelihoods of people are thus linked to the numerous resources that mangroves sustain.

Mangrove conservation has contributed to the success of Cooperostra since dense roots provide abundant surface area for oyster habitat. Cooperostra has also created artificial habitat, increasing yields and expanding the harvesting season, with minimal environmental impact. In addition to maintaining high sustainable yields, Cooperostra has also tripled the value of the oysters by constructing a purification station to cleanse harvested oysters and thereby command higher prices on the market. For its significant and unique contributions to the reconciliation of conservation and development goals, Cooperostra has received international recognition. Cooperostra is one of the twenty-seven projects worldwide, short-listed for the Equator Initiative (EI) award (Timmer and Juma 2005). The EI award is granted by the United Nations Development Programme (UNDP) for significant achievement in community initiated biodiversity conservation and poverty reduction in the tropics (UNDP 2002).

As population and consumption demands increase towards the planet's environmental carrying capacity, there is limited time to resolve socio-economic

inequalities that are linked with the present degradation of resources and conservation (Gómez-Pompa and Kaus 1999). With a limited time frame to learn by trial and error, studies of success stories, such as the Cananéia Oyster Producers' Cooperative, are important since such knowledge is vital to speed up adaptive management (Holling et al. 1998) and thus help conserve biodiversity and achieve sustainability.

The principal goal of this research was to determine **what lessons may be learned from Cooperostra on the simultaneous reconciliation of development and conservation**. During the study, local input was used to further refine objectives and help increase the relevance of study results for Cooperostra.

CHAPTER 2
OBJECTIVES, STUDY AREA AND RESEARCH METHODOLOGY

Introduction

This chapter presents the specific objectives of the study. An explanation for site selection is also provided, along with a brief description of the study area. The last part of the chapter describes the conceptual and theoretical framework of the research methodology, specific research questions, and detailed research methods.

Objectives

I. What can be learned from the Cooperostra in terms of self-organization?

The research focused on the precipitation of the Cooperostra; how the Cooperostra was funded and organized; the role of leadership in the evolution of the project; capacity development; identification of any obstacles to self-organization and how the obstacles were overcome.

II. What can be learned from the Cooperostra in terms of cross-scale institutional linkages?

The study identified and determined the extent of involvement of the Cooperostra with various levels of government, NGO's, and development agencies. Key institutional linkages that facilitated, or hindered, the development and security of the Cooperostra were addressed.

III. How successful has Cooperostra been economically and at livelihood improvement?

Cooperostra's total production and total sales were assessed along with challenges to improving sales and management. The distribution of salaries and benefits among Cooperostra members were also explored quantitatively and qualitatively.

IV. How has Cooperostra contributed to conservation efforts?

Oyster harvest yields and the use of biodiversity indicators were explored to assess Cooperostra's impact and conservation achievements. The research also focused on the development of the Mandira Extractive Reserve. Barriers to current and future conservation endeavours were examined.

Site Selection

The Cananéia Oyster Producers' Cooperative (Cooperostra) was studied instead of other Brazilian projects short-listed or awarded the Equator Prize for several reasons. Firstly, conservation of the Atlantic Forest is often overshadowed by the plight of the Amazon, however, the Atlantic Forest is much more threatened than the Amazon. Only 7% of the initial Atlantic Forest remains today and it contains the highest concentration of threatened species in Brazil (Brandon et al. 2005). Secondly, the proximity of the Federal University of São Paulo and Campinas University, which are some of the most prestigious universities in the country, were thought to provide better resources than universities in the Amazonian region. Access to the libraries and research conducted at these universities in São Paulo state, would facilitate a thorough investigation of

Cooperostra and Cananéia. Furthermore, travel and infrastructure in Cananéia was also considered to likely be better developed than in Amazonian region, thus facilitating transportation to and from study sites.

Study Area

The present study concerns the reconciliation of conservation and development goals in the Cananéia lagoon estuarine system of southeast Brazil. The Cananéia lagoon estuarine system is located on the coast of São Paulo, Brazil at 25^{o}S (Fig 2.1). The population of the region is approximately 13,000. It is the poorest region of Sao Paulo state, which is the richest state in Brazil.

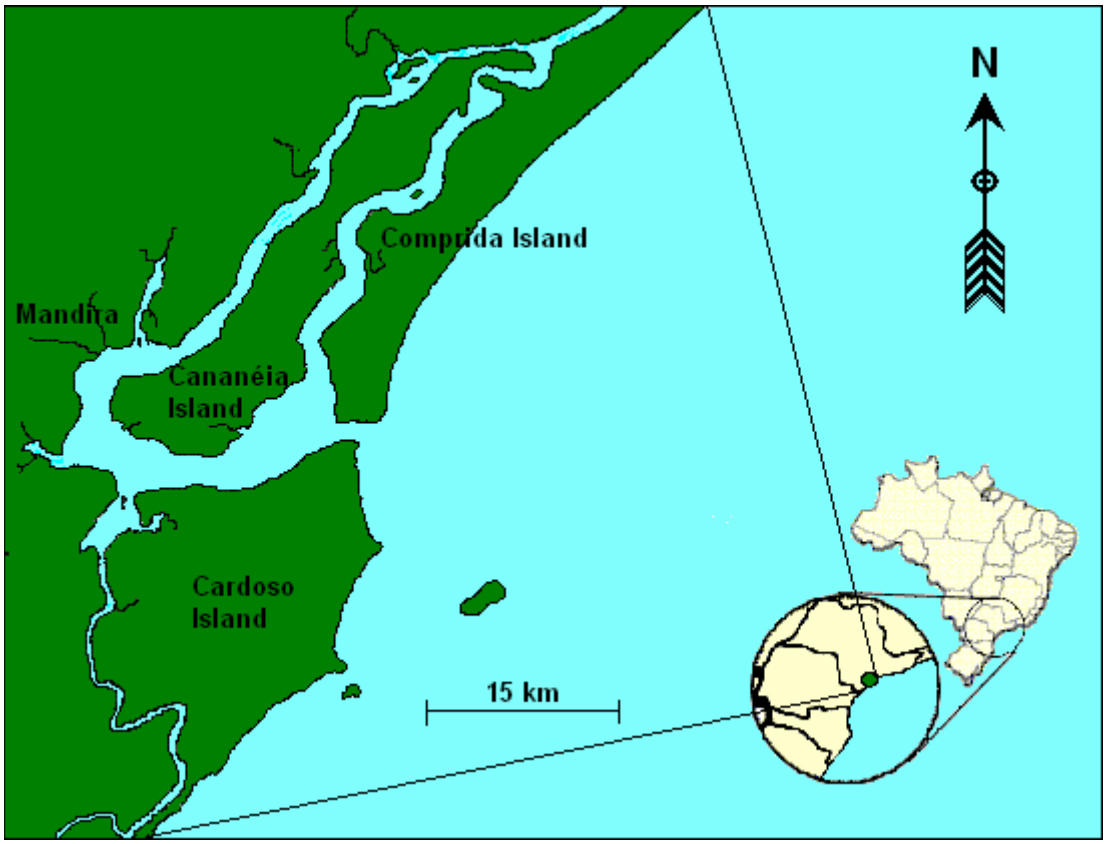


Figure 2.1 Map of Cananéia and its location in southeast Brazil.

The region is subtropical and has a mean annual temperature of 21.4^{o}C (Schaeffer-Novelli and Cintrón-Molero, 1990). Mean annual rainfall is 2,269.6 mm. February and March are the wettest months, with 312.5 mm and 316.3 mm respectively and August is generally the driest month with an average precipitation of 82.9 mm (Schaeffer-Novelli and Cintrón-Molero, 1990).

The total intertidal area covered by the entire Cananéia Lagoon estuarine system is about 90km^2. Mangroves dominate this intertidal region in Cananéia (Schaeffer-Novelli and Cintrón-Molero, 1990). Red mangrove (*Rhizophora mangle*) is located along the fringes and backed by basins dominated by white mangrove (*Languncularia racmosa*). Black mangroves (*Avicennia schaueriana*) also occur interspersed in the basin forests. *Spartina* grass also colonizes narrow fringes and sand bars but is eventually displaced by mangroves.

Research Methodology

Conceptual and Theoretical Framework

The research followed a conceptual framework based on complexity theory and systems thinking (Holling 2001), resilience, and adaptive management (Walters 1986) and political ecology (Young 1999). I obtained data to answer objectives through various Rapid Rural Appraisal (RRA) (Pido et al. 1996) methods using an interactive adaptive approach (Nelson 1991). An interactive adaptive approach allowed me to modify my methods to maximize efficiency and ensure validity of the results, based on knowledge obtained earlier in the study. The interactive approach also enabled me to make slight modifications to focus the study to better suit the needs of Cooperostra members. In line

with RRA methods, information was obtained from various sources since such iteration ensured the validity of results and conclusions.

I conducted this study as part of a team with fellow researchers at the University of Manitoba, which investigated select Equator Initiative cases, primarily from 2002 and 2004 Equator Prize winners. Our team's research was conducted under the guidance of Fikret Berkes and Cristiana Seixas. Berkes and Seixas developed core questions for the Equator Initiative team to examine self-organization and cross-scale institutional linkages across cases. Consequently, the following specific research questions for Objective I and II were developed by Berkes and Seixas but adapted for my use.

Specific Research Questions

Objective I: Self-Organization

- What precipitated Cooperostra? Was it:
  - (1) mandated by government ("planning-led);
  - (2) the outcome of a visionary leader ("vision-led");
  - (3) and/or initiated by citizen movements and inter-university networks ("learning-led") (Westley 1995)?
- What was the role of leadership in the evolution of the project?
- How was the project funded and organized?
- How was capacity developed?
- What were the main obstacles to self-organization? What facilitated overcoming these obstacles?

Objective II: Cross-scale Institutional Linkages

- What are all the organizations connected to the Cooperostra?
- How is the Cooperostra connected to the various levels of government, NGOs, and development agencies through institutional cross-scale linkages?
- What were the roles of horizontal (across space) and vertical (across hierarchical levels of organization) institutional linkages?
- What horizontal and vertical linkages facilitated, or hindered, the development and security of Cooperostra?

Objective III: Economics of Cooperostra and Livelihood Impact

- What have been Cooperostra's annual sales since its inception in 1997?
- What are the main barriers to increasing sales?
- What is the distribution of salaries and benefits among Cooperostra members?
- How is Cooperostra managed?
- Are there any recurring problems with oyster quality?
- What are the non-material improvements brought upon by Cooperostra?

Objective IV: Cooperostra's Conservation Impact

- Have biodiversity indicators been used to assess Cooperostra's conservation impact?
- How has Cooperostra reduced conservation threats?
- How was the extractive reserve developed and how is it managed?
- What proportion of the total oyster stock and harvest does Cooperostra currently consume?
- What is necessary to complete the full cycle of oyster aquaculture (i.e. capture and raise oyster seed to market size)? Can aquaculture methods be improved with existing technology and knowledge of oyster biology?

Field Research

Field research was conducted from September 2003 to February 2004, and April 2005 to May 2005.

Background Research

I visited the Nucleus of Support for Research on Populations in Humid Areas in Brazil (NUPAUB; *Núcleo de Apoio à Pesquisa Sobre Populações em Áreas Umidas no Brasil*) for background and program information on Cooperostra. Technical reports, journal articles, graduate theses, and other documents on Cooperostra and Cananéia were accessed from the University of São Paulo (USP) library. I also accessed government monographs, reports, and articles pertaining to Cooperostra and the Cananéia region from the following state government organizations: the Forest Foundation of São Paulo (*Fundação Florestal de São Paulo*), Fisheries Institute of São Paulo (*Instituto de Pesca de São Paulo*), and Environmental Health Technology Company (*Companhia de Tecnologia de Saneamento Ambiental* - CETESB). Information from literature I acquired in Brazil, helped answer research objectives. To strengthen the authenticity and widen the scope of the study database, I also formed a partnership for information exchange with graduate research being conducted at the University of São Paulo.

Documents obtained in Brazil helped me identify key organizations and people involved with Cooperostra. Pre-established contacts with a professor at NUPAUB-USP and a technician at the Forest Foundation, also helped me identify other key personnel who have worked or were currently working directly with Cooperostra.

Interviews

I interviewed representatives from key organizations involved with Cooperostra (i.e. through funding, administrative, or technical support) as determined from the literature review. After I obtained oral consent, structured and semi-structured interviews were conducted in person and in Portuguese, to determine the extent of the organization's involvement with the Cooperostra (Appendix A). I used the interviews to verify information previously obtained from the literature. Specific questions were developed for each organization and depended on the previous information I acquired. I interviewed thirteen different key personnel. However, numerous follow up interviews were also conducted with some selected representatives. For example, I regularly interviewed representatives from the São Paulo Forest Foundation and São Paulo Fisheries Institute to monitor progress in activities and trends, verify results, and or explore more details on new findings.

I collected primary field data through semi-structured interviews with Cooperostra members (Appendix B). I interviewed twenty-eight active oyster harvesters, most of whom were registered members of the Cananéia Oyster Producers Cooperative. I realized that one survey instrument could not cover all elements of the study objectives, and numerous follow up interviews were therefore carried out with Cooperative members to obtain further information.

Attending Cooperostra Meetings

I obtained permission from Cooperostra to attend meetings. Additional data on the Cooperative structure and functions were collected by attending meetings of the

Cooperative; I attended a total of nine such meetings. In the Cooperostra meetings, a wide range of issues were covered, including implementation of an extractive reserve, an appraisal by the Brazilian Fund for Biodiversity, and an urgent need to increase profits for Cooperostra. The information I obtained from discussions and presentations during meetings was used to answer all relevant research questions. The meetings themselves were analyzed to examine Cooperostra's functioning (i.e. What proportion of members attended? Does every member have an opportunity to speak? Was the meeting well organized?). I also noted whether any educational exchange occurred at the meeting (i.e. discussion of forthcoming methods of harvesting or aquaculture). As with the entire study, code names were used to identify people to ensure confidentiality.

Understanding Oyster Aquaculture

To acquire a technical understanding of oyster aquaculture, I participated in a three-day oyster aquaculture seminar developed by the Fisheries Institute. Detailed instructions were provided for each step of the aquaculture process. Barriers and constraints to aquaculture production were also discussed. Furthermore, participant observation of the complete cycle of oyster harvesting and aquaculture operations in Cananéia helped me grasp the opportunities and constraints with oyster aquaculture and Cooperostra operations. I also visited other oyster enterprises to develop a better understanding of aquaculture operations and oyster economics. I visited one other private oyster aquaculture enterprise in Cananéia and several in Santa Catarina State, to compare and contrast operations with Cooperostra. Along with focused discussions, I conducted face-to-face interviews with the owners of these enterprises during such visits.

Field Observation and Exploration of Ideas and Findings

I also recorded informal observations since such observations provided further insights into Cooperostra's structure and function and attitudes of its cooperative members. Time was spent with Cooperostra members fishing, and chatting on diverse subjects, ranging from the ecology of the region, Brazilian music, climate in Canada, and family life in Canada. The researcher never brought up the subject of Cooperostra, however, if the cooperative member commented on Cooperostra, information was written down from memory as soon as possible. Subsequent semi-structured interviews were conducted after these informal and non-research based events, revealing greater depth, and likely honesty into function and perspectives of Cooperostra and its members.

Feedback from prominent Brazilian researchers on presentations of this research at the University of Sao Paulo (November 2003) and University of Campinas (May 2005), played important roles in developing the ideas from a Brazilian perspective, and verifying conclusions.

Additional Methods for Objective III and IV

Objective III - Economics of Cooperostra and Livelihood Impact

I obtained data on income distribution from a graduate student conducting a socio-economic evaluation of Cooperostra. She also helped provide background information on the socio-economic conditions of Cooperostra. I also obtained further information on total Cooperostra sales directly from the cooperative. Unfortunately, only some years of data were available. To account for missing years of information, I asked Cooperostra members and key personnel to estimate total Cooperostra sales since its start

in 1997 and on a monthly basis from May 2004 to May 2005. However, only two cooperative members felt comfortable providing estimates of total annual and monthly sales.

I also conducted detailed interviews with several Cooperostra members to construct detailed life histories of cooperative members. I selected interviewees to portray the range of impacts Cooperostra has had on the lives of rural inhabitants.

Objective IV – Cooperostra's Conservation Impact

I explored archival research and information obtained from key personnel to determine if biodiversity indicator benchmarks had been established in Cananéia and whether there was active monitoring of these indicators. However, the lack of benchmark data made it impossible for me to quantitatively assess Cooperostra's impact.

To help identify different species of oysters, which may be confounding oyster aquaculture attempts, I asked Cooperostra members and other oyster collectors in the region about characteristics of different types/species of oysters. One Cooperostra member who identified three types of oysters was then asked to supply six samples of each type for cytological analysis. I then sent samples to the Cell Biology Department at the University of Campinas for analysis of sperm cellular structure to help determine if the different types of oysters are distinct species.

CHAPTER 3
LITERATURE REVIEW

Conserving Mangrove and Coastal Atlantic Rainforest Biodiversity in Southeast Brazil

Introduction

This chapter presents a review of literature on biodiversity conservation in southeast Brazil. The chapter begins with a description of biodiversity, highlighting its importance for sustainability, with particular focus on the Atlantic and mangrove forest. I then discuss community-based resource management and the role of cross-scale institutions to help organize and capacitate rural inhabitants to successfully manage resources. An array of livelihood options are then examined that can provide win-win opportunities for conservation and development.

Biodiversity and Sustainability

Biodiversity is the total variety of life on our planet and can be observed at various scales, including genetic, species, and landscape levels. Genetic diversity is the variation of DNA nucleotides and the subsequent variety of amino acid combinations. Differences in genetic makeup contribute to the speciation of different taxa, hence biodiversity also includes the total variety of species. Biodiversity may also be considered at the landscape level, since differences in topography and climate, will greatly influence the evolution of different communities of interacting species. Consequently, each level of biodiversity (genetic, species, and landscape) must be addressed to help conserve biodiversity.

Our planet is losing biodiversity at an alarming rate. Anthropogenic pressures are accelerating extinction rates by one to ten thousand times greater than natural extinction rates (Koziell 2001). Accelerating extinction rates are partly attributed to socio-economic pressures as countries strive for economic development. Compounded with a growing global economy and the potential alteration of ecosystems, biodiversity conservation is facing an uncertain future.

Biodiversity loss threatens the sustainability of our world since biodiversity maintains ecosystem health and confers ecosystem resilience to change (i.e. climate, pests, and disease) (Holling 2001). When change occurs, socio-economic flexibility and security can be maintained with access to a rich biodiversity. The full potential of biological resources has not been thoroughly investigated; potentially invaluable species may be lost forever without conservation efforts.

Biodiversity conservation and development are commonly thought of as being antagonistic (Clark 1995). A reconciliation of development goals with conservation goals is required to achieve sustainability. Poverty must be alleviated to facilitate biodiversity conservation and resources from a wealth of biodiversity are needed to help alleviate poverty. Natural resource management needs to place simultaneous and equal consideration on poverty alleviation and biodiversity conservation, if sustainability is to be achieved.

Brazilian Atlantic Rainforest

Strong conservation efforts to maintain sustainability are particularly vital within the Brazilian Atlantic Forest. The Atlantic Forest has very high levels of biodiversity and

is composed of several different floristic communities, including mangrove, humid forest, and *restinga* (dune forest). The Brazilian Atlantic Forest holds the world record for the greatest diversity of woody tree species within one hectare of land with 458 species identified within one hectare of land (Pinto 2002). However, it is highly threatened since it is situated within the most populated region of Brazil, which is occupied by 70% of the Brazilian population or approximately 110 million people (Pinto 2002). Initially the Atlantic Forest spanned over 3,000km of the Brazilian coast, but urbanization, industrialization, and intensive agriculture in recent decades have completely decimated the forest to less than 8% of its initial domain (Pinto 2002) (Fig. 3.1). Strong conservation efforts are required to preserve the remaining fragments of Atlantic forest.

Threats to Mangroves

One of the most threatened forest fragments of the Atlantic Forest are mangroves since they are greatly undervalued (Aldger and Luttrel, 2000). The importance of mangroves is often not fully recognized since mangroves are viewed as wastelands and thus are prime candidates for development. As the human population continues to grow mangroves continue to be converted and or degraded by urban sprawl, pollution,

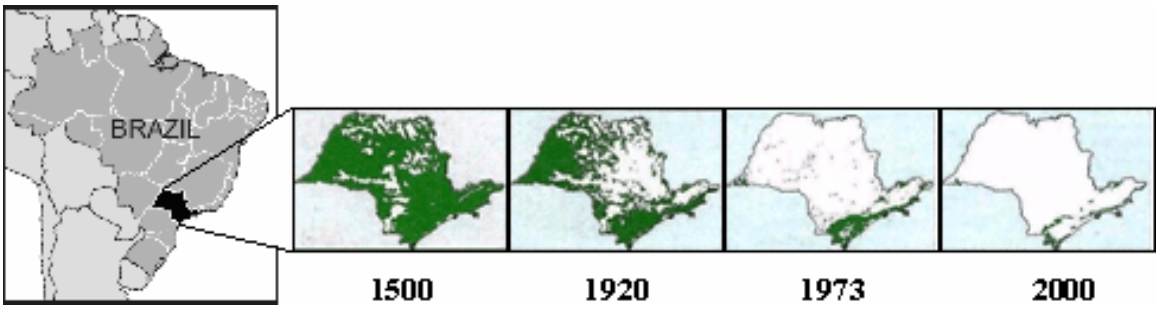


Figure 3.1 Decimation of Atlantic Forest in São Paulo State since the time of Brazil's discovery by Europeans in 1500 to the year 2000. (Adapted from Reserva da Biosfera Mata Atlântica, 2004).

infrastructure development to access beaches, and hotel/resort development (Hogarth 1999). Originally mangroves covered approximately 75% of tropical coasts and inlets, but now only occupy about 25% (Farnsworth and Ellison, 1997).

The conversion and degradation of mangroves does not internalize the costs associated with the degradation and lost productivity of the mangrove (Gammage et al. 2002). The conversion of mangroves to large-scale shrimp farms has destroyed land and water quality over vast areas (Rönnbäck 1999). The stagnant pools of water resulting from the conversion led to a population explosion in mosquitoes, resulting in increased cases of malaria in Vietnam (Macintosh 1996 *In* Rönnbäck 1999). Between 1985 and 1995 approximately 150,000 ha of shrimp farms were abandoned worldwide (Assad and Bursztyn, 2000). The viability of farming was severely hampered by widespread disease and poor water quality, resulting from pollution and excessive nutrient build-up from waste and feed.

Large-scale shrimp farms also lead to the eutrophication of the marine environment. With fewer mangroves to assimilate nutrients from run-off, coupled with excess nutrient rich wastes from large aquaculture farms, algal blooms are frequent and persistent, resulting in the subsequent decimation of neighbouring coral reefs and other marine ecosystems (Rönnbäck 1999; Moberg and Folke 1999). Consequently, the loss of mangroves for economic development will have numerous and far reaching implications for the sustainability of coastal regions. To maintain the sustainability of our planet, strong conservation efforts are crucial in mangrove ecosystems.

Importance of Mangrove Conservation

The loss of mangrove forest is especially threatening to the sustainability of the planet for various reasons. Mangroves are important for the ecological integrity of neighbouring ecosystems. In some areas, such as coastal Brazil, mangroves serve as an important extension of rainforest, buffering the forest from edge effects. Mangroves also improve the quality of water flowing into the ocean by filtering out pollutants and allowing for the sedimentation of particulates (Rönnbäck 1999). Consequently, mangroves are vital for the maintenance of water quality required by coral reefs and other marine ecosystems (Moberg and Folke 1999).

Mangroves also provide numerous other valuable functions. Interlocking mangrove roots help protect the shoreline from erosion (Kairo et al. 2001). Dense mangrove roots also provide shelter for small organisms and are known to serve as nurseries for various organisms, some of which are important renewable food resources (Blankensteyn et al. 1997; Glasser and Grasso, 1998). Mangroves are also the basis for a complex marine food chain, thereby providing food for fish stocks in the open ocean (Schwamborn et al. 1999, Medeiros et al. 1999). Furthermore, mangroves serve as important nesting and rookery sites for various species of birds (Olmos and Silva, 2002). Mangrove organisms may also yield valuable products, e.g. pharmaceutical compounds in sponges, sea anemones, and sea cucumbers (Bell and Gervis, 1999). Mangrove conservation is thus linked to the livelihoods of people dependant on the numerous resources that mangroves sustain.

Conservation Through Community Exclusion is Not a Viable Alternative

Conservation of areas by excluding use by people is a North American concept that does not work well in developing countries (Diegues 1998; Brown 2002). Socio-economic goals often take on higher priority than conservation goals (Kellert et al. 2000), thus basic needs need to be met if conservation is to be achieved. Most tropical "wilderness" regions are already occupied by people that need to earn a living. They will not be easily coerced to seek a living elsewhere, such as overcrowded slums in larger cities. This lack of local support will increase the costs for monitoring and enforcement since the local people will be persistent in continuing their livelihoods (Diegues 2002). Illegal hunting, gathering, and habitation by traditional communities are difficult to prevent (Diegues 2002). Instead of investing resources for monitoring and enforcement of exclusion, resources could be used more efficiently to help traditional communities achieve improved, sustainable livelihoods and conservation goals. However, conservation backfires may occur if increased revenues support increased destruction or degradation of protected areas, i.e. purchasing equipment that increases logging and agricultural operations (Langholz 1999). Therefore, government regulations (i.e. co-management) and investments in education are also needed to prevent such backfires from occurring. Nevertheless, conservation must consider basic needs and rights of local people; command and control barrier conservation is not enough (Folke et al. 1996).

Furthermore, the local community can provide numerous benefits for the conservation of biodiversity. Knowledge of the local community provides important feedback, thereby ensuring that management can respond and adapt quickly to changes. This is particularly important in developing countries, where ecological studies have not

been thoroughly conducted due to a lack of resources. Moreover, it is also assumed that the traditional community has a genuine concern for the land they occupy (Diegues 1998). Consequently, the traditional community may help prevent unscrupulous logging and mining industries from taking over, claiming short-term benefits and leaving long-term ecological degradation (Diegues 1999). Thus, maintaining traditional people on the land can greatly aid efforts to conserve biodiversity (Diegues 1998).

The establishment of protected areas is a powerful political weapon for the dominant elite of many developing countries, who continue to obtain external financing for large projects with serious ecosystem and economic impacts (Diegues 2002). However, the most valuable instrument for conservation is not the park fence in isolation but policies and reforms that also achieve environmental and social justice (Folke et al. 1996). There has been a recent paradigm shift in biodiversity conservation from exclusive protected areas towards people centered conservation, known as new conservation which includes: integrated conservation and development projects, community-based natural resource management, extractive reserves and wildlife utilization (Brown 2002). This new conservation now adopts an understanding of the dynamics and disequilibria of ecological systems and rejects the myth of wilderness and pristine areas (Brown 2002).

Community-Based Natural Resource Management

Community-based natural resource management (CBNRM) involves (1) incorporating local residents into land-use policy and management decisions, (2) giving people ownership of biological resources, and (3) returning economic benefits for conservation to local people (Hackel 1999). Thus CBNRM includes environmental

education, local level involvement in management, regulated access to protected lands, compensation for conservation and activities such as hunting and tourism (Hackel 1999).

CBNRM has been advocated as a model for the conservation of common property resources. Common property resources (CPR) are resources from which it is difficult to exclude use and consumption of which reduces the availability of the resource for others (Ostrom et al. 1999). Successful management of CPR is vital in mangroves since mangroves contain numerous resources, such as fish stocks, crabs, wild game, and wood that are difficult to regulate due to the inaccessibility of mangrove regions. However, successful management of CPR is difficult since Hardin's (1968) "Tragedy of the Commons" predicts that most individuals will selfishly seek short-term gains, resulting in the inevitable decimation of CPR from overexploitation. In order to prevent such devastating outcomes in mangroves, diverse institutions are necessary since the use of CPR is highly dependent on various interrelated factors, such as the physical, economic, and social contexts under which resource extraction is taking place.

Nevertheless, it is difficult to integrate conservation with people's economic needs. Traditional options conducive for conservation are not flexible enough for demographic and economic developments and changing values (Leach et al. 1999). Some traditional communities may want change from traditional lifestyles and impoverished communities may overlook conservation goals in pursuit of short-term economic gain (Hackel 1999). For example, the Masai would like to convert their traditional range into more lucrative agricultural land (Norton-Griffiths 1995 *In* Hackel 1999). Intense demand for short-term economic gain constrains sustainable alternatives, which are more beneficial in the long-term but less lucrative for immediate needs. Furthermore,

communities' aspirations may differ as a result of breakdown of traditional authority, commercialization, modernity, social change and new urban aspirations, immigration of different people and/or intrusion of unsuitable state policies (Leach et al. 1999). However, there are several principles that may be followed to help achieve successful natural resource management in mangroves (Ostrom 1992).

Self-Organization and Cross-scale Institutional Linkages for Successful Management of Mangrove CPR

Resource users must become organized and undertake capacity building with the assistance of diverse cross-scale institutions to conserve mangrove CPR and help secure livelihoods. Access to CPR must be restricted and there needs to be incentives and regulations to prevent overuse (Ostrom et al. 1999). Resource users need to be clearly identified and granted property rights (Ostrom 1992). Secure property rights are needed to prevent open access conditions and ensuing degradation of common property resources (Smith and Berkes, 1993). If resource rights are insecure, individuals will seek rapid short-term return on the resource while they can, foregoing long-term considerations due to the high levels of consumption and powerlessness to regulate resource use by others. For instance, the absence of property rights and sufficient level of organization contributed to the unsustainable use of mangroves in El Salvador by failing to guarantee incentives for conservation and omitting to enforce compensation and restoration for ecosystem degradation (Gammage et al. 2002). However, once secure property rights have been established, resource users may invest in the long-term maintenance of the CPR since they are expected to reap the benefits of conservation. For example,

communal property rights of mangrove forest in Mankote, St. Lucia led the local resource users to change from indiscriminate cutting to more careful cutting with conservation in mind for the long-term (Smith and Berkes, 1993).

However, difficulties may arise from the absence of an authority structure to define resource users and exclude non-members (Johnson 2001). Particularly as populations increase there may be a need to deal with excessive users relying on the dwindling resource (Ostrom et al. 1999). An authority structure is also needed to deal with shifts in resource use patterns; some communities may develop an interest when a previously untapped resource in the area becomes highly profitable (Ostrom et al. 1999). Transparency is needed so as not to favour one group of resource users over the other (Berkes et al. 1998; Gammage et al. 2002) since resource users will differ depending on age, caste, religion, wealth etc. (Johnson 2001). A cross-scale authority structure is vital to assist in the regulation and enforcement of CPR (Barret et al. 2001).

The authority structure needs to incorporate both local and governmental management. Such a partnership between the local community and government is referred to as co-management and has proven conducive for successful CPR management (Gammage et al. 2002). Co-management ensures that feedback about the resource is readily available from the local users and also helps address any possible conflicts between resource users with other interests. The government may also help facilitate assembly of the resource users, support research to identify resource problems and solutions, along with enforcing agreements between users (Diegues 2001).[1] It is in the best interest of the government to recognize/legitimize locally developed rules since the

[1] Governments may also hinder the effective management of CPRs by defending overuse (i.e. subsidizing returns even when returns are not economically nor possibly ecologically sustainable) and by preventing regulation (not preventing overuse to capitalize as much as possible in the short-term) (Ostrum et al. 1999).

community is in a better position to enforce their own rules themselves (Berkes 2002; Gammage et al. 2002; Diegues 2000). Moreover, in most developing countries, two centuries of colonization followed by state-run development policy has yielded great resistance to externally imposed institutions (Ostrom et al. 1999). Consequently successful CPR management is facilitated with the strengthening of local level organization and management by state recognition, capacity building, and local institution building (Berkes 2002). Robust, well-organized institutions are needed for successful CPR management in mangroves. Weak institutions in mangrove regions of El Salvador have resulted in common property regimes degenerating into *de facto* open-access systems (Gammage et al. 2002). The co-management partnership and cross-scale institutional linkages between the knowledge of local resource users and the power of the central government are vital to help ensure the sustainability of mangrove CPR.

Diverse cross-scale institutional linkages are also needed to harness knowledge from both local and scientific sources to address complexity and uncertainty for development and conservation interventions. The utility of solely local knowledge may be limited since it was developed under earlier environmental conditions and does not control for externalities that arise from global demands, free market policies, and local demands of a growing population (Gómez-Pompa and Kaus 1999; Williams 2002). Nevertheless, local knowledge provides detailed site-specific information, which can lead to failures if overlooked (Drew 2005; Carlberg 2005; Davis and Wagner 2003). The use of solely external scientific knowledge for development interventions is also inappropriate since local needs are not adequately understood and incorporated, thereby impeding the successful adoption of the intervention (Lado 1998; Clement et al. 2004;

Cramb and Culasero 2003). Incorporating local knowledge empowers local communities to self-organize and pursue their own goals and destiny, and thereby commit to conservation and development goals (Lado 1998; Drew 2005). The success of interventions hence depends on the use of knowledge from both external and local sources.

However, the mere dissemenation of information between sources is not enough (Carlberg 2005). Fusion knowledge, developed by a mutual exchange of external scientific and local experiential knowledge, would help adaptation by creating new opportunities in a constantly changing world to develop win-win solutions for conservation and development (Brown 2003; Schusler et al. 2003; Campbell 1998; Agrawal and Gibson 1999).

There is no single solution for the complex issue of rural poverty and mangrove conservation in Latin America (Richards et al. 2003). Conservation and development endeavours are often considered antagonistic, i.e. for conservation to prevail development must be limited or in other words, development leads to the destruction of conserved areas (See bottom line in Fig 3.2). However, this antagonism is often the result of inefficient use of poorly distributed resources. Opportunities need to be embraced that enable win-win situations, which significantly reduce the magnitude of compromise between conservation and development goals (Fig. 3.2).

The value of goods and services conservation needs to be enhanced with diverse institutional interventions, such as, processing, certification, education, and elimination of middlemen (Diegues 2000). These interventions must ensure that local governments and communities must reap the benefits of conservation. Conservation is more likely if

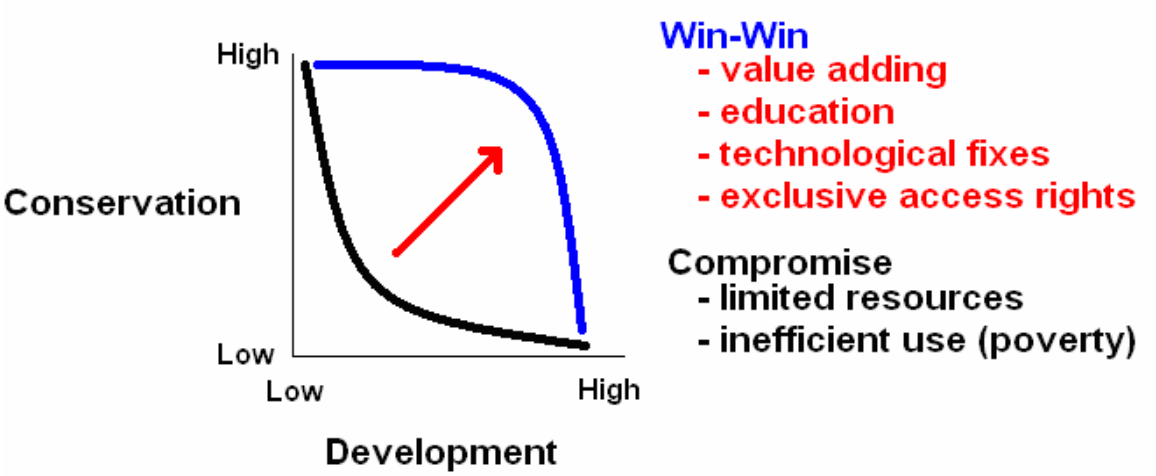


Figure 3.2 Graph depicting a win-win curve to simultaneously achieve conservation and development goals. The bottom curve represents an antagonistic view of conservation and development. The top curve represents a win-win view that may be developed through value adding, education, technological fixes, and exclusive access rights (Cochrane 2004).

opportunity costs (i.e. forgone opportunities) and direct costs (i.e. infrastructure, education, monitoring, administration and staff) are less than the value of conservation (Gössling 1999). Consequently, diverse institutions are necessary to help capacitate and organize local communities so they may obtain maximal value for their livelihoods and conservation efforts.

Livelihoods for Mangrove Biodiversity Conservation and Poverty Alleviation

Diverse livelihood options are necessary to maintain flexibility in the face of socio-economic and ecological instability (Francis et al. 2002). Thus, to achieve sustainability, it is necessary to consider various livelihood options that contribute to economic development with negligible impact on ecological integrity.

Small-Scale Aquaculture

Aquaculture has great potential to improve livelihoods without compromising ecological integrity. Emphasis on industrial-scale culture of high valued carnivorous

species for export markets has impeded the potential of smaller-scale coastal aquaculture to improve income and protein supply (Rönnback et al. 2002). The feeding of carnivorous species is not efficient since 2-5kg of wild fish is needed to yield 1kg of aquacultured fish (Rönnback et al. 2002). Consequently, aquaculture of carnivorous species may still result in the depletion of fish stocks worldwide. However, pressure on global fish supplies may be reduced with aquaculture of herbivorous fish, such as milkfish and rabbit fish, which render greater yields without environmentally and economically costly inputs (Rönnbäck et al. 2002). Income and protein supply may be increased by culturing species low on the food chain which require inexpensive feed (i.e. filter feeders, such as oysters and sea cucumbers).

The efficiency of aquaculture systems may also be increased through the development of integrated farming systems (Rönnbäck et al. 2002). Integrated farming systems incorporate various species to increase resource use efficiency and produce less waste. For example, a commercial integrated farming system used for abalone in South Africa uses nutrient-rich outlet water from the abalone tanks to grow seaweeds. The seaweeds are then fed to the abalone, reducing the cost of feed and the amount of waste emitted into the environment (Rönnback et al. 2002).

Cheap and low-impact aquaculture systems have been used in mangroves in Asia: Chinese *gei wai* (Hogarth 1999), Indian *pokali* (Rönnbäck et al. 2002), and Javanese *tampak-suri* ponds (Vannucci 1998). These small-scale systems exclude predators and facilitate shrimp harvest and fish capture with minimal environmental degradation. Negligible environmental impact is also incurred by floating cages used in the aquaculture of crabs and mollusks (Diegues 2001). The use of these systems over

centuries attests to their sustainability. Yields from such systems are lower than conventional aquaculture operations created in mangrove regions, but the yields are sustainable and the surrounding ecological integrity is not drastically compromised.

In addition to traditional aquaculture products, aquaculture of other marine fauna and flora may provide a valuable source of sustainable income for coastal regions. Seaweed aquaculture can provide a source of revenue from valuable compounds in seaweeds used in food agents, cosmetics, and pharmaceuticals (Rönnback et al. 2002). Aquaculture of organisms for the marine aquarium trade, such as *Turbo* snails and corals may also yield high profits (Bell and Gervis 1999). Valuable industries have already been developed for pearl oysters, microalgae *Spirulina*, milkfish, macroalgae *Euchema*, abalone, and sponges (Bell and Gervis 1999). Sea cucumbers are a very profitable and suitable aquaculture product. Sea cucumbers are very easy to cultivate and harvest since they are filter feeders and very slow moving. Sea cucumbers are a high value food fare in Asian markets (Bell and Gervis 1999).[2] Some species of sea cucumbers also have pharmaceutical value (Bell and Gervis 1999). Consequently, there are a diverse number of aquaculture species that may be sustainably reared to improve livelihoods in coastal regions. Nevertheless, benefits of capitalization on new market opportunities through diversification need to be weighed against increasing efficiency of aquaculture operations (Bell and Gervis 1999).

However, a diversity of species is also important to maintain sustainability and resiliency in the face of socio-economic or ecological uncertainty. Concentrating on one species may be risky since maintaining a large population of organisms at high densities

[2] Brazil has the largest population of Japanese people outside of Japan along with large populations of Chinese, Vietnamese, and other Asian ethnicities, thus, aquaculture of sea cucumbers Brazil may prove very profitable due to the proximity of local buyers/markets.

in aquaculture operations facilitates the transmission of biological plagues, such as viruses and pests (Rönnbäck et al. 2002). In addition to dealing with ecological uncertainty, a wide variety of organisms would provide greater economic stability in case the value of one species drops rapidly. Maintaining socio-economic and ecological sustainability through the aquaculture of a diverse array of aquaculture organisms should only be attempted using indigenous species. Not only are indigenous species better suited to the local conditions to which they have evolved, but the accidental escape of indigenous species would have much less impact on than the escape of exotic species.

Nevertheless, even the escape of a large number of indigenous species may still have detrimental effects on local biodiversity. The escaped organisms may over consume their food sources (i.e. zooplankton, small fish) thereby decimating the food source for the wild populations as well as any other species which preyed on the extirpated food source. However, escaped filter feeders, such as sea-cucumbers and bivalves, would likely negligibly decrease their phytoplankton and detritus food source since the primary productivity of mangroves is very high (Hogarth 1999). However, escaped filter-feeders may also have trophic-scale cascade effects by providing an abundant and easily accessible food source for predacious species, which may lead to a high concentration of predators within the area and possibly a population boom. Subsequent high densities of predators may then overconsume and decimate the wild stocks of filter feeders along with populations of other prey species. Such detrimental effects may be greatly minimized by maintaining aquaculture operations at a small scale, thereby decreasing the probability that the quantity of escaped individuals will be sufficient to have cascade effects on the trophic structure of the ecosystem.

Extractivism

Extractivism in mangrove and neighbouring forests may also provide additional sources of revenue and subsistence for rural, coastal communities with minimal impact on ecological integrity. Gathering food, such as fruits and honey, along with hunting and fishing serve as important sources of sustenance for traditional communities in southeast Brazil (Begossi et al. 2000; Diegues 2001). In addition to sustenance, other compounds may be collected and sold for extra sources of revenue such as medicinal compounds, ornamental flora (i.e. orchids and moss), palm fibers, and dyes (Begossi et al. 2000). Wood may also selectively be harvested (for construction, art, and firewood) using a rotational method (cut every 25-40 years) with minimal impact on overall forest structure (Diegues 2001). Extrativism of diverse number of species will help decrease pressure on any one species, for example over 115 species of plants are utilized by the Mandira community in south-east Brazil (Moreira 2001). Government supervision is necessary to ensure that the local communities are not receiving unjust compensation from pharmaceutical firms, and other organizations, seeking valuable compounds and knowledge (Clark 1995). Extractivism in Brazil is currently supervised and regulated by the Brazilian Environmental and Natural Resources Institute (IBAMA: *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*) and municipal governments (Begossi et. al 2000).

Small-scale Agriculture

Small-scale agriculture, in upland areas adjacent to mangroves, is another activity that may provide sustenance and revenue for coastal, rural communities. Experiments

have been conducted with different agricultural methods to identify practices that minimize biodiversity loss. Under-story agriculture has successfully yielded cash crops, such as cacao and palmito (*Euterpe edulis*) with limited impact on forest canopy species (Matos and Bovi, 2002). However, complete forest stand regeneration has been reported to be slower in cacao and palm orchards than in abandoned pastures (Fernandes and Sandford, 1995) and abandoned pastures recover stand structure slower than traditional slash and burn plots (Kammesheidt 2002). Thus, traditional slash and burn, shifting agriculture may have the least impact on biodiversity than understory agriculture and conversion of land for pastures.

In fact, shifting agriculture is thought to have contributed to the evolution and maintenance of diversity in Central and South American rainforests (Diegues 2000). The small-scale temporal and spatial heterogeneity imposed by human land use in the rainforest may contribute to enhancing biodiversity. Balée (2003) compared tree species area curves within $100m^2$ plots of disturbed and primary forest and did not discover a significant difference between the curves. Thus, both types of forest had similar quantity and frequency of tree species diversity. Nevertheless, different tree species were observed in each plot, thus human activity contributed to enhancing overall biodiversity of both plots. Begossi and others (2000) feel that shifting agriculture should not be forbidden or excluded from the management of biodiversity in Brazilian rainforests.

Traditional agriculture systems have also proven to be very productive. Crop yields obtained by the Amazonian Kayapó were three times higher than those obtained by small-holder colonists and landholders and produced 176 times more output in weight per hectare than beef cattle ranches (Browder 1989). Kayapó rely exclusively on natural and

locally available inputs. Kayapó also use mixed-cropping or patch inter-cropping to help overcome soil nutrient depletion, weed competition, and plant disease (Browder 1989). Such traditional knowledge may be useful to help rural communities achieve larger, more efficient yields. In southeast Brazil, better agricultural and resource management decisions may be made with traditional knowledge of the caiçaras, descendents of Tupinambá Indians who inhabited the Coastal Atlantic Rainforest (Begossi et al. 2000).

Ecotourism

Ecotourism provides huge potential for economic gain. Forest tours, cetacean watching, and diving may generate revenue for coastal, rural communities (Gössling 1999). In addition to generating funds, tourism could also be used to gain political support and increase local level support for conservation efforts (Oliveira 2002). Guiding is particularly important because it not only provides employment for the local community, but it increases the knowledge acquired by tourists and assists with the regulation of tourist behaviour, thereby increasing the carrying capacity for ecotourism ventures (Gössling 1999).

However, ecotourism is often fraught with regulation dilemmas and therefore policies need to be in place that protect the environment, maximize local participation, and ensure profits are fairly distributed at the local level (Young 1999; Gössling 1999; Bookbinder et al. 1998). Some ecotourism ventures tend to benefit only a few individuals while increasing costs, such as rising prices for goods and services, for the majority (Young 1999; Bookbinder et al. 1998). Access rights and benefits from use must be allocated accordingly among all affected stakeholders (Young 1999).

Consequently, whether ecotourism will provide sufficient incentive for local people to safeguard natural resources can only be answered on a site-specific basis (Young 1999). Even if ecotourism provides a significant new source of income from an environmentally friendly use of resources it may not be sufficient to reduce intense extractive pressures from other sectors of the community (Young 1999). Other sustainable uses of biodiversity need to be integrated with ecotourism to help achieve conservation goals.

Summary

The conservation of biodiversity is facing an uncertain future, threatening the sustainability of our planet. To achieve and perpetuate sustainability, development goals must be reconciled with conservation goals. The reconciliation of development and conservation goals is vital in southeast Brazil since its extremely biodiverse Atlantic Forest and associated mangroves are highly threatened from intense anthropogenic pressures. Mangrove conservation is particularly important since mangroves serve as nurseries for numerous biological resources, including valuable marine fisheries. Since the total value of the ecological functions that mangroves provide is often not considered, mangroves are particularly susceptible to large-scale transformation. Consequently, minimization of anthropogenic destruction of mangroves is necessary. However, complete exclusion of human use is not a viable alternative for conservation of the majority of the world's mangrove forest, which are located in developing countries and already occupied by people. Resident populations need to be incorporated in management through community-based natural resource management to achieve better conservation

success. Mangrove conservation, and sustainability, may best be achieved by pursuing a diverse array of small-scale activities that may improve livelihoods with minimal environmental impact.

The sustainable use of biodiversity helps guarantee the conservation of biodiversity. Once people can use biodiversity to meet their basic needs, they would like to continue to use the biodiversity to meet their needs into the future and thus strive to maintain conservation goals. The returns from a diverse array of livelihood activities may not be as profitable as large-scale logging and aquaculture operations in the short-term, but the benefits would be sustainable and would not cause whole-scale destruction of the Atlantic forest and mangrove ecosystems. A combination of ecotourism, extractivism, along with small-scale aquaculture and agriculture, may provide sufficient benefits to attain better livelihoods with minimal environmental impacts.

Nevertheless, there have been limited studies quantifying the actual impact of small-scale activities on the surrounding biodiversity. The impact on biodiversity from such activities needs systematic analysis to confirm whether they are indeed minimal. Unfortunately, such research is lacking and most research centered on development discusses biodiversity in superficial terms, without any actual quantification of a biodiversity measure at either the genetic, species, or landscape level. However, quantification of diverse biodiversity measures in tropical regions is particularly difficult due to the overwhelming diversity of living organisms and lack of taxonomic knowledge that adequately identifies all taxa. The identification of taxa requires a large investment of resources, which is often limited in developing countries. Consequently, resource investment in quantification of biodiversity needs to be weighed against resources spent

on improving livelihoods through small-scale use of resources, with the assumption that better livelihoods will help achieve better conservation results.

Conservation of biodiversity is crucial to maintain ecosystem functioning and sustainability. However, it is not known how much biodiversity is necessary to maintain ecosystem functioning and sustainability (Jenkins 2003). Strong efforts are required to conserve as much biodiversity as possible to safeguard against crossing the threshold for ecosystem collapse and the subsequent eradication of prospects for maintaining sustainability.

CHAPTER 4
SELF-ORGANIZATION AND CROSS-SCALE LINKAGES

Introduction

This chapter focuses on the first two objectives:

I. What can be learned from the Cooperostra in terms of self-organization?

II. What can be learned from the Cooperostra in terms of institutional cross-scale linkages?

The chapter starts with a brief socio-economic description of Cananéia, São Paulo, Brazil with specific emphasis on the conservation and livelihood dilemma encountered by rural inhabitants in Cananéia. I then discuss the development of solutions for the resource use dilemma with the development of oyster aquaculture and Cooperostra. The main purpose and objectives of Cooperostra are presented along with descriptions of how Cooperostra's endeavours were executed with the assistance from diverse organizations. The end of the chapter provides an analysis of Cooperostra's organizational and institutional dynamics.

Conservation and Livelihood Dilemma:

Transformation of the Mandira Community

Located in São Paulo State of southeast Brazil, Cananéia is considered to be one of the oldest towns in Brazil. Established by Portuguese colonialists in 1531, Cananéia currently has a regional population of approximately 13,000. From the 17th to 19th centuries, Cananéia prospered through economic cycles of gold mining, shipbuilding, and agriculture (Bernardo et al. 1993). During the 19th century, landowners prospered from a

strong agricultural-based economy and cheap labour provided by slavery. In the mid 19th century, one such landowner had a son with a slave, named Francisco Vicente Mandira. Mandira eventually inherited 1,200 hectares in the municipality of Cananéia. Today this area is known as Bairro Mandira, and continues to be occupied by descendents of Francisco Vicente Mandira (Fig. 2.1).

The community has evolved with limited financial resources of its own, primarily because expansion of the coffee market in the 20th century shifted economic development and acceleration of wealth to interior regions of São Paulo and neighbouring states. Since the region is not climatically suitable for coffee plantations, Cananéia and the entire region of the Vale de Ribeira gradually became marginalized (Bernardo et al. 1993) and currently Cananéia is the poorest region in São Paulo state. With very limited economic development, the Mandira community engaged in shifting-agriculture and extraction of rain and mangrove forest products for subsistence in parts of Brazil's highly threatened Atlantic Forest (Sales and Moreira 1996).

The pace and severity of biodiversity loss in the Atlantic Forest region instigated strong legal and organizational conservation measures by the national government. Along with many other communities of Brazilian southeast, the Mandira community was therefore legally banned from traditional farming and hunting practices in the 1960s. The Cananéia region was transformed into an Area for Environmental Protection (Area Proteção Ambiental – APA). The Mandira community had to change its livelihood means from traditional subsistence agriculture and hunting to oyster harvesting (*Crassostrea spp.*). For more than 30 years, the Mandira community has relied on oyster harvesting for more than 90% of its livelihood earnings.

New challenges:

Mangrove Conservation, and Livelihood Security and Improvement

Since the shift of the Mandira community in the 1960s, economic returns obtained from the oyster harvest were very small. The problem of maintaining livelihoods was augmented by the existence of middlemen who claimed large portions of the profit. The community did not have direct contact with retailing and the market at large. The gathering and preparation of the oysters was conducted in secrecy, since the community did not have the means to meet strict sanitary and harvesting regulations. The low economic return obtained from the oysters forced the community to overexploit the oyster resource to attain a minimal standard of living. The exploitation of mangrove products was further intensified by "outsiders" who also were usurping the mangrove resources. Members from neighbouring states often entered the mangrove region of Cananéia and used resources without considering the aspects of ecological sustainability. Some residents of the Cananéia city also periodically gathered mangrove resources to supplement their livelihoods. Tourists from all over Brazil and the world also regularly entered the mangrove forest for recreational fishing. Furthermore, increases in demand for mangrove resources resulted from road construction in the 1970s, which opened access along the entire São Paulo coast, increasing the number seafood craving tourists flocking to the coasts. Consequently, open access conditions coupled with high demand and low economic return resulted in overexploitation and the subsequent decline of oyster stocks.

Without autonomy over the oyster resource, the local community was also obligated to follow legal sanctions established by the Brazilian Institute of Environment

and Renewable Resources (IBAMA). Oyster harvesting is prohibited from December-February[3], the principle reproductive period of the oysters. This period coincides with the time of the year with greatest demand as numerous Brazilians seek coastal regions for summer holidays. There are also size restrictions on the harvest; oysters less than five cm and greater than 10 cm in length can not be harvested. The Mandira community hence had very limited options to secure a sustainable livelihood.

Oyster Aquaculture in Cananéia

Oyster harvesting and rearing have provided the Mandira community with a primary means of attaining a sustainable livelihood. Oyster rearing methodology in Cananéia was developed in the 1960s and 1970s by Wakamatsu (1973), a biologist from the Oceanographic Institute at the University of São Paulo. Researchers from the São Paulo Fisheries Institute further developed knowledge on oyster biology, conditioning, and cultivation (Akaboshi and Bastos 1977; Akaboshi and Pereira 1981; Pereira 1983; Pereira et al. 1991; Pereira and Soares 1996; Galvão et al. 2000; Pereira et al. 2001b).

The first attempt to transfer oyster rearing technology occurred in 1974 in an oyster aquaculture course offered by Sao Paulo Fisheries Institute and the state organization SUDELPA (Sao Paulo Coastal Development Organization). It was attended by three Mandira community members, however, no major changes occurred after the course due to a lack of local and outside leadership and/or initiative. Other oyster rearing courses were offered by SUDELPA, in 1981, and the non-governmental organization SOS Atlantic Forest, from 1988-1992. Even though these courses were better developed

[3] IBAMA legislation Portaria N^{o}40 (1986-1987) banning year-round oyster harvesting.

than the initial course offered by SUDELPA in 1974, the courses had limited success due to lack of economic return to course participants.

The lack of acceptance may also be attributed to the different cultural context imposed by aquaculture on these families, whose main livelihood was from fishing. Fishermen are accustomed to seeing immediate results after working for several hours, i.e. in several hours they can catch several kilos of fish. Since there was a long time lag between working and remuneration, fishermen had a difficult time comprehending the need to wait two years to obtain economic returns. Despite difficulties in engaging rural fisherman to pursue careers in aquaculture, the potential value of aquaculture for rural development in Cananéia was not undermined.

The value of oyster rearing and aquaculture for sustainable, regional development was recognized in 1989 by the Coastal Management Program, in an ecological and socioeconomic zoning project sponsored by the Secretariat of the Ministry of Environment (SMA). This zoning project concluded that aquaculture was the only economically important activity with potential to alleviate poverty and simultaneously preserve environmental quality. The biologists and others scientists urged the development and application of an aquaculture program to initiate economic development and conserve biodiversity in the region.

Precipitation of the Project

With the results of the Coastal Management Program, in 1991 the Brazilian Center for Sustainable Development of Traditional Communities (CNPt) and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA)

established a partnership with scientists from the University of São Paulo, with a common goal of creating an extractive reserve in Coastal Atlantic Rain Forest. It was realized that aquaculture would play a pivotal role in maintaining the livelihood of reserve inhabitants, and a research team investigated the socio-ecological viability of an extractive reserve in Cananéia.

Researchers from the forest foundation of São Paulo studied several rural communities in Cananéia to assess the viability of introducing oyster rearing beds to increase production. The Mandira community was selected as an ideal site for an extractive reserve for numerous reasons (Bastos 1999):

- Strong community and family ties provided a high degree of social capital that would facilitate development of well-structured community organizations for the establishment of an extractive reserve.
- Excellent ecological integrity of surrounding ecosystems; the extractive reserve would be surrounded by a mosaic of protected areas, namely Jacupiranga State Park and Federal Zone for Wildlife Protection (*Zona de Vida Selvagem da Área de Proteção Ambiental* [APA]).
- Mandira is one of the most productive areas of the estuary for oyster production.
- Mandira residents had been dedicated to oyster collection for more than 20 years for 90% of their income.
- The possibility to grant exclusive access rights to Mandira residents because of the quilombola[4] law passed in 1988 (Tuaratti 2002), and thus reduce outsider pressure from other neighbourhoods and states (Paraná and Rio de Janeiro).

[4] Quilombola communities, such as Mandira, were established by African slaves or their descendents.

- There was a possibility to increase oyster value with construction of a depuration station.
- There was a good opportunity to unite forces with the "Project for Research on the Viability of Promoting Oyster Aquaculture" (*Projeto de Estudo da Viabilidade de Fomento da Ostreicultura*), developed by the State Ministry of Environment, a local Cananéia fisher group, and Fisheries Institute of São Paulo.

The previous organization attempts by government support staff and Mandira residents throughout the 1990s for the development of the Mandira Extractive Reserve played a key role in the success of the Cooperostra. Previous organization attempts fostered a high level of social capital that facilitated the organization of Cooperostra. Other oyster extractors were then recruited and readily adapted to the relatively high level of organization. The Cananéia Oyster Producers Cooperative was thus formed as a community based organization centred on the Mandira Extractive Reserve.

Inclusion of Cooperostra Members Outside Mandira Extractive Reserve

Government researchers initially envisioned Cooperostra's concept only for the Mandira community, however, logistical considerations for the construction of the depuration centre resulted in expansion of Cooperostra to other rural communities. The depuration station was built 6km from Cananéia city since land there was more suitable for construction and had access to reliable supplies of electricity and water. The current location is also conveniently located off of highway SP-226, which connects to the major thoroughfare Rodovia Régis Bittencourt (BR-116), the principal highway in southeastern Brazil with links to major metropolises such as São Paulo and Curitiba. Furthermore, the land for the depuration station was also donated by the municipal government. Because

of all these considerations, other oyster collectors from the region were also recruited for the cooperative. The idea for an oyster producers' cooperative initiated in 1994 and culminated with the formation of Cooperostra into 1997. Cooperostra members reside in six different rural communities, including Mandira, Acaraú, Ariri, Porto Cubatão, Retiro, and Itapitangui (Table 4.1). However, slightly more than 50% (12/21) of Cooperostra's active members are from Mandira.

Table 4.1 Total active and inactive COOPEROSTRA members from each location (Garcia 2005).

Location	Active	Inactive	Total
Mandira	12	7	19
Itapitangui	2	9	11
P.Cubatão	0	8	8
Acaraú	7	2	9
Retiro	0	3	3
Ariri	0	2	2
Boacica	0	1	1
Total	21	32	53

Challenges of Economic Viability and Formation of Cooperostra

Attempts to transfer oyster rearing technology occurred more than 20 years before the formation of the Cananéia Oyster Producers' Cooperative. Each attempt in 1974, 1981, and from 1988-1992 had limited success primarily due to the lack of economic return for participants to adopt the new technology. From 1998-1992 the SOS Atlantic Forest project distributed 1,200 dozen oyster larvae to six rural families (200 oyster larvae per family). However, only 30% of oyster larvae reach commercial size within 2 years. Thus after 2 years, only 60 dozen oysters may be sold. Since the economic returns after 2 years were relatively small, the families and their communities did not become interested and involved with oyster aquaculture (Bernardo and others 1993). Without

secure economic returns, the transfer of oyster aquaculture technology did not gain acceptance or local support.

Government researchers envisioned several interventions to secure greater economic returns for oyster harvesters, through the formation of a cooperative, innovative use of rearing beds, acquisition of health certification for oysters, and creation of an extractive reserve. With these ideas, the government official began recruiting Cooperative members in the early 1990s. Scientists from the São Paulo Forest Foundation and Fisheries Institute discussed with more than 125 oyster harvesters in and around Cananéia to gauge the quantity of oysters being harvested in the region and to gain support for the formation of an oyster producers' cooperative. However, government workers had difficulty introducing the project to some rural oyster harvesters. Some of the harvesters were anxious and suspected that the government workers were there to expropriate land from them, since they lacked legal documents to prove ownership of the land they had inherited for generations. Consequently, it took several meetings to build up a relationship of mutual trust and respect before interactive discussions commenced on project development. Local leaders were important for mobilizing greater local support from oyster harvesters sceptical of joining Cooperostra. Local leaders also provided vital feedback to government researchers for further iterations of Cooperostra's development.

In 1993, the Fisheries Institute, Forest Foundation, and the local fisher organization in Cananéia (*Colônia de Pescadores de Cananéia*) developed a proposal on the "Viability of Oyster Aquaculture and Culture of Other Marine Bivalves in Cananéia" (*Viabilidade da ostreicultura e criação de outros bivalves marinhos na região de*

Cananéia). The proposal specifically explored the possibility of introducing oyster rearing beds to increase oyster economic yield. Numerous consultations with local residents and other government officials, led to further refinements of this proposal and the development of the project "Oyster Harvesting Management in the Mangrove Estuary of Cananéia, São Paulo," which was coordinated by officials at the Forest Foundation and Fisheries Institute and assisted by diverse institutions. This project was conducted between 1994 and 1997, during which various interrelated initiatives were undertaken/supported:

- The Forest Foundation and Center for Wetlands Conservation (NUPAUB), University of São Paulo, initiated studies in 1994 on the development of a management plan for resource use in the Mandira Extractive Reserve, and eventually led to the creation of the Association of Inhabitants of Mandira Extractive Reserve in 1995
- The Fisheries Institute, Adolfo Lutz Institute, Regional Laboratory of Registro, and the NGO Gaia Ambiental conducted a project entitled "Contribution to the Organization and Feasibility of Commercial Production of Mangrove Oyster Crassostrea brasiliana in the Cananéia Estuarine-Lagoon Region." Main objectives of this project included expansion of oyster rearing bed use to other communities and assessment of potential pathogens that may be present in the mangrove ecosystem, as well as pathogens that may be introduced during processing for markets
- Scientists from the São Paulo Forest Foundation and Fisheries Institute contacted more than 125 oyster harvesters in and around Cananéia to gauge the quantity of oysters being harvested in the region and to gain support for the formation of an oyster producers' cooperative.

- During more than 100 meetings, external leaders and local participants worked together to improve organization amongst the oyster harvesters and further develop and test oyster rearing technology.
- Funds were obtained through the Programs for Decentralized Execution Fund (PED) from the Brazilian Ministry of the Environment (MMA) and World Bank, for the project "*Sustainable Use of Lagoon-Estuarine Comlpex of Iguape, Cananéia, and Ilha Comprida*" which proposed a subproject in the "Management of natural oyster beds: rearing, depuration, and commercialization." This project was co-executed by the Fisheries Institute along with the Forest Foundation, and proposed the expansion of the oyster rearing beds for 25 families within the extractive reserve, the construction of a depuration station, and support to initiate community organization and commercialization of oysters. With release of PED funds from the government in 1997, the proposal for Cooperostra, the Cananéia Oyster Producers' Cooperative was carried out (See page for a summary of Cooperostra's purpose and main objectives).
- The Forest Foundation, Gaia Ambiental, and Fisheries Institute, with financial support from PED funds, conducted a market analysis for oysters in the São Paulo capital and Santos Bay Area.[5] Questionnaires were formulated to understand the market niche and demands for oysters.

[5] Coastal region of São Paulo state surrounding the city of Santos and encompassing nine cities from the northernmost city Bertioga to the southernmost city Peruíbe.

Summary of Cooperostra's Purpose and 3 Main Objectives

By the end of the project for "Oyster Harvesting Management in the Mangrove Estuary of Cananéia, São Paulo," in 1997, Cooperostra had been developed with the following purpose and objectives:

Purpose

"Improve the sustainable use of mangrove resources to improve the quality of life for traditional oyster harvesters in Cananéia through the economic development of traditional extractors and improving the quality of the product" (Maldonado 2002).

Objective 1:

Conservation of the Environment

A. Conservation Education

B. Reduce Extractive Pressure by:

- Increasing value of oysters (see Objective 3)
- Increasing oyster yield with aquaculture and rearing bed technology

C. Creation of Extractive Reserve (granting exclusive access rights)

Objective 2:

Provide High Quality Oysters

A. Oyster Rearing Beds

- More uniform shell vs. highly variable oysters obtained from mangrove
- Increased Size
- Greater Resistance of oysters

B. Maintenance of a virtually pristine environment to rear and harvest oysters (protect against large-scale anthropogenic disturbance)

C. Health (SIF) certification [required construction of the depuration station]

D. Efficient delivery of product

Objective 3:

Increase Socio-Economic Returns for Cooperostra Members

A. Oyster Beds

- Sell oysters throughout year (i.e. during closed season)
- Yield higher quality oysters; command higher prices on market
- Increase total yields of larger, more profitable oysters

B. Certification

- Health (SIF) → now command higher prices since oysters safe to eat
- Environmental (Marine Stewardship Council, Green Seal)*

C. Improve organization and education of Cooperostra members

- Help them form a cooperative and undertake collective action
- Eliminated unscrupulous middlemen, deal directly with local buyers

D. Marketing and Market Development Studies

- External marketing research firm conducting market studies
- Divulging product and Cooperostra name in media and at diverse fairs

*Have not obtained environmental certification but are currently exploring opportunities

Capacity Building

Education of Cooperostra Members

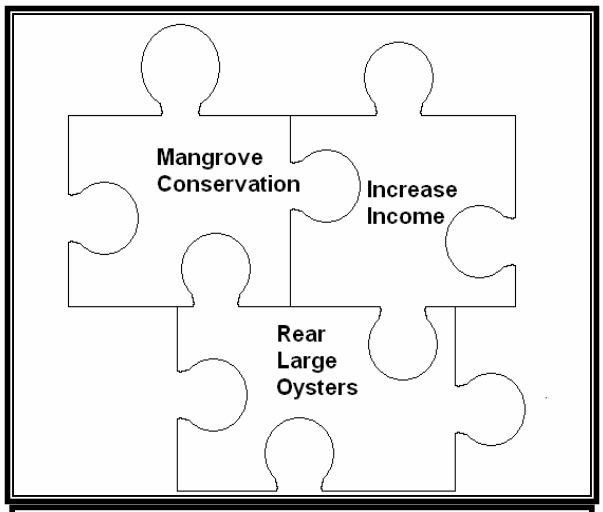


Figure 4.1 Interlocking figure used by government researchers to help explain the direct links among mangrove conservation, rearing large oysters, and improved livelihoods (Machado 2004).

The contributions from diverse institutions, including marketing organizations, university-based research institutes, and government agencies, have helped better organize Cooperostra's initiatives. Organization for development of the cooperative was also aided by courses offered by government researchers. During such courses, participants were taught about efficient production methods and organizational management, competitiveness, the unfair share middlemen claim, and the benefits from belonging to a cooperative. In addition to organizational education, the importance of mangrove conservation was also highlighted. Through classroom discussions, participants learned about human ecological systems; focusing upon direct links between mangrove conservation, rearing large oysters, and improved livelihoods. These links between healthy environment and improved well-being were reinforced with the use of clear, concise diagrams (Fig. 4.1). The meetings also engaged cooperative members to contemplate the adverse ecological impacts of previously common practices, such as cutting mangrove roots to facilitate harvesting. Cutting mangrove roots is not a sustainable manner to collect oysters since it removes places that can yield oysters in the future and excessive cuts may also kill the tree and lead to the erosion of mangrove substrate and reduction of mangrove area. Negative ecological and

economic impacts of selling small, deshelled oysters in packages were also addressed. The practice of selling deshelled oysters contributes to over-harvesting and inefficient use of oyster stocks since packages of deshelled oysters sold for only R$2.00[6] and contained up to ten dozen oysters. Instead of practices that undermine ecosystem health and sustainability, participants were encouraged to engage in innovative, socio-economically and environmentally beneficial practices, such as the use of oyster rearing beds.

Innovation and Introduction of Rearing Bed Technology

The use of rearing beds was envisioned in very early stages of Cooperostra's oyster stock management (Fig. 4.2). The rearing beds allow oysters to reproduce as they attain larger, more profitable sizes, thereby increasing the total oyster reproductive yield and helping replenish oyster stocks of the region. The use of the rearing beds helps prevent genetic deterioration of the oyster stocks since large oysters are not completely removed from the reproductive population for immediate sale. Large oyster genes may thus persist through successive generations since the selective pressure for large oysters is mitigated, ensuring that remaining reproductive populations will not consist of progressively smaller individuals.

Further, oysters grown in rearing beds yield greater economic return since oysters grow to larger, more valuable sizes. Reared oysters are grown detached from gnarled mangrove roots and hence have a more uniform appearance with greater market appeal. Other than being more visually appealing, the more uniform shape of aquacultured oysters makes them easier to open instead of oysters that have grown contorted on mangrove roots. Opening oysters can sometimes be a very difficult task (Pereira et al.

[6] Brazilian Reals (R$); R$2 is approximately $1 Canadian [December 2005]

Figure 4.2 Rearing beds within the Mandira Extractive Reserve, São Paulo, Brazil –April 2005.

1992). Cooperostra has handed out pamphlets to help educate people on the best methods to open oysters, as well as how to store and prepare oysters (Fig. 4.3). The value of oysters grown in rearing beds is also higher due to their greater physiological resistance, induced by the conditioning from the rearing process. Reared oysters thus have lower mortality rates during depuration and shipment than oysters harvested directly from the mangrove. The use of oyster rearing beds also enables Cooperostra members to sell oysters during the peak tourist season from December to February, during which the sale of "wild" oysters is prohibited by law.

Financial support from external agencies (i.e., university and government sources) was obtained to purchase the materials for the construction of the rearing beds. Lessons were given to participants with demonstrations on how to construct and use the rearing beds to the fullest potential. A pilot project transferring rearing bed technology to the Mandira was carried out in 1994. The success of the pilot project helped spread the technology to oyster harvesters in other municipalities.

The transfer of this technology has been realized through an interactive process; local knowledge and experience was specifically sought and used to enhance productivity. For example, in response to high oyster mortality from solar heat stress, Cooperostra members shaded oyster rearing beds with palm fronds to protect the oysters

Figure 4.3 Pamphlet distributed by Cooperostra to educate consumers on best methods to store and open oysters.

from intense sunlight. The fisheries researchers further suggested mediating the heat stress by elevating the top mesh of the rearing bed, which gets very hot when exposed to the sun, from touching the oysters. Currently, both local and external mediation mechanisms are used. Such an open, two-way exchange between government officials and Cooperostra members helped gain support for the inception of Cooperostra.

Depuration, Certification, and Benefits

Increasing the value of the oysters by obtaining health certification from the Federal Inspection Service (SIF) was envisioned by scientists from the Forest Foundation and Fisheries Institute. This was particularly important after cholera outbreaks in southern Brazil from February to May 1993 left 1044 ill and 12 dead (Neto 1993) and resulted in plummeting oyster sales (Bernardo et al. 1993). Oyster sales would increase if consumers could be guaranteed that the oysters they purchase are safe for consumption. Health certification could ony be obtained if the oysters underwent depuration. The depuration process consists of exposing clean, live oysters in good condition to purified water. Cooperostra currently purifies water through a mechanical filter (80 μm) and a microfilter (25μm) followed by an ultraviolet light filtration system to sterilize any biota remaining in the purified water. Oysters filter purified water during the depuration process, purging impurities within the oyster and making the oysters safe to eat. By ensuring the oysters are safe for consumption, Cooperostra may command higher prices on the market with SIF certification.

The Federal Inspection Service, which is an institution under the Ministry of Agriculture and Food Supply, requires analysis of water and oyster samples within the depuration station. Such official analyses are conducted by SIF agents in accredited

laboratories for a minimum of eight times a year. Microbiological analyses are conducted to detect salmonella, estimate fecal colliform bacteria, and *Vibrio spp.*, which are the pathogens that pose the greatest risks with the consumption of oysters. With assurance that the oysters are safe for consumption, SIF certification is granted.

Researchers at the Fisheries Institute and the Adolfo Lutz Institute conducted studies on potential contaminants that may risk consumer safety, which was also a key requirement to obtain certification from the Federal Inspection Service (SIF). Machado et al. (2002b) examined heavy metal (lead, cadmium, mercury, and copper) levels within oyster tissue and found that they were very low and thus the oysters were safe for consumption. Machado and other researchers examined fecal coliforms within estuarine waters (1998a) as well as within oyster tissue and fluids (1998b). Coliform counts with oyster tissue and fluids was found to be more a useful parameter since coliform populations fluctuate greatly within estuarine environments due to high levels of organic material and microorganisms, the spatial heterogeneity of the environment, along with the effect of currents, rain, tides, and winds.

Difficulties with SIF Certification for Small-Scale Producers

SIF has very stringent and costly demands, such as a separate office room for SIF monitors during visits to the depuration station. These demands are very costly for small-scale producers. SIF also demands numerous water tests. Since oysters are filter-feeders, they accumulate pathogens present in the water, thus testing oysters for pathogens should be sufficient. The lack of technical and financial resources, presents considerable challenges to conduct the additional water testing. Furthermore, the criteria SIF has adopted for testing are from other regions of the world, particularly temperate, open

ocean conditions. The criteria are not suited for tropical, estuary conditions resulting in numerous dilemmas for meeting SIF standards.

Construction of Depuration Station

In accordance with SIF regulations, Fisheries Institute scientists designed the depuration station (Fig. 4.4). Land for construction of the depuration station, along with Cooperostra's main office, was donated, upon request, by the Cananéia municipal government. Financial assistance was obtained from various national and international organizations (Fig. 4.4). The national support received, i.e. from the Brazilian Fund for Biodiversity (FUNBIO) and funds from the Brazilian Ministry of the Environment, (MMA) also have international connections since these funds originate from the World Bank (Fig. 4.5).

Figure 4.4 Pictures of Cooperostra's depuration station – February 2004.

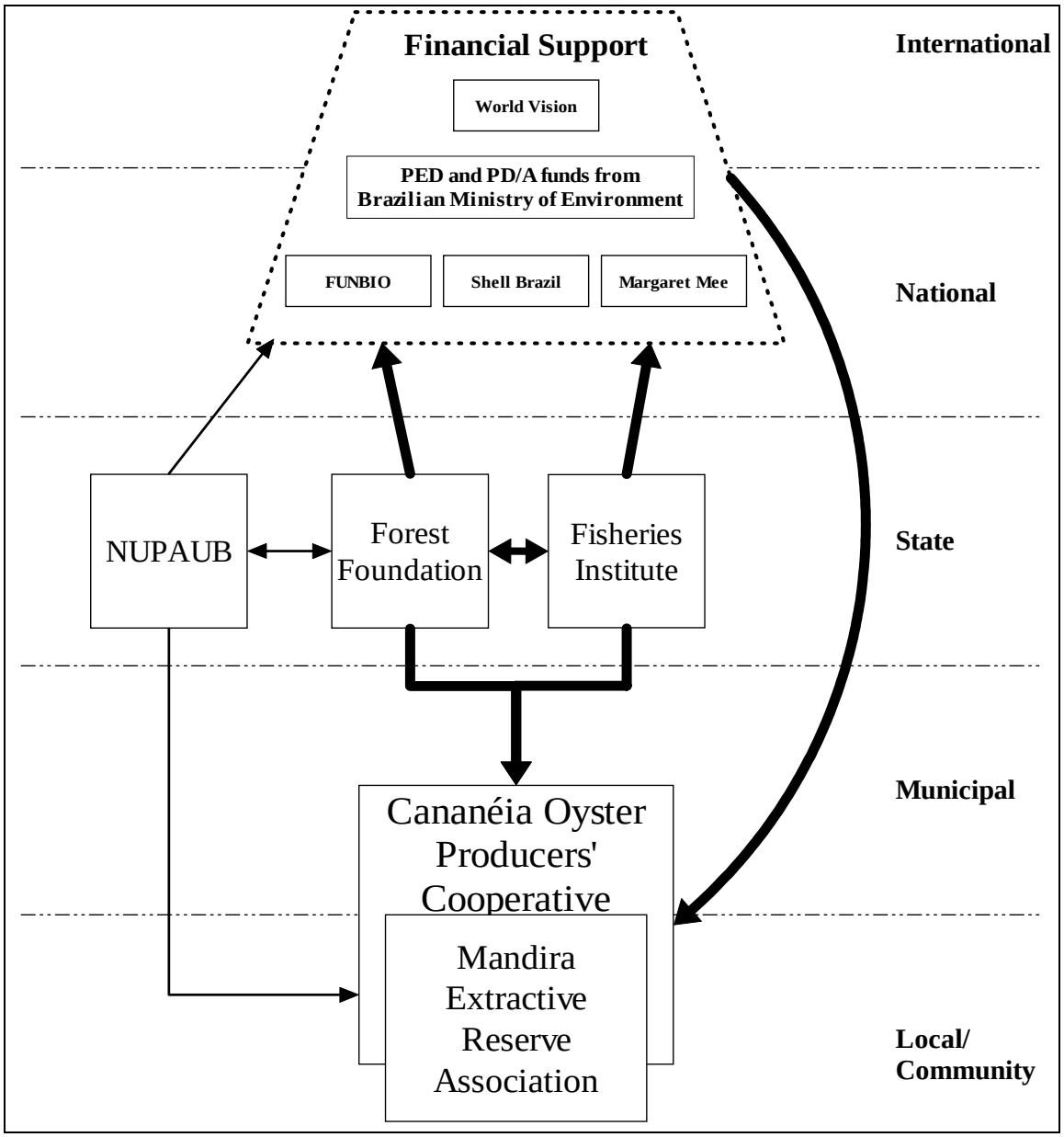


Figure 4.5 Key institutional cross-scale linkages that facilitated the creation and development of the Cananéia Oyster Producers' Cooperative.

Funding was obtained both directly and indirectly from diverse institutions (Fig. 4.6). Funding was obtained by directly applying to the Ministry of Environment, which administers the allocation of various funds. Direct support was also obtained from World Vision. Indirect funding was obtained with assistance, from contacts at the Magaret Mee Botanical Foundation which helped obtain great financial support from Shell Brazil.

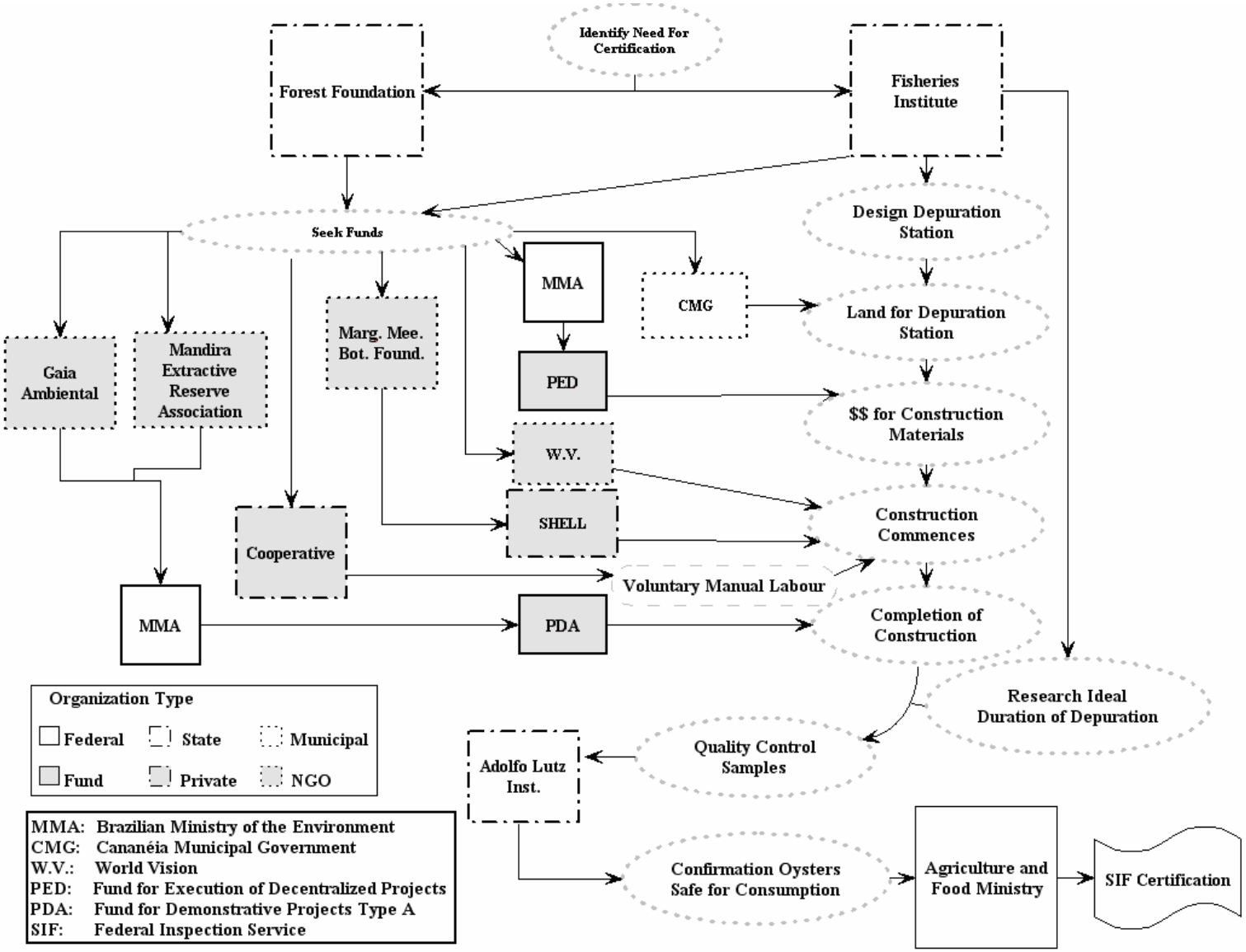


Figure 4.6 Organizational cross-scale linkages, which enabled Cooperostra financially and technically, to obtain SIF certification for its oysters.

Funding for Cooperostra was also indirectly secured through the Mandira Extractive Reserve Association and Gaia. The non-governmental organization Gaia was created on paper to help secure funds quicker, since the Fisheries Institute along with Cooperostra would have a more difficult time seeking funds. The Fisheries Institute is already funded by the government, making it difficult to seek additional, funding for the project. It is also difficult for Cooperostra to obtain financial support from the government or non-government organizations since it has lucrative endeavours. It is easier for a non-governmental, non-profit organization, such as Gaia, to obtain funding[7]. Gaia along with Mandira Extractive Reserve Association played key roles in the successful application to the fund for Demonstrative Projects Type A (PDA) from the Ministry of Environment (Fig. 4.5). The PDA funds were used to cover operational costs for depuration station and commercialization of the oysters.

In addition to financial support, voluntary work was also important for the construction of the depuration station. Cooperostra members provided voluntary manual labour to aid with construction efforts. Completion of the depuration station was only possible with reliance on diverse institutions. However, in the case of Cooperostra, reliance on diverse institutions was a very time consuming process. For instance, the proposal to purchase construction materials for the depuration station was drafted in 1995, however, the depuration station only started functioning in December 1999[8]. Upon

[7] *Negative outcome from Gaia* - A previous external and presumably fraudulent Cooperostra manager wrote the Federal Ministry of the Environment that the funding obtained through the NGO Gaia was a method for researchers from the Fisheries Institute to earn larger salaries for themselves. A counter suit has been filed against this accusation. This case will go to trial but the date is yet to be set by the Brazilian judicial system.

[8] The depuration station was officially inaugurated in May 1999 but only started to function in December 1999. The depuration station was inaugurated before it was completed to accommodate the busy schedule of the Minister of Environment.

completetion of the depuration station, Fisheries Institute scientists also conducted experiments on the length of depuration necessary to reduce fecal coliforms to meet safety regulations so as to use resources more efficiently and prevent overexposure of oysters to the depuration process. During the depuration process, oysters are not obtaining sustenance as they expend energy to filter water and consequently lose strength. If the oysters become very weak, they are predisposed for mortality during the stresses of shipping. To avoid such losses, the minimal duration required to purge impurities and pathogens within the oysters needed to be determined to minimize overexposing the oysters to depuration. The ideal depuration time was found to be six hours in research conducted by the Fisheries Institute (Machado et al. 2002a). Using this time frame of six hours, the depuration station is capable of processing up to 40,000 oysters per day.

Environmental Certification

Cooperostra is also attempting to obtain environmental certification. They have attempted to receive certification from the Marine Stewardship Council (MSC), however, it is difficult since parameters used are suited for fish stocks and not for raised oysters. Meeting the demands of report writing to obtain MSC certification will also be costly for Cooperostra since the MSC requires detailed multidisciplinary reports to achieve and maintain certification. Contacts made with Meredith Lopuch (Director - Community Fisheries Program World Wildlife Fund - California Marine Office) as well as Dr. Yemi Oloruntuyi from the Marine Stewardship Council in London may help obtain financial

assistance in the future for Cooperostra to conduct further research and produce reports necessary to obtain MSC certification.

However, the value of the environmental certification is questionable since it is unknown whether most Brazilian consumers would be willing to pay more for environmentally certified products. For instance, it appears that most Brazilians would rather purchase cheaper oysters, without health certification, than pay more for oysters that are certified safe to eat. If the consumers are not willing or capable of paying more for their individual health, it is unlikely consumers will pay more for environmental health.

Marketing

With Cooperostra established and infrastructure functioning, the cooperative still relied on additional external assistance to help expand marketing endeavours. Initially Cooperostra members dealt directly with clients but with limited success, because of their lack of skills and experience. Cooperostra then hired professional sellers[9] to market and sell oysters with much better results. The sellers picked up the product in Cananéia and distributed it to restaurants and markets along the São Paulo coast and in São Paulo city. However, the fixed wages of these sellers, transportation costs, plus commission were too costly and economically unsustainable for Cooperostra so these sellers were laid off. Cooperostra members have since been trying to sell their products but with limited success. Now Cooperostra has realized that perhaps sellers could be used to sell their product, but under different conditions that would be more profitable for the cooperative. One such arrangement being explored is the possibility of transporting the product to one

[9] These sellers could be considered as professional/legal middlemen, since they were still usurping a disproportionate share of Cooperostra's earning.

place in São Paulo so distributors could acquire and then sell the oysters at various locations in the city. Alternatively, Cooperostra is also considering contacting responsible sellers willing to purchase oysters directly from the depuration station to sell oysters autonomously, thereby allowing Cooperostra to omit costly transportation costs.

With funds from FUNBIO, a professional marketing firm was hired to develop marketing plans, but Cooperostra and the Forest Foundation are unsatisfied with the plans. Both parties feel they have not learned anything new from the firm's reports. The greatest remaining challenges for Cooperostra are increasing its marketing capacity to sell greater oyster quantities, as well as organizing its financial management and administration. Overcoming these obstacles will help Cooperostra become self-sufficient.

Cooperostra Organizational and Institutional Dynamics

Role of Leadership

Strong external and local leaders were primary forces for the development of Cooperostra (Table 4.2). The cooperative was created with the vision, drive, and determination of key positive leaders, coupled with their connections to diverse institutions for financial and technical support (Table 4.3). In the case of Cooperostra, it is difficult to classify distinct single solitary leaders since numerous people working together have contributed synergistically to the cooperative's endeavours. Leadership roles also shifted throughout different stages of the project (Table 4.3). Leader I brought the project from the State University to the State Forest Foundation. Leader II undertook leadership of the project once Leader I left the Sate Forest Foundation. Leader II collaborated extensively with Leader III from the State Fisheries Institute. When Leader

II left the Forest Foundation, Leader IV undertook leadership, followed by Leader V, and both continued to collaborate with Leader III. Leader A's role decreased with time and Leader B became president of Cooperostra (Table 4.2).

External leaders have been critical to build capacity for Cooperostra, however, negative outcomes also occurred because of the poor leadership of a few individuals, namely external managers who incurred a large debt for Cooperostra. Cooperostra has been externally managed by three different, unsuccessful managers. The second manager was particularly negative for Cooperostra's endeavours because his fraudulent use of the cooperative's money shattered the trust of Cooperostra members in hiring external assistance. Forest Foundation and Fisheries Institute technicians worked hard to rebuild trust in Cooperostra members so that they would once again accept external suggestions. Cooperostra needs external help for further capacity development, however, cooperative members are learning to be very critical of external ideas and interventions.

Table 4.2 Role, origin, and gender of key positive people involved with Cooperostra.

Leader	Origin	Gender	Role
I (State University → State Forest Foundation)	Outsider	Male	1st principal research on viability of extractive reserve and introduction of oyster beds
A (Mandira community)	Local	Male	Regularly provided Leader I feedback on plans and results
B (Mandira community)	Local	Male	Current president of Cooperostra
II (State Forest Foundation)	Outsider	Male	2nd principal researcher, further developed oyster bed viability and helped obtain health certification
III (State Fisheries Institute)	Outsider	Female	Current primary technical researcher, collaborated with Leader II and now collaborates with Leaders IV and V
IV and V (State Forest Foundation)	Outsiders	Both female	Primary administrative coordinators of project

Table 4.3 The role and connections of five different external leaders throughout five different phases of the project.

Key Leader (Years Active) Org. Affiliation		Project Phase	Role of Leader(s)	Connections
Leader I (1990-1996) University Research Institute (Phase I) and then State Forest Foundation (Phase II)		**1** and **2**	**Phase I:** Grad student: research socio-ecological viability of reserve **Phase II**: Government researcher: start attempt to implement reserve	**Phase I:** Environmental Ministry, State Secretariat of the Environment, State Forest Foundation. **Phase II:** University Research Institute, State Fisheries Institute, Community-Based Org., Leader II and III
Leader II (1995-Present) Fisheries Institute (Phases 3-5)	**Leader III** (1995-1999) Forest Foundation	**3**	Government researchers: contact all oyster harvesters, initiate Cooperostra	University Research Institute, State Health Organization, Municipal Government, Local NGO, Local Religious Organization, Leader IV
	Leader IV (2000-2004) Forest Foundation	**4**	Government researchers: capacity development of oyster harvesters, establish reserve	National and International Funding, University Research Institute, State Health Organization, Local NGO, Education Agent, Economic Planning Agent, Market Development Agent, Leader V
	Leader V (2004-present) Forest Foundation	**5**	Government researchers: assist Cooperostra management and sales	National Funding, State Health Organization, Market Development Agents

Access to Diverse Institutions

The leadership of key people introduced diverse organizations into Cooperostra's institutional network (Table 4.4). Each institution acted across various social scales to secure support from diverse locations for Cooperostra (Table 4.5). These diverse institutions provided capacity building mechanisms which enabled Cooperostra to pursue its purpose and objectives. Without the support of such a diverse array of institutions, Cooperostra would have limited technical, financial, and administrative capacity.

Table 4.4 Specific assistance, role, and origin of different organizations linked to Cooperostra.

Organization	Origin	Role	Specific Assistance
Cananéia Oyster Producers Cooperative	Organization of Oyster Producers/Collectors	Project Participants	Organization of oyster collectors
Mandira Reserve Association	Community Organization	Project Participants	Organization of community members, experimentation with aquaculture methods
Forest Foundation of São Paulo (State Secretariat of the Environment)	São Paulo State Government	Coordination of the Program for oyster use in mangrove regions within the estuary of Cananéia	Technical support to conduct projects, obtaining financial resources, diffusion of initiative, political and financial support.
Fisheries Institute (State Secretariat of Agriculture and Supply)	São Paulo State Government	Co-coordination of the Program	Research on oyster stocks in mangrove and aquaculture; education and training
NUPAUB	University of São Paulo	Technical and Financial Support	Sociological research; political and financial Support
C.E. Gaia Ambiental	NGO	Technical Support	Organization of oyster collectors, participation in studies conducted
Margaret Mee Botanical Foundation	NGO	Financial Support	Help obtain financial support, administrative support
Comissao Pastoral da Pesca	NGO	Political Support	Organization of collectors, political support
Adolfo Lutz Institute (State Secretariat of Health)	São Paulo State Government	Technical Support	Quality control; laboratory analyses
Ministry of the Environment (PED, PDA, and PDAII Funds)	Federal Government	Financial Support	Financial Support
Cananéia Municipal Government	Municipal Government	Financial Support	Donated land where the purification station now stands
Shell Brazil	Private Initiative	Financial Support	Financial Support
World Vision	NGO	Financial Support	Financial Support
Brazilian Fund for Biodiversity	Fund	Financial Support	Financing for the elaboration and implementation of the Business Plan

Table 4.5 Cross-scale connections; names and levels of organizations linked to the Cananéia Oyster Producers' Cooperative.

LEVELS OF ORGANIZATION	Oyster Cooperative	Mandira Reserve Association	SP Forest Foundation	SP Fisheries Institute	NUPAUB	Gaia Ambiental	M.M. Botanical Foundation	Local Fisher Group	Adolfo Lutz Institute	PED, PDA, and PDAII Funds	Cananéia Municipal Government	Shell Brazil	World Vision	Brazilian Fund for Biodiversity
International														
National														
State														
Municipal														
Community														

specific location of organization

existence of institutional cross-scale link

Tag-team Effort of Fisheries Institute and Forest Foundation

The combined efforts of both the Fisheries Institute and Forest Foundation were vital for Cooperostra's development (Fig. 4.5). There is no formal written agreement between these two organizations; however, they have developed a very strong and interactive partnership[10]. Both organizations split the work to complete tasks quickly and efficiently. However, the Forest Foundation and Institute also work in a tag-team effort. If one organization is having difficulty completing a task, the other organization assists.

The division of responsibilities was generally based on location. The Fisheries Institute is located in Cananeia, whereas the Forest Foundation is based 240km away in São Paulo. Consequently, the Fisheries Institute readily provided technical support on site in Cananéia. Closer to numerous governmental and non-governmental support bases in São Paulo city, the Forest Foundation actively sought financial and political support for the project. The Forest Foundation has also worked, and continues to work, on opening the market in São Paulo for Cooperostra's oysters by establishing contacts with marketing firms, restaurant firms, and even large grocery chains, such as the Pão de Açucar. Despite the geographic distance from the actual project, the Forest Foundation remained very close to the project. Frequent contact with the Fisheries Institute and Cooperostra coupled with frequent trips to the study site, enabled the Forest Foundation to be connected tightly with the project and resource base.

[10] This partnership is further strengthened by strong friendships that have developed over time, and in one case, even led to the marriage of a Forest Foundation representative with a Fisheries Institute scientist.

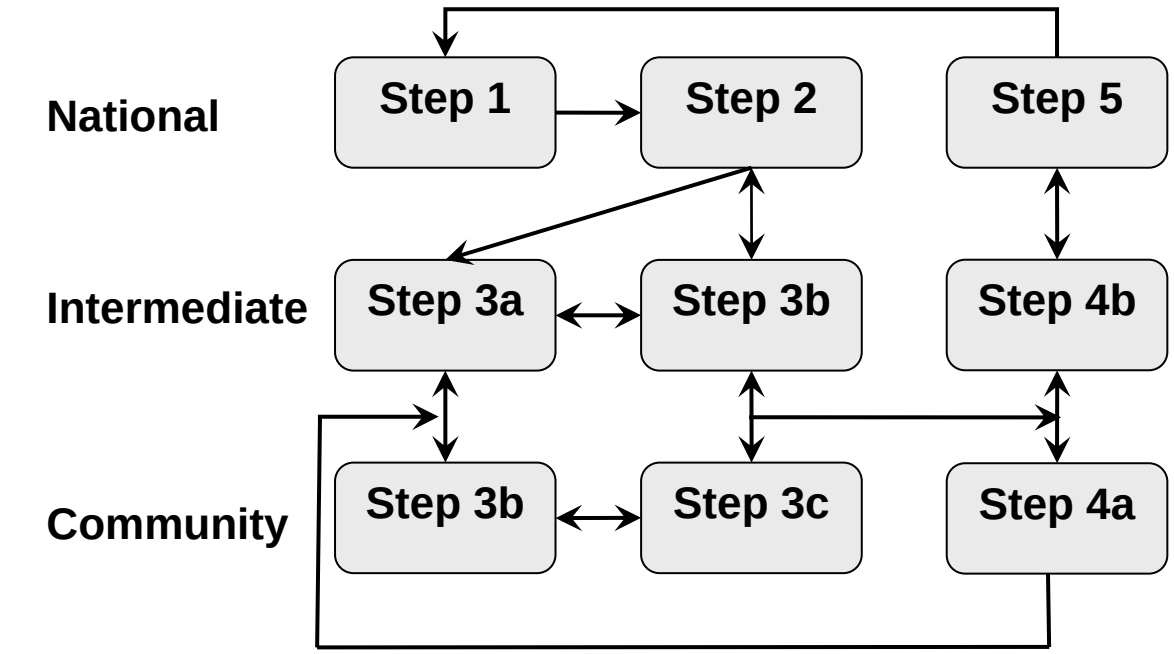
Frequent meetings also provided a platform to openly discuss any problems and brainstorm potential solutions amongst all support staff and Cooperostra members.[11] Such an open dialogue, has contributed to the rapid learning and adaptability of the project. Learning is further enhanced by drawing upon outside expertise, i.e. for marketing assistance, when assistance outside the knowledge base of project participants is required.

Cross-scale Adaptive Resource Management:

National priorities, often greatly influenced and supported by international conventions, were formulated for conservation of biodiversity, livelihood development, and public health, and these percolated to lower level institutions (Fig. 4.7). To achieve goals of national priorities, international support and guidance were secured to initiate programs to provide guidelines and resources for diverse endeavours, such as funds for the establishment of extractive reserves (i.e. PED and PDA funds), health certification standards for oysters (i.e. guidelines for SIF standards), and environmental and health education. Intermediate level organizations (i.e. Forest Foundation and Fisheries Institute) then secured national support and guidance to assist community level organizations (i.e. Cooperostra).

Decisions to assist community level organizations were based on site specific details, which for Cooperostra included the suitability of implementing and extractive reserve. Planning and implementation of endeavours at intermediate and community level then proceeded simultaneously, since there was active participation of Cooperostra

[11] However, Cooperostra members would like greater independence over their operations. Both Cooperostra members and outsiders would like to see the roles of the Forest Foundation and Fisheries Institute decrease over time but there is no clearly defined exit strategy.



Legend

STEP 1: Develop national priorities and seek international support.

STEP 2: Secure international support. Initiate programs providing guidelines/resources for national priorities

STEP 3a: Assess communities suitable for interventions. Seek national support.

STEP 3b:
Decide local needs and goals. Communicate with higher levels.

and

Secure resources for project interventions. Actively consult project participants.

STEP 3c: Carry-out interventions. Actively and regularly provide feedback on interventions.

STEP 4a: Assess conservation and development impact. Revise initial intermediate and community plans.

STEP 4b: Provide or facilitate assessment of information by higher levels

STEP 5: Compile site-specific data from lower levels for assessment. Revise national plans and priorities

Figure 4.7 Cross-scale Adaptive Resource Management Model as derived from Cooperostra.

members in the development of Cooperostra (Step 3 a, 3b, 3c, and 3d in Fig 4.7). Frequent evaluation led to repeated revisions in the initial plans for Cooperostra at both the community and intermediate levels (Step 4 a in Fig 4.7). Much slower than evaluations at lower levels and encompassing a broader scale of actors, national level evaluations were conducted to assess the impact of initial national plans (Steps 4b and 5 in Fig 4.7). Based on the impact of previous plans, new plans were formulated and/or new priorities are established

Although the implementation of Cooperostra has essentially been a top-down process (Fig. 4.7), the establishment of a respected platform of information exchange between Cooperostra members and governmental support staff allowed for active participation of community members (Step 3 in Fig.4.7) while securing guidance and support from higher levels.

Summary

The livelihoods of rural inhabitants were severely restricted by legislation compelling many inhabitants to harvest oysters as a primary livelihood. Poor economic return coupled with open access conditions was resulting in the over-harvesting and decimation of oyster stocks in the region. In order to secure oyster stocks, and provide a livelihood, and comply with environmental legislation, oyster aquaculture was encouraged and further developed by governmental efforts. The participation of diverse government agencies with connections to an array of supporting organizations enabled the precipitation of Cooperostra. The main goal of Cooperostra is to improve the sustainability of mangrove resource use by improving the livelihoods of traditional oyster

harvesters and the quality of the oyster. Cooperostra has pursued its goal by providing environmental education, introducing oyster rearing beds, constructing a depuration station to attain health certification, and exploring marketing opportunities. Leadership, particularly from the tag-team effort of the Forest Foundation and Fisheries Institute and their cross-scale links to diverse institutions, has been critical for the development of Cooperostra and execution of Cooperostra's objectives. Moreover, Cooperostra provides an interesting example of cross-scale adaptive resource management.

CHAPTER 5

POVERTY ALLEVIATION: ECONOMICS OF COOPEROSTRA AND IMPACT ON LIVELIHOODS

Introduction

This chapter focuses on the third objective:

III. How successful has Cooperostra been economically and at livelihood improvement?

The chapter begins with a brief socio-economic description of Cooperostra members. I then discuss Cooperostra sales in the past year (May 2004-April 2005) and since the inception of Cooperostra in 1997. I then present numerous sales and management dilemmas that have contributed to increasing debt for Cooperostra. The impact of Cooperostra on the lives of its members is then examined by comparing salaries among members. The varying impact of Cooperostra is further highlighted in case studies of different members. I conclude the chapter by discussing impacts in terms of time, future of the next generation and pride and dignity of Cooperostra members.

Socio-economic Context

As discussed in Chapter 4, Cananéia and the entire region of the Vale de Ribeira were not suitable agriculturally for profitable coffee monocultures, and thus became economically and politically marginalized (Bernardo et al. 1993). Cananéia is the poorest region in São Paulo State. With limited economic development, the Mandira community and other rural inhabitants engaged primarily in shifting-agriculture and extraction of rain and mangrove forest products for subsistence in Atlantic Forest fragments (Sales and Moreira 1996). The region's biological resources provide a steady, reliable source of subsistence. The poverty encountered in Cananéia is not as extreme as may be

encountered in other regions of the world, i.e. rural inhabitants never experience extended periods of starvation and famine. The "poor" residents in Cananéia live very simply, yet contently. Most poor inhabitants in Cananéia also have sufficient means to purchase some basic consumer goods (i.e. See Table 5.1).

Cooperostra Socio-economic Characteristics

Some basic socio-economic characteristics for 31 Cooperostra members are summarized above in Table 5.1. Most Cooperostra members have large families and the average education obtained is approximately equivalent to a grade 4 level (Table 5.1). However, most of the children have surpassed or presumably will surpass the level of education attained by their parents. Most families own electronic goods; for example 27 own a television set, 28 own a refrigerator, and 26 own an iron (Table 5.1).

Cooperostra Sales

Actual data for Cooperostra's total oyster sales within the past year and for each year since its inception were unavailable. However, data on sales for 2002 and 2003 were obtained from the Cooperostra headquarters. Cooperostra members, along with three key technicians from the Forestry Foundation and Fisheries Institute were asked to provide estimates of the Cooperative's sales since its establishment in 1997. The technician from the Fisheries Institute and the two technicians from the Forestry Foundation declined making an estimate since they felt they lacked sufficient knowledge of Cooperostra's sales to make a valid estimate. Similarly, most cooperative members did not feel comfortable providing a valid estimate, representing a lack of transparency or interest

among cooperative members for Cooperostra's management. Only two Cooperostra members provided estimates.

Table 5.1 Socio-economic characteristics for 31 Cooperostra members (after Garcia 2005).

Age (Years)	**< 30**	**31-40**	**41-50**	**51-60**	**> 61**	**Min**	**Max**
	8	8	9	4	2	22	67

Marital Status	**Married**	**Single**	**Common Law**	**Widowed**
	23	4	3	1

Education	**Illiterate**	**Grade 2**	**Grade 4**	**Grade 7**	**Jr. High**	**High School**
	2	4	15	8	2	0

# Individuals in Household	**1 - 3**	**4 – 6**	**7 – 10**	**>10**
	3	15	10	3

Housing	**Own**	**Rent**	**Borrowed**
	30	0	1

# of Rooms	**1 – 3**	**4 – 5**	**6 – 7**	**> 8**
	2	19	6	4

Material	**Brick**	**Wood**	**Mixed**
	27	1	3

Sanitary System	**Open Sewer**	**Plumbing**
	20	11

Electricity	**Yes**	**No**
	31	0

Health Plan	**Yes**	**No**
	1	30

Dental Plan	**Yes**	**No**
	29	2

Own Consumer Goods	**TV**	**VCR**	**Terrestrial Vehicle[12]**	**Boat**	**Boat Motor**	**Other Elect.**
	27	1	26	19	13	17
	Refrigerator	**Telephone**	**Cell. Phone**		**Iron**	**Radio**
	28	4	2		26	13

[12] Includes 2 cars, 4 motorcycles, and 20 bicycles.

Sales in the Past Year

Monthly oyster sales estimates from May 2004 to April 2005 provided by both cooperative members followed similar trends to actual sales from May 2002 to April 2003 (Fig. 5.1). However, total annual sales from May 2004 to April 2005 were predicted to be much lower than from May 2002 to April 2003. Total sales from May 2002 to April 2003 were 29,959 dozen, whereas predictions of total sales in the past year by Member #1 and #2 were 10,250 and 31,900 dozen, respectively.

Estimates and actual monthly oyster sales show the marked seasonality of sales with peak sales during the Brazilian summer, from December to February (Fig. 5.1). During the summer, great numbers of Brazilians and tourists frequent beaches along the São Paulo coast and crave fresh seafood, including oysters. The use of rearing beds to supply the market during the Brazilian summer is vital for Cooperostra since the wild oyster harvesting is banned from December 18 to February 18 by IBAMA legislation.

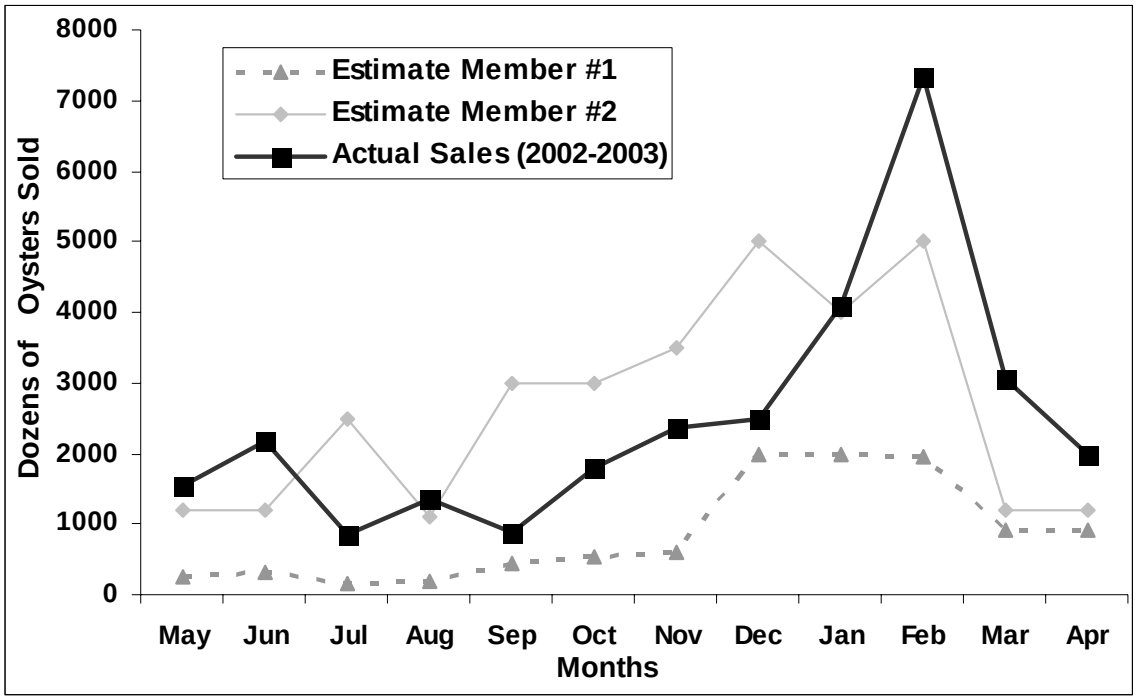


Figure 5.1 Estimates on dozens of oysters sold from May 04 to April 2005, along with actual amount of oysters sold from 2002-2003 [Data from Cooperostra headquarters]

Sales Since the Inception of Cooperostra

Estimates for total annual sales since the Cooperostra's inception were very similar, and thus likely represent reality (Fig. 5.2). Both cooperative members noted that sales increased rapidly until 2000-2001, and then decreased in 2003. The actual sale of oysters obtained from Cooperostra headquarters show that the total sales for 2002 and 2003 were 32937 dozen and 30991 dozen respectively, which were underestimated by both members. However, both members noted the decreasing trend from 2002 to 2003. These results were expected since the second manager hired professional sellers and expanded the Cooperostra market from 1999-2001. However, this chart does not represent profit since, the professional sellers had very high salaries, high commission, and expensive travel costs. According to cooperative members and external technicians, a huge debt was incurred during this period. After the economically unsustainable professional sellers were laid off in 2001, there have been limited successful attempts at expanding the market for Cooperostra, resulting in relatively steady sales from 2002 to 2005 (Fig. 5.2).

Member #1 estimated relatively high sales for 2004 and 2005, but these values may be slightly exaggerated to protect the image of Cooperostra. Similarly, Member #1 may have underestimated 2002 and 2003 sales to hide a large drop in sales. Estimates for monthly production in the past year from May 2004 to April 2005 by Member #1 yielded an annual total of only 10,000 dozen oysters sold (Fig. 5.1), even though he stated the Cooperative's sales were about 30,000 dozen in 2005 (Fig.5.2). Member #2 works daily at the depuration station and likely provided a better estimate since he has more exposure to the quantity of oysters the depuration station receives and ships for sale. Nonetheless,

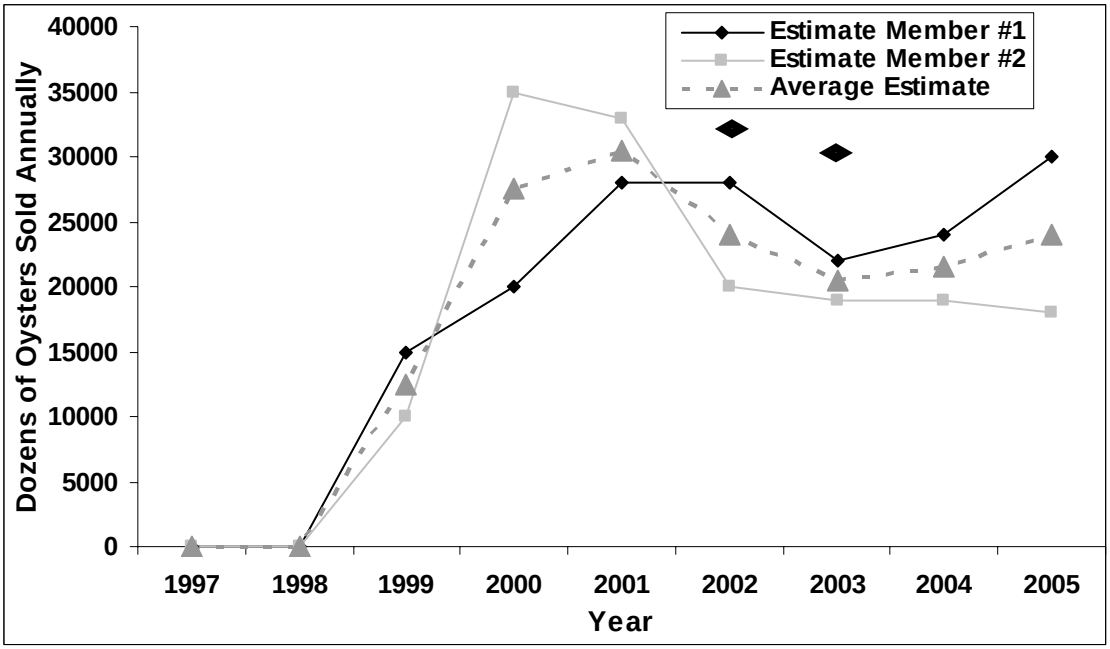


Figure 5.2 Estimates for total dozens of oysters Cooperostra sold on an annual basis since its inception in 1997. Actual quantity of oyster sales in 2002 and 2003 indicated with black, unconnected diamonds.

Member #2 who predicted 18,000 dozen for 2005 (Fig. 5.2) provided an annual total of 32,000 dozen from May 2004 to April 2005 (Fig. 5.1). Given these values, the actual total of oyster sales in 2005 is likely around 25,000 dozen. Consequently, sales for the past 3 years have likely been around 25,000 dozen per year. Total sales around 25,000 dozen oysters per year, have not been sufficient to grant economic self-sufficiency for Cooperostra. The continued existence of Cooperostra relies on further attempts to expand the sales of the cooperative's oysters and/or securing additional external financing.

Selling Excess Oysters to Middlemen

Due to insufficient sales, Cooperostra cannot buy all the oysters that cooperative members supply (Fig. 5.3).

> "The Cooperative needs to sell more…we produce more oysters than it can sell."
> - Cooperostra member, 2004

For example, in 2003, 36,749 dozen oysters were turned in but Cooperostra only sold 30,991 dozen for that year (Fig 5.3). The cooperative members were remunerated for the extra 5758 dozen, at a cost to Cooperostra. The excess oysters would have also been used to replace those that had died from high mortality rates. Numerous Cooperostra members are also upset that they are not able to sell more oysters to the Cooperative.

Consequently, some cooperative members continue to sell to black market[13] middlemen, out of necessity, for half the price obtained from Cooperostra to supplement their income. These black market middlemen undercut the cooperative's market, making it difficult for Cooperostra to charge more for its oysters along the São Paulo Coast (Fig 5.4). Some cooperative members continue to sell to middlemen to retain connections to the market since they are uncertain, and doubtful, about the future of Cooperostra.

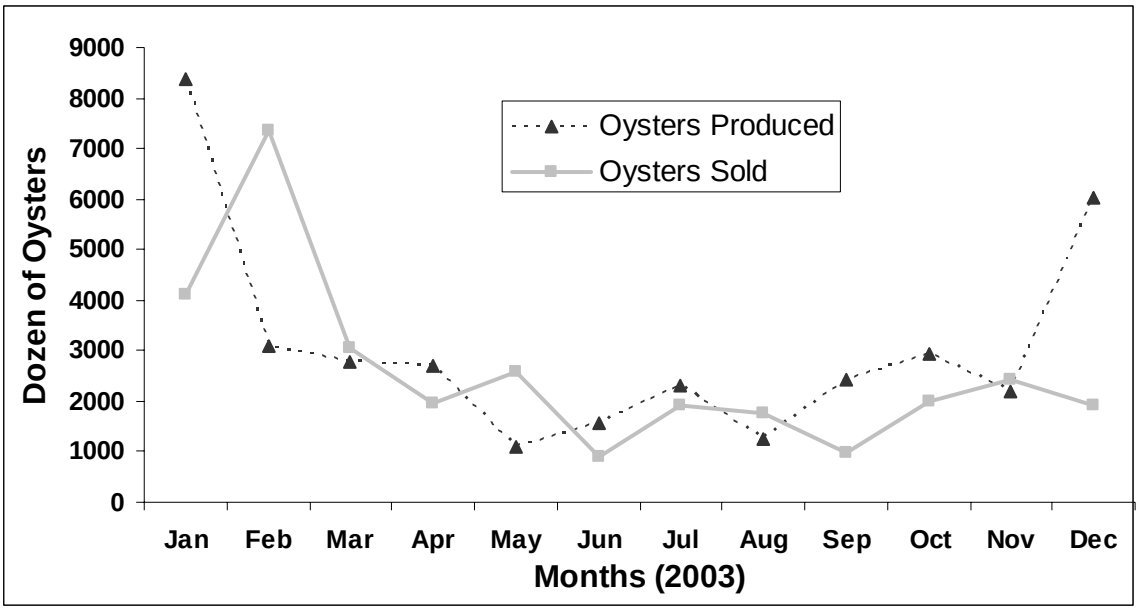


Figure 5.3 Monthly quantity of oysters turned in to and sold by Cooperostra in 2003. (Dozens of oysters turned in = 36749. Dozens of oysters sold = 30991. Difference = 5758)

[13] The selling of oysters without certification from the Federal Inspection Service (SIF certification) is considered to be the black market. SIF certification ensures that oysters are safe from consumption and have been depurated of pathogens such as *E. coli*.

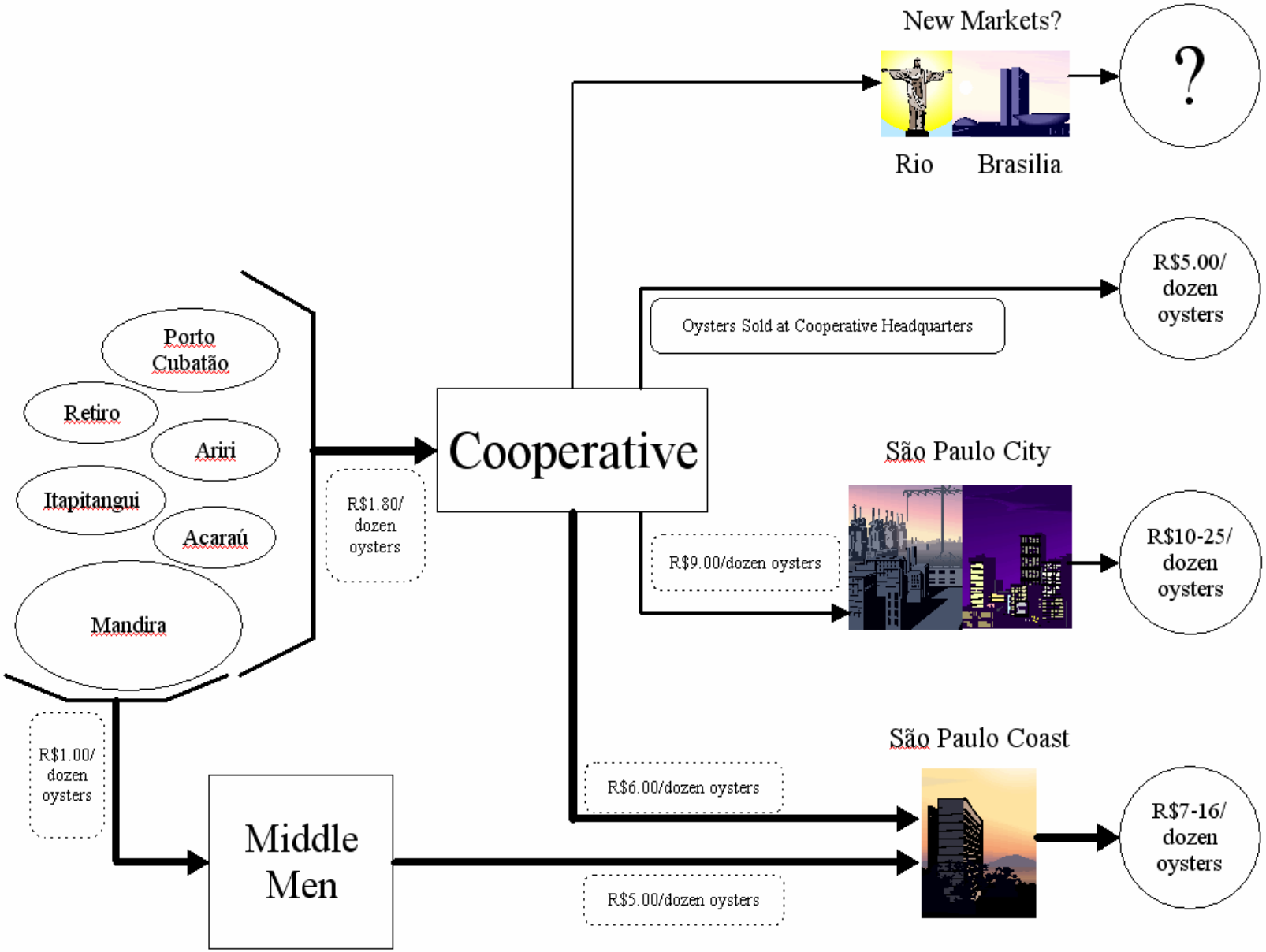


Figure 5.4 The chain of custody of Cooperostra oysters from producer to final consumer.

Market Connection

Cooperostra is still at the mercy of markets. By conquering a greater portion of the current market and opening new markets, the cooperative would overcome its most critical barrier of increasing its total sales. To overcome these constraints, Cooperostra would need to have access to expanding markets throughout Brazil and outside its national border. However, suitable methods for securing markets are unknown or currently not economically viable.

Nevertheless, the Cooperostra members are not totally at the mercy of markets. External financing has helped buffer cooperative members from market fluctuations[14]. Cooperostra along with its external financing cover the costs from limited profits, not individual cooperative members. Currently, the members are paid for oysters once sent to the depuration station. Yet costs imposed by high mortality, which has been a significant problem, are paid by Cooperostra. Furthermore, prices obtained for oysters along the coast, where most sales occur, have low (sometimes even negative) return due to black market competition. These poor returns are not enough to cover operational and maintenance costs to sustain Cooperostra. External financing has been used before to cover these costs, but now external funding has been drastically reduced and Cooperostra is encountering difficulties in sustaining its business. Consequently, cooperative members may not be buffered for long if Cooperostra does not attain economic self-sufficiency.

[14] **Total External Financing**
Garcia (2005) estimates that approximately R$640,000.00 has been invested in Cooperostra, since its establishment in 1997. This total divided by the number of members that have ever been registered with Cooperostra (n = 53), yields about R$12,000.00 per Cooperostra member. However, representatives from the Forest Foundation and Fisheries Institute feel that this figure was over-estimated.

Cooperostra Debt

The poor economic return and lack of sales has led to a large debt for Cooperostra. The debt is further compounded by poor accounting of taxes. Poor accounting and administration, has led to a backlog of unpaid taxes and fines for not paying taxes on time. For example, Cooperostra has not been paying the employer's share of the I.N.S.S. tax [15]. According to Forestry Foundation scientists, failure to pay these taxes could lead to the incarceration of Cooperostra's president.

Governmental Influence on Cooperostra Debt

Although the municipal government granted land and initially provided some assistance to the project, they have not granted any tax breaks for the cooperative to help alleviate Cooperostra's debt. Cooperative members and external support staff feel that the municipal government is not being flexible because most Cooperostra members belong to a different political party than the current party in power. Furthermore, additional taxation, at the state level, is contributing to poor economic returns. São Paulo has a commercial sales tax on oysters of 18%. Whereas in Santa Catarina, the state that produces the most oysters and has conquered the Brazilian oyster market, sales are exempt from tax. Exemption from such taxes, provides a competitive advantage for oyster producers in Santa Catarina. Consequently, without changes in Brazilian tax policy, the development and sustainability of small-scale oyster producer cooperatives in São Paulo State is challenging and limited.

[15] National Social Security Institute tax (*Instituto Nacional do Seguro Social*); for public pension, healthcare, and other public services.

Management Dilemmas within Cooperostra

Poor Management

Cooperostra has had three official, external managers. The first manager was a zoologist who knew very little about business and consequently encountered numerous problems and had limited success. The second manager had considerable business knowledge and experience, however, cooperative members and other external researchers have strong reason to believe that he stole a significant amount of money from Cooperostra. It is believed that he also kept cooperative members from developing a strong basic understanding of the business operations so as to facilitate the fraudulent use of money. The third manager was a geographer who also knew very little about running a business. A large debt was incurred under his supervision and management. In 2002, Cooperostra started, and is currently, self-administering their business with limited assistance, yet significant guidance, from the Forest Foundation and Fisheries Institute.

Inefficient, Centralized Decision-Making Process

Since Cooperostra is responsible for self-administration, major management decisions are determined through voting by all cooperative members, which is greatly influenced by the Forest Foundation, along with input from the Fisheries Institute. However, decisions for day-to-day business operations are dependent on the current Cooperostra president. Such centralized decision-making is a problem since the president is difficult to contact. Firstly, the president is frequently out working in the mangrove and since he lives in Mandira, which is relatively isolated (25km from Cananéia via mostly a dirt road). Furthermore, only one cellular phone may be used as a means of quick contact,

which does not work sometimes depending on atmospheric conditions. Responses to critical questions have sometimes been severely delayed since the response from the president could not be obtained.

Internal Conflicts Among Members

Moreover, there are some minor grudges between some Mandira and non-Mandira Cooperostra members. The Mandira have been crucial in starting the project and even obtaining PDA funding through the Mandira Reserve Association, however, some Cooperostra members feel that the Mandira community favour themselves. This affects decisions of Cooperostra since the majority of cooperative members are from Mandira.

There has been some development in cooperative thinking and such development has led to the teamwork used in the construction of the depuration station and the Mandira Extractive Reserve headquarters. However, some cooperative members feel that true cooperation is not occurring within Cooperostra. Developing a sense of cooperation is difficult since each cooperative member is responsible for his or her own production (Garcia 2005). Cooperostra members do not work as a large team to harvest oysters so it is difficult to rationalize belonging to a team to sell oysters. Garcia (2005) reasoned that some cooperative members see Cooperostra as if it were a middleman that pays better than others. Cooperostra members are particularly upset about the unfair distribution of resources. For example, a fair allocation system needs to be devised to decide the quantity of oysters each Cooperostra member may submit for sale[16]. The current sale of

[16] Nevertheless, cooperative members must decide how much they want to contribute, and thus, receive from Cooperostra. Different people have different needs, i.e. living alone versus supporting a large family, so differences occur.

oysters to Cooperostra by each member is highly biased; i.e. two cooperative members handed in 30% of Cooperostra oysters for sale in 2004 (See Chapter 5).

High Oyster Mortality

The allocation system also needs to consider the size and quality of oysters each Cooperostra member is turning in to discourage the handing in of weak oysters, which die readily during depuration and transportation. Cooperostra is having problems with high mortality rates. High levels of mortality may be induced by several, likely compounding, factors. Firstly, oysters are weakened from reproductive efforts, since the peak in market demand coincides with the reproductive period of the oysters (December to February). Oysters are already stressed and weakened by the production of gametes and do not have substantial energy reserves. Secondly, cooperative members are not leaving oysters long enough in the rearing beds and thus the oysters do not develop physiological resistance. The cooperative members remove encrusted organisms, mainly barnacles, from the oysters by hitting them swiftly with the blunt edge of a machete. This activity stresses and weakens the oyster. It is important for the oysters to be returned to the rearing bed for several days to recuperate from the stress. Furthermore, oysters are placed into large mesh bags for transportation to the depuration station and to save time, some cooperative members clean and place oysters into the bags over several days; i.e. place some oysters in the bags on Sunday, then Monday, and bring in oysters on Tuesday. However, the bags have really small mesh and coupled with crowded conditions within the bag, prevent the oysters from feeding efficiently. Without sufficient nourishment, oysters become very stressed and weakened. High mortality rates may also be attributed

to the over-stocking of oysters outside the depuration station. The conditions outside the depuration station are not ideal for stocking oysters since it further stresses and weakens the oysters as evidenced by increased mortality under those conditions.

Consequently, oysters weakened by any of the factors mentioned above, may die during the depuration, shipping, and transportation process. Death of oysters during transportation has particularly negative consequences for reputation and future sales of Cooperostra. Disappointed consumers will be highly dissuaded by excessive mortality from purchasing oysters from Cooperostra in the future. Especially considering market studies conducted by the Forest Foundation in 1997 and marketing firms in 2001, which revealed that the oyster consumers' primary concern is quality. Consumers who regularly buy oysters are generally wealthy and not concerned with price but fastidious with oyster quality. Moreover, Cooperostra pays its members for oysters upon arrival at the depuration station. If some oysters die, costs are paid by Cooperostra and not the cooperative member. This lack of accountability is contributing to Cooperostra's increasing debt.

Fisheries Institute scientists have raised awareness about high mortality rates to the Cooperative. Mitigation measures to reduce mortality have also been extensively discussed (i.e. ensure the oysters have adequate recovery time on rearing beds, do not overstock at the depuration station, bag all the oysters in one day, etc.). However, Cooperostra has been slow to act on the recommendations of the Fishery Institute.

Lack of Conflict-Management Mechanism

Cooperostra does not have a clear conflict-management mechanism. Ideally, voting and pressure from other cooperative members would deal with conflicts. However, the conflict-management of Cooperostra is poorly developed. Recently a cooperative member betrayed Cooperostra and began to sell black market oysters to Cooperostra's clients. Cooperostra did not take immediate action to shun and expel this member from the cooperative. Family ties make it difficult for Cooperostra to take critical action.

Future Management of Cooperostra

Management problems have been recognized by the Forest Foundation, Fisheries Institute and Cooperostra members, however, there is a lack of understanding and/or consensus on how to ameliorate the current situation. Forest Foundation and Fisheries Institute scientists, along with Cooperostra members, have realized that cooperative members cannot control the entire process from producing oysters to selling oysters, particularly the administrative and commercial aspects. An external manager would help ensure that cooperative members are treated equally and that everyone has decision making input. The manager would assist in the allocation of fair quantities of oysters each member sells to Cooperostra and help monitor quality control to ensure freeloaders do not supply poor quality oysters. Furthermore, the external manager would also oversee distribution of oysters and purchasing of goods for Cooperostra. However, one critical set-back to obtaining an external manager is that the expected minimum wage for a manager in Brazil is much higher than most of Cooperostra members' earnings. Not only is it very costly but it also creates some social tension between cooperative members and

the manager. Particularly, since cooperative members mistrust external managers due to bad experiences with Cooperostra's three managers. It has been suggested that the members become segregated into different groups to enable the specialization of each group into different sectors of the process, thereby increasing the overall efficiency of the groups. For example, unique groups should be involved with production, product enhancement, marketing, and administration.

Training has commenced for the future marketing and administration group. Six adolescents, whose fathers are Cooperostra members, are taking courses on computer usage, administration, and marketing so that in the future they will be able to run Cooperostra themselves. Self-sufficiency may thus be attained by Cooperostra in the future when this group of youths can successfully engage in marketing and administration roles. Further funding was sought to finance the education of these youth by the Forest Foundation and Fisheries Institute through PDA II funds from the Federal Ministry of Environment.

Despite Challenges, Cooperostra is Learning by Doing

- Oysters used to be cleaned of mud and sedentary marine organisms, such as barnacles and seaweed, once they arrived at the depuration station. Now oysters are cleaned at the rearing beds to allow time to recover from cleaning stress before shipping to improve oyster resistance and decrease shipping mortality.

- Oyster-rearing beds were initially made of bamboo but now concrete is used, when affordable, since it is more durable.

- Cooperostra members started placing the oyster crates on PVC tubing during the depuration process to keep the oysters away from purged contents that settle to the bottom of the depuration tank

- Initially the delivery truck did not have an emergency kit, however, after the first breakdown, Cooperostra invested in an emergency kit to speed up recovery and avoid high costs imposed by the need for immediate assistance.

- A fence has been built around the area where oysters are stocked before entering the depuration station to dissuade theft.

Further Processing of Oysters to Increase Sales and Value

Cooperostra is currently exploring processing options to increase the value of its oysters. Research is being conducted on freezing oysters (Portella in progress) to increase their durability. Such research may help Cooperostra increase sales since shipping of the oysters will no longer be restricted by a five-day time limit.

Futher technical and financial support is required to explore other options to process oysters. Canning options currently appear to be too costly for the small-scale of Cooperostra. However, vacuum packing and freezing oysters in half the shell, for restaurants to serve as baked oysters, needs further exploration. Selling oysters in the half shell reduces weight and therefore shipping costs. It also facilitates the preparation for cooking, making it more convenient to prepare and therefore more appealing to customers. Furthermore, the oyster shell could be sold to pharmaceutical companies or animal feed producers that need calcium carbonate extract.

Livelihood Impact

Greater Earnings While Harvesting Fewer Oysters

Following the numerous endeavours of Cooperostra discussed in Chapter 4, cooperative members have been able to double, and in some cases, triple the monetary value obtained for their oysters without compromising the sustainability of the harvest. Cooperostra attained greater value for their oysters partly by dealing directly with local buyers and eliminating transactions with middlemen. With the larger and improved appearance of oysters, coupled with certification and the elimination of middlemen, Cooperostra has increased the value cooperative members obtain for oysters. Figure 5.5 clearly depicts that while the total volume of oyster harvest has declined in all participating communities after joining Cooperostra, income has generally increased significantly. Given the high dependence of Cooperostra members on the oysters for income, the conservation of oyster stocks is vital for their economic security.

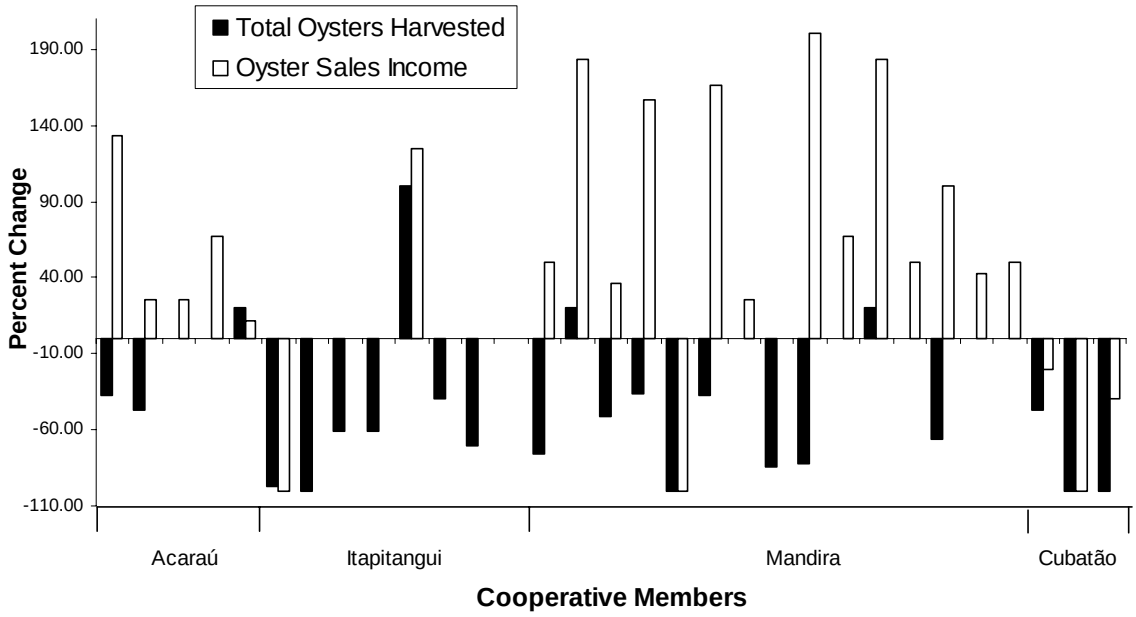


Figure 5.5 Percent change of total oysters harvested and income for each cooperative member after joining Cooperostra (Garcia 2005).

Impact on Individuals and Families: Case Studies

Each Cooperostra member's situation is different within Cooperostra. Cooperostra has also had different degrees of impact on each Cooperostra member. The range of situations and impacts Cooperostra has had on its members is better portrayed in the following life story case studies.

Privileged Family #1 (Mandira)

Family

History

The mother of this Cooperostra member is a direct descendent of Mandira. She met his father, who was from the nearby rural municipality of Jacupiranga, at a regional ball. They fell in love and eventually became married. The couple pursued a life in Mandira since they valued the high social capital of the Mandira, which enabled them to engage in teamwork to productively cultivate the land.

Present

The Cooperostra president is married and has five children, ranging in age from 11 to 23. Two of his sons are intending on going to university with scholarships available to them because of their quilombo designation (Tutarati 2000). Two other sons finished obtained their Grade 11 education and the youngest son is in the fifth grade. He would like his sons to remain in Mandira, however, he understands that opportunities for them here are limited. Ideally, he would like to see them take over different aspects of Cooperostra.

His wife is part of the Seamstresses' Cooperative which was established in the Mandira Extractive Reserve by several wives of the Cooperostra members.

Two of his sons also work harvesting mussels. His other two sons also carve wooden sculptures and weave baskets to earn extra money. One of his sons has completed training to be an environmental monitor for eco-tourism activities on the reserve.

The family lives in the seven room, brick home of the mother which he has inherited and owns. The flooring is tiled. The family owns a TV, refrigerator, VCR, satellite, radio, motor boat, dugout canoes, car, fishing equipment, and oven; all purchased with earnings from Cooperostra. He does not borrow money from people or the bank, but if necessary, he would borrow money from the bank.

Cooperostra Involvement

His primary source of income is from Cooperostra. However, he does fish for subsistence and make traditional baskets as a hobby and to earn some extra money. He has a total of 28 rearing beds, which he works on with his sons. He claims to sell 100% of oysters to Cooperostra. In total he has attended approximately 200 meetings. He feels very well respected within Cooperostra and always feels comfortable to make suggestions at meetings. He feels that he is an active decision maker. He is very happy to be part of Cooperostra. However, he feels Cooperostra could improve by opening the market and increasing sales. If sales increased, he would like to include every single oyster harvester in the region in Cooperostra.

Learning Exchange

Most everything he has learned is primarily from the Forest Foundation and Fisheries Institute, but NUPAUB has also been very important. IBAMA has also played a

role for devising regulations for the extractive reserve. IBAMA arranged for him to meet with rubber-tappers who lived in a reserve in Pará State to discuss key issues of living within an extractive reserve. He would rather learn horizontally from people in similar situations since it is difficult to understand scientists. He also feels that scientists do not know the reality of their situation and rely too heavily on theory.

> "Scientists only know theory, they don't know the day-to-day [reality]."
> - Cooperostra member May 2005

He has also provided numerous lessons on oyster harvest and aquaculture to other people from diverse Brazilian states, including Ceará, Rio de Janeiro and Paraná. He has pride in having contacts all over Brazil. He also has numerous contacts through Cooperostra's market, primarily in São Paulo city and along the São Paulo State coast.

Cooperostra Impact on Life

He takes great pride in what he does now, he is proud to work for Cooperostra. Before he worked in fear of the Environmental Police, but now they are his friends and treat him as equal. Cooperostra has also given him the opportunity to travel extensively within Brazil and he also attended the World Summit on Sustainable Development in Johannesburg, South Africa. He is very proud to be the first Mandira descendent to fly in an airplane (three other Mandira members have flown within Brazil as well).

Privileged Family #2 (Non-Mandira)

Family

History

The family of this Cooperostra member has been living in Cananéia for generations and are likely of mixed Portuguese and indigenous ancestry. His family have subsisted for generations primarily from fishing, but also on resources from the Atlantic and mangrove forests in the region. Such rural coastal inhabitants of Southeast Brazil are referred to as *caiçaras*.

Present

This Cooperostra member is recently divorced, and living with a new partner. He has 3 children, ranging in age from 4 to 12. His children are now attending a private elementary school, which provides much better educational services than public schools. He hopes his children will live in Cananéia, however, he understands that they may have to move to pursue better futures. He does not want them to be a fisherman or work with Cooperostra. Ideally, he would like to see his children become teachers or doctors. His ex-wife and current partner are homemakers and the children are too young to work.

He owns two brick houses, one with 7 rooms (his divorced wife and children live) and the other with 5 rooms (where he lives now). The larger house has tiled floors, but he intends to put tiles in the second home too but has been really busy with construction and other renovations. He has not had to ever borrow money, but if he did he would not borrow money from a bank because he

does not trust banks. He owns a TV, VCR, refrigerator, cellular phone, satellite dish, radio, two motor boats, fishing equipment, and stove.

Cooperostra Involvement

This cooperative member estimated that he earns 80% of his livelihood from Cooperostra. He also fishes and hunts sometimes, even though he is aware that it is illegal. He does not harvest any oysters or own any rearing beds. He earns a salary to work and oversee operations at the depuration station. He has attended all the Cooperostra meetings since the beginning, but could not provide an estimate. He feels well respected by Cooperostra. He feels that he is an active decision maker in Cooperostra. However, he is shy to speak publicly so he does not speak up often at meetings. Nonetheless, he provides suggestions and feedback by whispering to other members near him at the meeting who are bolder and speak up readily. He also discusses Cooperostra issues outside of the meetings and feels that he has great influence via such methods. He is happy to be part of Cooperostra.

He feels that Cooperostra could improve by increasing its sales, improving the quality of production, and its administration. In particular, he thinks that too much emphasis in past advertising campaigns was placed on promoting oysters from Cananéia. Although it has helped Cooperostra, it was also free publicity for the competitor in the region, Jacostra. He feels that Cooperostra needs to promote their name more.

Learning Exchange

The Forest Foundation and Fisheries Institute have provided detailed technological training and support. This Cooperostra member really appreciated the

respect that the technicians show when teaching or advising Cooperostra. For instance, the technicians insisted on being referred to on a first name basis and never doctor. This helped break down social barriers and create a platform of mutual respect. This Cooperative member stated that he has learnt a lot with Cooperostra, though it is difficult to provide specific examples. He has especially learnt how to be flexible to mediate diverse opinions for completing diverse tasks.

> "I have learnt to work with different people,
> with different attitudes and manners."
>
> – Cooperostra member 2005

He also feels that it is easier to learn horizontally from other people with experience than from external technicians. Communication is difficult sometimes with external technicians. Learning from others horizontally is easier since they share a common language. He also values practice much more than theory, and thus would rather limit theory and learn as much as possible about practice.

This cooperative member has also learnt to teach. He stated that he regularly teaches other people from all over Brazil and sometimes the world, about Cooperostra and in particular the depuration station. He regularly provides lectures about Cooperostra to students, for which the Cooperative collects a fee of R$2.00 (Brazilian Reals; approximately $1 Canadian [December 2005]) per student. He also feels that these lectures are an important marketing opportunity for Cooperostra and readily encourages the students to eat Cooperostra oysters. He has made numerous contacts working for Cooperostra i.e. for assistance to maintain the depuration station, providing oyster and water samples for analysis, and marketing.

Cooperostra Impact on Life

He feels that his life has improved significantly because of Cooperostra. Now that he is working for Cooperostra, he feels much more respected. He is also very grateful for earning a fixed salary, so now he does not have to worry about whether he will make enough money to pay for expenses. Before he used to spend 4-5 days away from home on fishing trips, but now he gets to be home everyday. He also has money to enroll his children in extra-curricular activities, which he feels is very important for their long-term development. As they approach their teenage years, he wants them to be involved with positive activities and goals so that they will not get involved with substance abuse, which he feels has been increasing over recent years in Cananéia.

Relatively Neutral, Yet Grateful Family (Non-Mandira)

Family

History

The family of this Cooperostra member has been living in Acaraú for generations and like the previous member is of *caiçara* descent. Caiçaras are of mixed Portuguese and indigenous ancestry and traditionally subsisted primarily from fishing, but also on other mangrove and Atlantic forest resources.

Present

This Cooperostra member lives in a household with 7 family members. He supports his mother who is 78. He also has one son (23 years old) and two daughters (14 and 16 years old). His daughters are in the 7^{th} and 8^{th} grade but his son only achieved a grade 3 level education. Ideally, he would like his daughters

to be lawyers or computer teachers. He thinks they will probably live in Cananéia. Other than his daughters and mother, everybody else in the household are fishers.

He owns one, 4-room brick house with rustic floors. He avoids borrowing money and never wants to be in debt, but he would use a bank if necessary. He owns a refrigerator, cellular phone, radio, and fishing gear.

Cooperostra Involvement

This cooperative member estimates that he earns nearly 90% of his livelihood from Cooperostra, but he also fishes regularly and harvests mussels and crabs infrequently. He currently has 4 functioning rearing beds, however, he would like to set up 10 to 12 more to have more oysters to sell during the banned season. He's attended numerous meetings and had difficulty providing an estimate but guessed 40 or more. He feels well respected by Cooperostra and that he is an active decision maker. Normally he feels comfortable to speak up at meetings. Even though sometimes he gets slightly annoyed with other Cooperostra members, he is very happy to be part of the cooperative.

He feels that the most critical aspect Cooperostra needs to improve is increasing its sales. He also thinks additional concrete rearing beds need to be built since they require much less maintenance and are very durable.

Learning Exchange

He feels that both the Forest Foundation and Fisheries Institute have provided valuable orientation and support. He learnt the ecological and economic importance of respecting the environment and IBAMA regulations, such as bans on collecting small oysters, nets with small mesh, and bans during the reproductive season. He stated that he

has learnt a lot from Cooperostra, from all the courses that have been provided to cooperative members. He stated that he would rather learn horizontally from people in similar situations than vertically from technicians. He feels that technicians are hard to understand at times and that it is easier to learn from other cooperative members. He also has made numerous contacts through Cooperostra. He actively networks by distributing cards to potential clients to divulge Cooperostra and his contact information.

Cooperostra Impact on Life

This cooperative member feels that his life has significantly improved; life is much easier now:

> "It was more difficult before [Cooperostra] ….much more difficult."
> - Cooperostra member, May 2005

Now he knows where he can have a steady source of income; a reliable place to sell oysters. Before Cooperostra, he also worked collecting moss and lichens for the floral design industry. He never earned as much money as he does now working for Cooperostra. He was actually invited to join a moss collectors' cooperative, but refused since Cooperostra requires huge time commitments. Even though he has not profited as much from Cooperostra as the two previous examples (i.e. owns less consumer goods and has a smaller home), he is nonetheless very grateful for what Cooperostra has provided him.

Disadvantaged Family (Mandira, but living in neighbouring town)

Family

History

The father of this ex-Cooperostra member is a direct descendent of Mandira. However, he moved to the nearby municipality of Porto Cubatão since his wife is from Porto Cubatão and to seek better a better living for his family.

Present Situation

He worked as a construction worker earning minimum wage and selling oysters to middlemen. However, when he was approached by a Forest Foundation worker and told that he could earn R$2.00 per dozen of oysters, he decided to devote nearly all his time to harvesting oysters in the mangroves near Porto Cubatão. Some disagreements ensued, which were likely exacerbated by his passionate and outspoken nature, and he was shunned by Cooperostra before he could even sell any oysters to the cooperative.

Cooperostra members must pay taxes to the Federal Revenue and Customs Administration (*Receita Federal*) on the cooperative's profits. Taxes are imposed on each cooperative member, regardless if he or she has earned money from Cooperostra. Cooperostra normally pays all these taxes, however, they have not paid taxes for this member. He is not capable of paying the taxes himself, since he has 5 children to support and is paying for medication for a circulatory disease. Since neither he nor Cooperostra have paid his portion of these taxes, the government has blocked his "Social Security Number" (Cadastro de Pessoas Físicas [CPF]) so he is currently unable to return to construction work. He can

also no longer vote since his CPF number has been barred. He now earns a lot less than he use to, by pursuing small, under-the-table jobs, fishing for subsistence, and selling shellfish (mussels and oysters) to middlemen. However, he says the middlmen are annoyed with Cooperostra and now offer even less renumeration in an attempt to sell oysters even cheaper to consumers and prevent Cooperostra from increasing sales. His wife provides most financial support for the family on her minimum salary which she earns preparing oysters for shipping at a nearby private oyster enterprise, Jacostra.

Ideally, he would like his children to pursue professional careers, i.e. law and medicine, however, he says times are tough and he does not know how long he can support them on the family's current income.

He owns one, 5-room brick house with rustic floors, which is in need of repairs. He avoids borrowing money and never wants to be in debt. With his CPF number barred, he is not able to use a bank. He owns a radio and fishing gear.

Cooperostra Involvement

Even though he is now currently shunned from the Cooperostra. He initially attended more than 30 meetings. He also provided manual labour to help build the Cooperostra headquarters and depuration station. He feels that Cooperostra is too centralized with only a few members earning benefits. In particular, he feels that the president (his relative) needs to be replaced and somebody else needs to be given the presidential position.

Learning Exchange

Due to his elevated state of agitation, especially considering the interviewee's health condition, the researcher did not feel that it was appropriate to discuss what this cooperative member has learnt from Cooperostra.

Cooperostra Impact on Life

This cooperative member feels that he was abandoned by Cooperostra and wishes that he never got involved with the cooperative. He feels that he wasted his time and efforts on Cooperostra. Because of his involvement with Coopersotra, he is no longer able to obtain legal work or vote. He has a negative outlook towards life. He also feels abandoned by the government, and thinks that the government imposes unfair regulations on the poor:

> "The government only taxes the poor, the rich can do whatever they want. The rich can destroy the mangrove to build their big houses, yet I can't collect oysters in the mangrove to feed my family."
>
> - ex-Cooperotsra member, 2005

Distribution of Income

As indicated by the case studies of Cooperostra's impact, Figure 5.5 (pg. 74) also shows that the distribution of income has not been equal for all cooperative members. Cooperostra members from Mandira have earned the largest oyster sales income. Whereas in Itapitangui the oyster sales income has generally remained unchanged and in Cubatão (actually Porto Cubatão), the oyster sales income dropped significantly.

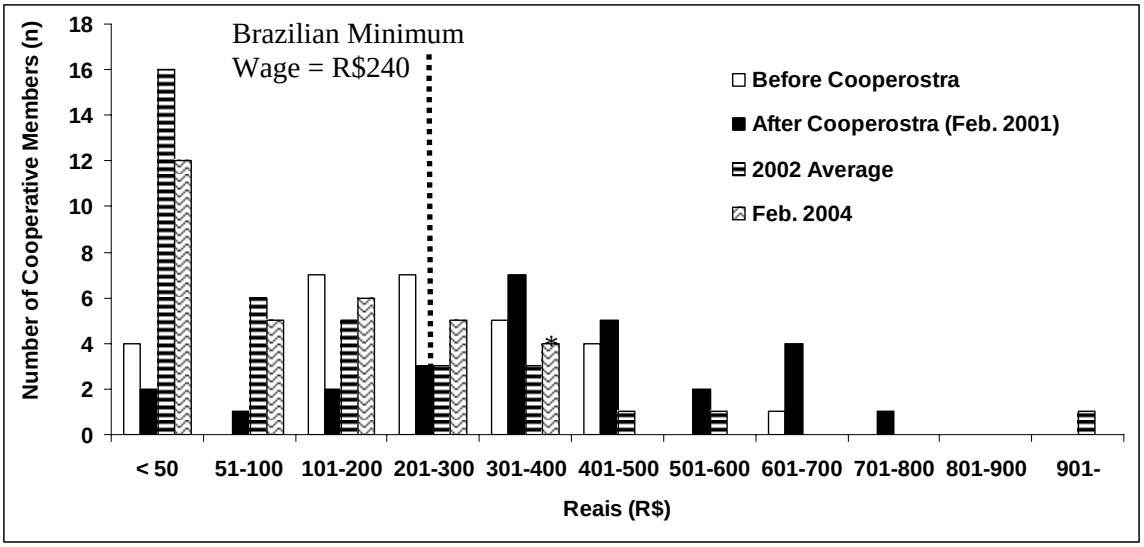


Figure 5.6 Distribution of earnings of cooperative members, before and after Cooperostra was started (around Feb. 2001), the 2002 average, and Feb. 2004. [Data obtained from Tatiana Garcia and Cooperostra's records].

Even though it is difficult to assess normality of distribution based on such a small sample-size, Figure 5.6 presents the distribution of cooperative member earnings before and after the establishment of Cooperostra, and in 2002 and 2003. Before the implementation of Cooperostra (white bars), salaries were relatively uniform and showed a distinct bell-shaped curve (Fig. 5.6). After the initiation of Cooperostra (black bars), salaries for each cooperative member improved slightly and uniformly, maintaining a normal distribution (See black bars, Fig. 5.6). The 2002 average (horizontal striped bars) shows that earnings are slightly skewed with most Cooperostra members earning less than the Brazilian Minimum Wage of R$240 and one individual earning approximate four times the minimum wage at around R$950 (Fig. 5.6). By Feb. 2004 (squiggly lined bars), declining sales led to a decrease in the overall earnings (Fig. 5.6).

Furthermore, the R$300-400, Feb. 2004 bar has an asterisk since the four Cooperostra members may be earning more than R$400, and consequently represent an even more skewed distribution of incomes among cooperative members. These data were

obtained during the periodic Cooperostra meeting in which the Forest Foundation was discussing the current problems of the cooperative. The value earned was likely reported as greater than R$300, and not the actual value, to prevent internal strife from having all Cooperostra members know about the concentration of earnings in just a few members. However, during the meeting, Forestry Scientists made Cooperostra members aware that in 2004, two cooperative members supplied 30% of the oysters Cooperostra sold. The Forest Foundation researchers informed the cooperative members that earnings need to be more equally distributed but did not provide mechanisms by which to achieve a fair distribution of salaries for Cooperostra members.

Impact on Time

Cooperostra members now realize selling small oysters in deshelled packages of up to 120 is detrimental to future oyster stocks, and they understand the benefits of harvesting larger oysters. Before cooperative members would spend a lot of time deshelling small oysters for sale but now have more time to pursue other activities.

Some Cooperostra members have also invested their increased earnings into the creation of concrete oyster rearing beds, which require less maintenance work than bamboo rearing beds. Those cooperative members have additional time now to expand their oyster harvesting operations or to fish and catch crabs. Cooperative members receive twice as much per dozen oyster from selling to Cooperostra than they do from selling to middlemen. (Cooperostra pays on average R$1.70/dozen and average black market price is R$0.70/dozen). Cooperative members recognize that they can work less

and gain more from being part of Cooperostra. However, they also recognize that they need to spend time participating in the various, lengthy meetings:

> "Cooperostra pays more than middlemen but
> it also demands a lot more of our time…
> we have to attend all these meetings."
> – Cooperostra member, 2004

Future of Next Generation

With PDA II funding, the second generation is being educated on business administration and marketing, and subsequently learning computer and networking skills. It is hoped that in the near future, they will oversee the administration and marketing of Cooperostra. Three of the youth have also been trained to be environmental monitors, to help monitor and enforce regulations in the Mandira Extractive Reserve. Some Cooperostra youth are also writing entrance exams to enter into in biology, aquaculture, or agriculture programs at public universities. Such an education would help emancipate them from their socio-economic constraints and contribute greatly to Cooperostra, Mandira Extractive Reserve, and possibly other conservation and development projects.

Communal Benefits

Most improvements have been at an individual level. Communal benefits include the construction of the headquarters for the Inhabitants of Bairro Mandira Reserve. Other than facilitating the organization of Cooperostra (i.e. a place to have meetings), the headquarters is also used for social events and other community activities (i.e. capoeira lessons).

Increased Pride and Dignity

Most cooperative members have great pride in belonging to Cooperostra. Before Cooperostra, oyster harvesters were embarrassed to admit they collected oysters for a living. However, now they are proud of the work they do:

> "*Before I use to lie and say I was a fisherman.*"
> - Cooperostra member 2004

> "*Oyster harvesters used to be the miserable class…*
> *now it's a job with dignity and moral.*"
> - Cooperostra member 2004

Cooperostra members take pride that Cooperostra was the reason for the first two times a Minister from the federal government visited Cananéia. The Minister of Environment inaugurated the depuration station in 1999 and the Minister of Fisheries visited Cooperostra in 2002. Cooperative members also stated that the first time the Cananéia bank branch manager dealt directly with a client was with Cooperostra members. Cooperative members are also very proud that people from different cities, states, and countries have come to visit, study, and learn about Cooperostra. They feel that they are now particularly well known in Cananéia and neighbouring cities such as Registro. Cooperative members feel that by wearing Cooperostra t-shirts they are better respected. The Mandira Cooperostra members also take pride in belonging to the only extractive reserve in São Paulo state. Public recognition from local, national, and international media has also instilled a sense of pride for the cooperative members.

International recognition from being a finalist for the 2002 Equator Prize greatly increased the pride cooperative members felt for Cooperostra. This increased pride helped motivate Cooperostra members to continue with their goals and overcome their

challenges. Despite major economic challenges, most Cooperostra members are optimistic that business will improve and they meet regularly to seek out new marketing strategies to overcome financial difficulties.

Summary

Located within the poorest region of São Paulo state, rural inhabitants rely on the regional biological resources to sustain their livelihoods. The abundance of biological wealth of the region provides a reliable source of nourishment and has even helped most residents to purchase consumer goods.

There is marked seasonality in oyster sales, with sales being greatest during the Brazilian summer, from December to February. Estimates of Cooperostra sales from cooperative members suggest that Cooperostra sales increased from 1999 to 2001 and have since plateaued. The provision of oysters to middlemen for sale on the black market has undermined the cooperative's own market. Current sales are insufficient for Cooperostra to be a profitable endeavour, consequently the cooperative has relied and still relies on external financing to cover costs. In addition to debt, Cooperostra has encountered numerous dilemmas with its management. However, the cooperative is learning from these dilemmas even though it is a very time consuming, and sometimes costly, process. Adolescent children of Cooperostra members are being trained in administration and marketing to help improve the cooperative's current situation. Despite its challenges, Cooperostra has enabled most of its members to harvest fewer oysters and earn better wages than before. Nevertheless, benefits have not been equally distributed among Cooperostra members.

CHAPTER 6
BIODIVERSITY CONSERVATION

Introduction

This chapter focuses on the fourth objective:

IV. How has Cooperostra contributed to conservation efforts?

This chapter is organized around key assumptions of conservation interventions; i.e. conservation may be facilitated by developing employment, education, exclusive access rights, and aquaculture intensification. Barriers and constraints for each intervention are presented in the context of Cooperostra. Oyster stock and harvest assessments in Cananéia and by Cooperostra are also discussed along with the development of the Mandira Extractive Reserve. Evidence supporting the co-existence of three different oyster species in Cananéia is presented and the implications for oyster aquaculture operations are discussed. The last part of the chapter addresses the lack of a biodiversity benchmark data and subsequent limitations for the quantitative assessment of conservation impact.

Biodiversity Conservation

Interventions to reduce conservation threats are based on several key assumptions (Fig.6.1). Three key assumptions for Cooperostra include that employment, conservation education, and granting exclusive access rights[17] will help change the attitudes and behaviour of cooperative members to reduce unsustainable practices. Another key assumption is that aquaculture intensification will reduce pressure on wild oyster stocks.

[17] Exclusive access rights have only been granted to cooperative members residing in the Mandira Extractive Reserve.

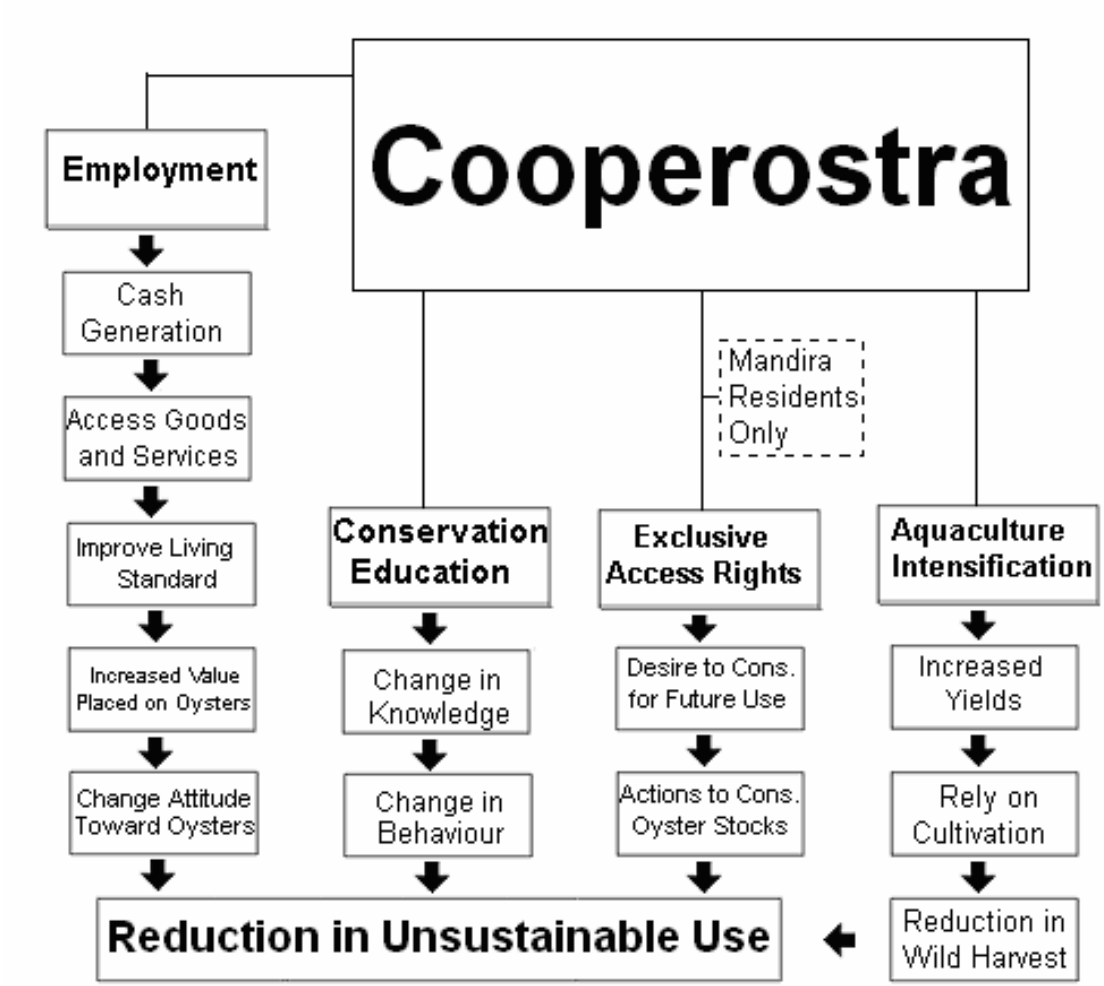


Figure 6.1 Rationalization model of Cooperostra conservation interventions for reductions in unsustainable oyster harvest.

It is very difficult and costly to assess the impact conservation interventions have on the surrounding biodiversity. For example, understanding Cooperostra's conservation impact would require extensive technical and financial support to conduct thorough, systematic oyster stock and ecological assessments. Assessment of conservation impact may be more efficiently defined and measured by using Threat Reduction Assessment (TRA) developed by Salafsky and Margoluis (1999). The TRA approach does not measure specific biological parameters but uses threat reduction to assess conservation impacts. The TRA approach is subject to bias, but it has numerous advantages over

conventional biodiversity assessments (Salafsky and Margoluis, 1999). TRA is sensitive to changes over small periods of time unlike complex ecological data, which have substantial lag time and are difficult to interpret due to high levels of natural fluctuations (Salafsky and Margoluis, 1999). The ease of interpreting TRA data also facilitates its dissemination and comprehension to all stakeholders, minimizing time and transaction costs. The TRA approach can also be done in retrospect, for cases in which baseline data has not been collected (Salafsky and Margoluis, 1999). Furthermore, TRA can also be used to compare conservation impacts in different areas (Salafsky and Margoluis, 1999).[18]

Barriers and Constraints to Conservation

Barriers and Constraints to Employment Intervention

Cooperostra has contributed greatly to the generation of cash and the standard of living has improved for most, albeit unevenly (See Chapter 5). Marginalized members who are earning less may not value oyster stocks and continue pursuing unsustainable practices (i.e. over-harvesting to sell to middlemen). In fact this dichotomy within Cooperostra could further aggravate conservation efforts by instilling new desires in marginalized members for consumer goods obtained by privileged cooperative members. Marginalized members may further exploit resources than previously before to maintain their status and dignity within Cooperostra and their community. Conservation and development interventions must distribute benefits evenly and include the most poor and

[18] Due to time and logistical constraints, a thorough exploration and application of TRA was not possible within this study of Cooperostra.

marginalized. Individuals not receiving a fair share of economic benefits may resort to practices, which threaten conservation, to supplement their meagre earnings.

Oyster Stock Assessment

Nevertheless, with the greater value obtained from oysters, pressure on wild oyster stocks from Cooperostra members has decreased since they no longer have to collect as many oysters to meet their basic needs. Informal stock assessment by cooperative members and government scientists confirm that oyster stocks within the mangrove and in particular the Mandira Extractive Reserve, have been relatively constant and possibly increased slightly since the implementation of Cooperostra. The lack of benchmark data, however, has prevented a systematic comparison of oyster stocks before and after the implementation of Cooperostra to verify these observations. Nevertheless, fisheries researchers conducted a two-year study in 1999 and 2000 to estimate oyster populations within mangrove forest stands (Pereira et al. 2000c) and along rivers and creeks (Pereira et al. 2001a) around Cananéia. Population estimates were calculated from data obtained on mangrove forest composition, tree diameter at breast height, root occupation diameter, tree density, oyster number/root area, and oyster number/sample plot area. Pereira and others (2000c and 2001a) estimated that there are 16,774,686 dozen oysters, of which only 1,550,000 dozen oysters are of commercial size (> 5cm).

Estimates for Maximum Sustainable Yield

Cananéia

Using previous oyster stock estimates (Pereira at al. 2000c and 2001a) along with knowledge of oyster recruitment and mortality rates, Pereira and others (2000b; 2003) suggested that the maximum sustainable yield per month is slightly more than 60,000 dozen oysters per month in the entire region of Cananéia. Similarly, and based on the same estimates of Pereira and others (2000c, and 2001a), Garcia (2005) estimated the annual maximum sustainable yield of oysters to be 700,000 dozen oysters or approximately 58,000 dozen oyster per month.

Mandira Extractive Reserve

Bastos (1997) estimated the maximum sustainable yield of oysters in the Mandira Extractive Reserve to be approximately 240,000 dozen per year or about 20,000 dozen per month. However, his methodology was flawed because he assumed that oysters occur in similar abundance throughout the mangrove forest. There are actually greater amounts of commercial sized oysters on the periphery of the forest where faster water currents transport greater quantities of oyster larvae and food. Thus, there is an increased likelihood that oyster larvae would establish themselves on the periphery of mangrove forest with faster currents providing nourishment for the oysters to grow faster and larger. Consequently, it is likely that the maximum sustainable yield of oysters within the extractive reserve is less than 20,000 dozen oysters per month.

Oyster Harvest in Cananéia

In the 1970s, oyster yields were estimated to be approximately 35,000 dozen per month (Campolim and Machado 1997). However, by the early 1990s average oyster yields were approximately 60,000 dozen per month. In 1997/98, the estimated oyster yield was 76,000 dozen per month (Sales and Maldonado 2000). The drastic increase in oyster harvesting over a twenty year period is attributed to 1) increased market demands 2) poor economic return received from selling oysters and 3) increased harvesting as a result of increasing rates of unemployment, underemployment, and inflation in Brazil (Sales and Maldonado 2000). In 1999, production declined and was estimated around 47,600 dozen per month (Pereira et al. 2000a)[19]. This decrease in production was considered to be the result of lower production because of adverse weather brought upon by el niño and increased enforcement of SIF certification (Pereira et al. 2000a). However, this decrease may also be indicative of dwindling stocks as a result of over-harvesting of significant numbers of the oyster reproductive cohort. In 2000 production is suspected to have declined further to 25,000 dozen oysters per month (Pereira et al. 2001a), which is less than 50% of the maximum sustainable yields (Pereira et al. 2000b; Garcia 2005).

Total Oyster Yield of Cananéia Oyster Producers' Cooperative

SIF reports examined at Cooperostra headquarters revealed that the cooperative's total annual sale of oysters in 2002 was 30,458 dozen and approximately 29,000 dozen in

[19] Approximately 70% of the yield is obtained from extractivism and the remaining 30% are obtained from artificial oyster beds (Pereira et al. 2000a).

2003.[20] Consequently, Cooperostra is harvesting approximately 2,500 dozen oysters per month, which in 2000 represented 3% of estimated total oyster production (81,0000 dozen oysters per month) (Pereira et al. 2000c), 10% of estimated total oyster harvest in Cananéia (25,000 oysters per month) (Pereira et al. 2000c), and 4.2% of the estimated maximum sustainable yields (59,000 dozen oysters per month) (Pereira et al. 2000b; Garcia 2005). These results suggest Cooperostra could increase production slightly without compromising the sustainability of the oyster stocks. However, an adaptive resource management approach (Walters 1986) should be implemented to account for unpredictable changes in oyster stocks due to climate, pestilence, socio-economic changes and other unpredictable factors. Moreover, Decisions to increase production should not be based solely on oyster production or estimated sustainable yields (Charles 1998). A resilient fishery system requires a multidimensional view examining ecological, socio-economic, community and institutional sustainability (Charles 1998).

Barriers and Constraints to Conservation Education

Conservation education is important, and it has played a key role in reducing conservation threats for Cooperostra; however economic wellbeing will always take precedence. Conservationists can preach about how biodiversity must be conserved for the resilience of our planet, but rural inhabitants must be able to meet their basic needs before they attempt to pursue conservation goals. Conservation goals may best be achieved by establishing a direct link between conservation and economic wellbeing. Consequently, education is required to reveal this link between conservation and improved livelihoods (i.e. See Fig 4.1). By improving and securing livelihoods, rural

[20] Data for other years was either not complete or not available.

inhabitants are emancipated from socio-economic constraints and granted the option to conserve resources. Conservation education alone is not sufficient to change people's behaviours to reduce conservation threats.

Barriers and Constraints to Exclusive Access Rights

The Forest Foundation, Fisheries Institute, and University of São Paulo helped Cooperostra members of Mandira obtain political voice and legal rights to their resource, by assisting with the designation of the Mandira Extractive Reserve. However, enforcing exclusive access rights is difficult. The lack of financial and technical resources, coupled with the difficulties of navigating the dense mangrove and Atlantic forest, make enforcement of regulations a very difficult task. Nevertheless, the Mandira Reserve Association is working with the Brazilian environmental agency, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), to ensure active enforcement of resource use laws within the reserve, primarily to prevent outsiders from claiming resources within the reserve.

Furthermore, even though the project members might be granted rights and active control of the resource, they are not economically secure to commit to long-term conservation goals. Project members need consistent organizational support to secure economic futures, since securing rights and active control over resources is necessary but not sufficient for sustainability. For example, rubber tappers in Amazonian extractive reserves are empowered with rights and control to their resource but are still at the mercy of highly fluctuating international rubber prices (Brown 2002). Furthermore, the extractive reserve needs to be sufficiently large to allow inhabitants to pursue sustainable

livelihoods within the reserve. Neighbouring inhabitants of the Mandira extractive reserve are outraged that they cannot enter the reserve to use the resources within yet the reserve inhabitants regularly usurp resources outside the reserve. To keep conservation goals an option and to attain them successfully, basic needs must always be sufficiently met. Solely granting exclusive access rights is not sufficient to promote conservation.

Development of the Mandira Extractive Reserve

A conservation strategy initially devised in Brazil is the establishment of extractive reserves. An extractive reserve is defined as "a natural area occupied by populations that have traditionally extracted local biota for subsistence and sustainable economic gain, in accordance with resource use plans previously established and approved by IBAMA." Extractive reserves protect vast areas of land from large-scale mining, forestry, and agriculture and protect the small-scale, sustainable livelihoods of traditional inhabitants.

In the early 1990s, numerous extractive reserves were established in the Amazon to protect the livelihoods of rubber-tappers, *seringueiros*, who primarily harvest latex from the rubber tree (*Hevea brasiliensis*). However, in 1991 the Brazilian Center for Sustainable Development of Traditional Communities (CNPt) and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) established a partnership with research scientists from Center for Wetland Conservation (NUPAUB) at the University of São Paulo, with a common goal of creating an extractive reserve in the Coastal Atlantic Rain Forest. NUPAUB[21], with the support of the Finnish Department

[21] NUPAUB continues to support academic and applied research of Cooperostra and the Mandira Extractive Reserve.

for International Development Co-operation (FINNIDA), they commenced socio-economic studies of communities within the region (see Sales and Moreira, 1996). The São Paulo Forest Foundation also collaborated with these research efforts investigating the viability of an extractive reserve in the region.

With the results strongly supporting the viability of the reserve coupled with a high level of support from the Mandira community, a preliminary development plan was drafted with the assistance of the Fisheries Institute. This plan was greatly influenced by the results of the an ecological and socioeconomic zoning project sponsored by the Secretariat of the Ministry of Environment (SMA), which suggested initiating aquaculture projects to achieve simultaneous development and conservation in the region. The development plan was further elaborated with active consultation from the future inhabitants and technical assistance from the Forest Foundation and Fisheries Institute scientists. The development plan also included the co-execution of the Cananéia Oyster Producers' Cooperative. Meetings were also held with technicians from IBAMA and inhabitants of Amazonian extractive reserves, to learn more about the concept, as well as the constraints and opportunities, of extractive reserves to produce a better plan. After more than one year of regular consultations, a detailed development plan was drafted and verified by all inhabitants and external collaborators. This Development Plan contains the norms and criteria for the transparent and participatory use of resources and space within the reserve. With this plan, scientists from the Forest Foundation, Fisheries Institute, and NGO Gaia, along with the community members, drafted a successful proposal to obtain funding from the Demonstrative Projects Type A (PD/A) fund available through the Ministry of Environment (MMA). This funding was vital for the

construction of the depuration station for Cooperostra and construction of the Mandira Reserve Association's headquarters.

During the elaboration of the Development Plan, the Mandira community also took steps to legally formalize their extractive reserve. With the technical support from the Forest Foundation, the Mandira community members formally solicited IBAMA to form the extractive reserve. Upon receipt of preliminary approval from IBAMA, the Mandira Reserve Association was created to administer the reserve. However, IBAMA was a newly formed organization[22] and did not have the know-how or technical capacity to create an extractive reserve in a non-Amazonian region, particularly in São Paulo State. The São Paulo State government possesses different legislation and norms than in Amazonian States. The newly formed Mandira Reserve Association thus made a request for São Paulo state land from the São Paulo Patrimony Secretariat, to thus create a state reserve instead of a federal reserve. However, the land was not given up by the São Paulo Patrimony Secretariat. After negotiations between state and federal governments waiting through lengthy bureaucratic delays, the Mandira Extractive Reserve was federally declared an extractive reserve on December 13, 2002. The 1,175 ha reserve is home to approximately 60 inhabitants from 10 different families (Fig. 6.2).

The federal designation as an extractive reserve grants exclusive property rights to the Mandira community occupying the reserve and thus the responsibility for the sustainable resource use within the reserve. However, extractive reserves may be visited by the public and undergo scientific study. There are also strict regulations prohibiting mining, hunting, and large-scale agriculture. IBAMA is responsible for the administration of extractive reserves, along with the formalization of regulations and monitoring.

[22] IBAMA was created in 1994.

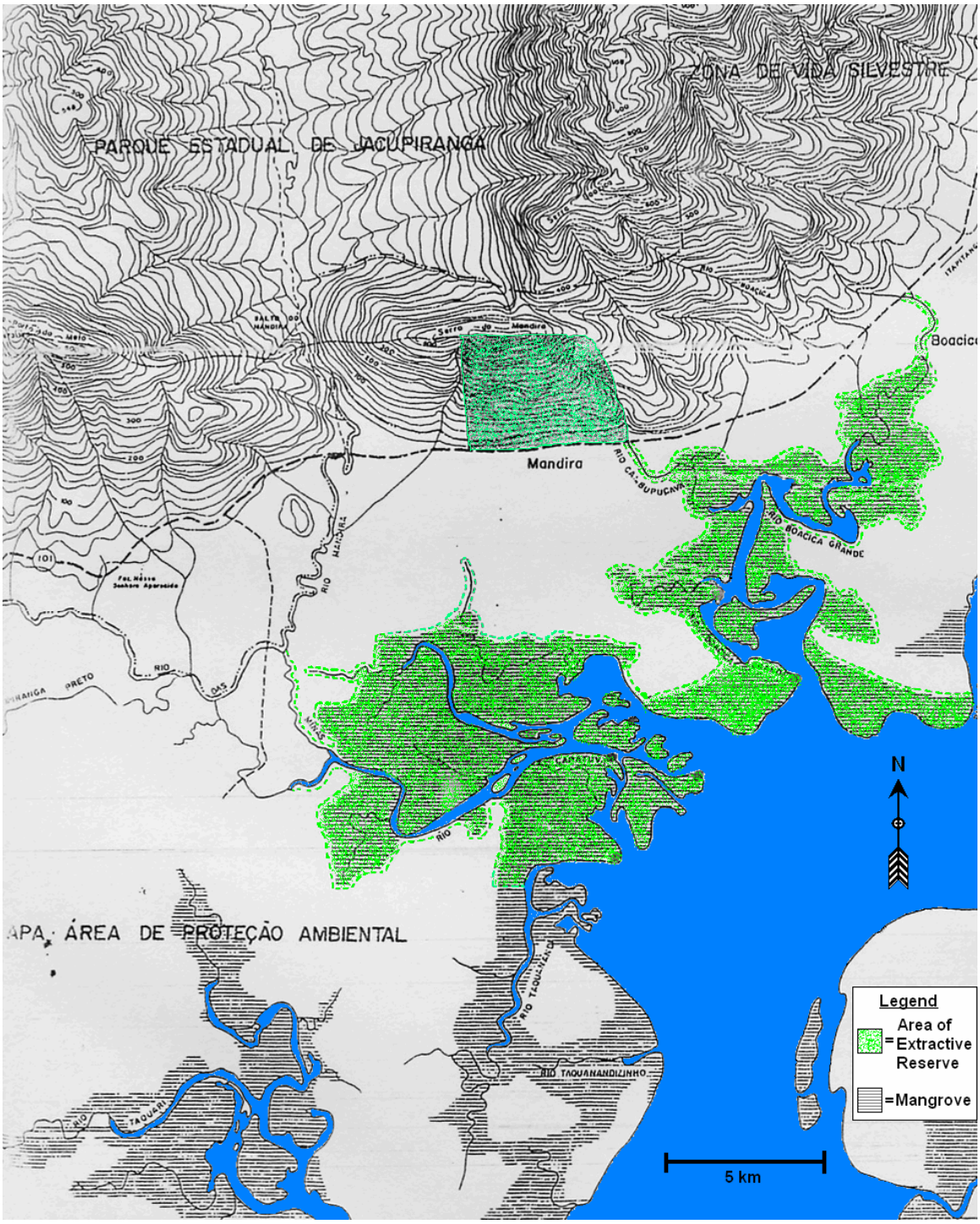


Figure 6.2 Map depicting the Mandira Extractive Reserve in São Paulo, Brazil 25°S, 48°W (after Bastos 1999).

IBAMA also provides funds to purchase signs[23] to demarcate the reserve and development and distribution of pamphlets to educate nearby residents. IBAMA also provides a monitoring course to train inhabitants monitoring and reporting procedures to help IBAMA identify and deal with any infringements. After completing the course, participants become certified Voluntary Environmental Agents. Reserve inhabitants have the authority to arrest outsiders breaking any laws within the reserve and can bring them to the police without excessive force. IBAMA officials will then confiscate any illegal equipment.

IBAMA also provides guidelines for the creation of a multi-stakeholder decision-making body for extractive reserves. This multi-stakeholder council should include representatives including extractive reserve members, inhabitants neighbouring the reserve, government officials, technical support staff, NGO's, police, and other resource users. This council would meet regularly to discuss key issues and decide on the implementation of new interventions to holistically improve the extractive reserve.[24] However, precise instructions on how to invite, encourage and remunerate participants was not provided. This decision-making body has not yet been formulated for the Mandira Extractive Reserve.

Need for Livelihood Diversification within Extractive Reserve

Diversification within the extractive reserve is necessary due to the limited size of the reserve. The inhabitants of the reserve cannot rely solely on one resource since it

[23] Signs cannot be aluminum since they will be stolen for domestic use, i.e. roofing. Consequently, there is a problem upon choosing a durable, affordable, conspicuous sign that will not be readily stolen.
[24] When IBAMA representatives first suggested the creation of a multi-stakeholder, decision making council, the reserve inhabitants expressed concerns that this council would restrict their rights. The trusted support staff from the Fisheries Institute and Forest Foundation played influential roles, in helping inhabitants understand the benefits the multi-stakeholder body would provide the extractive reserve.

would compromise the sustainability of the resource within the small reserve. Fishing has and continues to provide an important source of protein for the reserve inhabitants. Alternative species suitable for sustainable, low-impact harvesting and aquaculture are also currently being explored such as crabs and mussels. For example, the Fisheries Institute is currently experimenting with rearing mussels (*Mytella guyanensis*) on bamboo rafts and working with rural inhabitants to determine natural banks of this mussel species.

Furthermore, the wives of several Cooperostra members within the Mandira Reserve started *Corte Costura*, a seamstress' cooperative. A handicrafts initiative using natural products, such oyster shells, to make souvenirs for tourists, is also being developed. The Mandira community is also exploring tourism based on their African *quilombola* culture and surrounding ecology, particularly the Mandira Waterfall.[25] Steps have been taken to make the Mandira Waterfall more accessible to the public through the clearing of a trail and construction of wooden steps to pass the steep riverbank. Three youths have been trained to become environmental monitors. The environmental monitors will help ensure ecotourists will not have negative impacts on the environment as well as serve as educational guides for the biota and culture of the region.

Flora which can be harvested sustainably within the reserve include diverse tree species. Wood from trees, such as canela (*Ocotea spp.*), have long been used for canoes

[25] **Educational/Ecotourism**
Cooperostra and the Mandira community are capitalizing on educational/eco-tourism. Students from São Paulo, and even Brasilia, have visited Cooperostra, to learn about the cooperative on oysters for R$2.00 per student (Brazilian Reals; approximately $1 Canadian [December 2005]). The students also visit the Mandira Extractive Reserve to learn more about the Quilombo culture, extractive reserve, and ecology of mangrove and Atlantic forest. The Mandira community has developed different services that are available at a cost per student. For R$2.00 per student, the Mandira community would provide a lecture and tour of the Mandira neighbourhood. A lunch, prepared by the women of the community, could be added on to the lecture and tour for a price of R$6.00 per student. Environmental monitors also provide tours of the mangrove, rearing beds, Mandira waterfall, and surrounding Atlantic Forest. However, a further R$50.00 is required to pay for services of the environmental monitor in addition to fuel expenses for the boat. Capitalization mechanisms for other groups, i.e. recreational tourists, are still being worked out.

and paddles. Lumber obtained from trees, such arapaçu (*Sclerobium denodatum*) and jacatirão (*Tibouchina mutabilis*), have and continue to be used in the construction of homes and other structures (Sales and Moreira 1996). Caixeta wood (*Tabebuia cassinoides*) is ideal for making handicrafts and other small scale objects. In addition to the use of wood, numerous other plants provide useful products such as fibres from imbé (*Philodendron imbe)* and imbiriçu (*Eriotheca pentaphylla*); fruits from araça (*Psidium cattleianum*), bacupari (*Rheedia gardneriana*), and medicinal compounds from quina-branca (*Solanum inaequale*), enxertinho (*Struthanthus* spp.), and erva-de-macaco (*Casearia sylvestris*) (Sales and Moreira 1996; Davis et al. 1997).

Previously banned activities, such as farming and hunting, may also play key roles in securing sustainable livelihoods, particularly for reserve inhabitants. Small-scale agriculture via agroforestry practices, would have minimal impacts on biodiversity while helping sustain livelihoods. Similarly, the hunting of common species, such as Paca (*Agouti paca*), Capybara (*Hydrochoerus hydrochaeris*), and Collared-peccary (*Tayassu tajacu*), can also help supplement livelihoods. The over-harvesting of edible palm-hearts from palmito (*Euterpe edulis*), has led to the implementation of strict regulations banning its wild-harvest. The clandestine harvesting of palmito served as an important source of income for the reserve inhabitants in 1991 when outbreaks of cholera from contaminated seafood, severely reduced oyster sales (Turatti 2002). However, the reintroduction of numerous palmito plants within the reserve, where it once naturally occurred abundantly, can provide another valuable source of revenue. Since palmito grows best under a closed forest canopy, the small-scale cultivation of sporadic palmito plants will also help encourage the continued conservation of mature Atlantic Forest. Consequently, there is a

wide array of renewable resources and activities that can help sustain the livelihoods of extractive reserve inhabitants.

Barriers and Constraints to Aquaculture Intensification

Rearing beds used by the Cananéia Oyster Producers' Cooperative contain mangrove oysters (*Crassostrea spp.*) that are harvested from the surrounding mangrove forest. Extractive pressure on oyster stocks may be greatly reduced if methods were developed to allow the community to capture oyster seed and rear oysters to commercial size.[26] Methods to help ease harvesting pressure are vital since the Cooperostra would like to obtain greater economic returns and is currently trying to establish connections to larger markets with greater demands.

Successful methods have been devised to capture oyster seed (Pereira et al. 1991), however, current methods to rear oyster seeds to commercial size have been impeded by high mortality rates and slow growth rates of oysters less than 4cm (Machado 2004, personal communication). The current methodology of using continuously submerged cages (lanternas) to rear mangrove oysters, *Crassostrea rhizophorae*, is inadequate since it was devised to rear a different species of oysters, *Crassostrea gigas*. The oyster *C. gigas* is a temperate species which grows on rocks in the subtidal zone (below the water level of the lowest tides), whereas, *Crassostrea rhizophorae* is a tropical species which grows on mangrove roots in the intertidal zone (between the water levels of high and low

[26] Since the reserve inhabitants would no longer rely on wild oyster harvest, commitment to maintain a healthy mangrove ecosystem may diminish. Further education may be required so the link between healthy mangrove ecosystems and healthy oysters is not severed during the "domestication" of the oysters (Salafsky and Wollenberg, 2000). However, the development of ecotourism in the Mandira Extractive Reserve reinforces the need for a healthy mangrove ecosystem.

tides). Furthermore, the methods were devised in a different state, Santa Catarina, which is located about 600km south of Cananéia and thus has different water conditions (i.e. temperature, salinity, etc.). Different environmental conditions in Santa Catarina coupled with different requirements of the other oyster species, *C. gigas*, may explain the failure of continuously submerged *laternas* to rear mangrove oyster in Cananéia.

Experimentation with the current methodological design is necessary to develop methods to successfully rear mangrove oyster seeds in Mandira Extractive Reserve. Cooperostra members feel that the current methodology is failing because the newly established oysters remain continuously submerged in the water. Continuous immersion obtained the best results for the subtidal species *C. gigas* in Santa Catarina since the oysters can feed and assimilate mass continuously. However, Cooperostra members think growth rates may actually be increased and mortality rates reduced if the mangrove oysters (*C. rhizorphorae*) were periodically exposed during low tide. Mangrove oysters have evolved to occupy the intertidal zone. Cooperostra members have also observed peak abundance of mangrove oysters in the intertidal zone for numerous years. Consequently, mangrove oysters would be expected to thrive best with intertidal conditions. Studies need to be conducted to compare the growth and survival rates of mangrove oyster seeds reared in continuously submerged oyster cages (*lanternas*) with mangrove oyster seeds reared in oyster tables (*tabuleiros*), which are exposed during low tide, in mangrove forest in the Mandira Extractive Reserve. In addition to methodologies that are not adapted for local conditions and species, there is strong evidence supporting the existence of three oyster species in Cananeia, which are likely confounding oyster aquaculture results.

Diverse Oyster Species in Cananéia

Varying Growth Rates of Mangrove Oysters in Cananéia

The presence of more than one oyster species is supported by Fisheries Institute experiments. Growth rates of oysters reared in submerged *lanterna*s (Machado 2004, personal communication) and in the field (Pereira et al. 2003), have yielded mixed results. Some oysters reared in the *lanternas* grow rapidly, while other oysters in the same *lanterna*, which are exposed to nearly identical conditions, exhibit very limited growth (Machado 2004, personal communication). Similarly, Pereira and others (2003) observed that 72% of the wild mangrove oyster population exhibited slow growth rates, attaining market size (5cm) in 28 months. The remaining 28% of the oyster population had relatively faster growth rates, reaching 5cm in length in 19.5 months (Pereira et al. 2003). These different growth rates may be explained by different physiological requirements of different oyster species. Even though, both species may inhabit the same environment, each species will have different physiological requirements and different growth rates depending on the environment. Ideal growth conditions must be provided for successful aquaculture operations of mangrove oyster. However, the best oyster species for aquaculture in Cananéia must first be identified.

Difficulty in Identifying Oyster Species

Identification of genera and species rely on diverse attributes, which for shellfish, would include shell characteristics, larval structure, habitat, reproduction. However the identification of oysters at the species level is very difficult given the lack of knowledge on oyster biology along with great variability in the shell and soft tissue of oysters (Bastos 1997). External characteristics of oyster shell are related to environmental

conditions (Wakamatsu 1973). Therefore, different species may look similar because they occupy similar niches. Or conversely, a single species may appear to be a several different species depending on where it is growing (i.e. growing on a rock vs. mangrove root). Given the superficial variability of oysters, examinations of oyster molecular biology may provide the only reliable evidence for the existence of more than one species of oyster in Cananéia.

Molecular Evidence for Different Oyster Species in Southeast Brazil

Oysters were examined from Paranaguá Bay, Paraná (25°30'S; 48°30'W), which is just southwest of Cananéia (25°S, 48°W). Genetic evidence[27] was found proving the existence of two species of oysters, genus *Crassostrea*, in Southeast Brazil (Ignacio et al. 2000). The two species in this study were identified to be *Crassostrea brasiliana* and *C. rhizophorae*. *Crassostrea brasiliana* is a subtidal species, occurring on rocks continuously submerged at depths below the low tide. Whereas, *C. rhizophorae* is an intertidal species, occurring on mangrove roots and rocks that are exposed at low tides. *Crassostrea rhizophorae* tends to be slightly smaller than *C. brasiliana* (Ignacio et al. 2000). Possibly a third species of oyster, *Crassostrea gasar*, has also been identified in Paranaguá Bay, Paraná (Lapègue et al. 2002).[28] However, it is unknown if *C. gasar* and *C. brasiliana* are distinct species or whether they may hybridize and produce viable offspring. Like *C. brasiliana, C. gasar* occurs predominantly in the subtidal zone (Lapègue et al. 2002).

[27] Electrophoresis of adductor muscle allozymes were conducted on 17 loci of the two putative species. Five loci were found to have a gene identity of 0.46 to 0.47, proving that there are two species in sympatry.
[28] Karyological and molecular data also indicate that *Crassostrea gasar* has a trans-Atlantic distribution, since it also occurs on the west coast of Africa. Aquaculture methods developed for this species in Brazil, would thus may have direct application in Africa, and vice versa.

Local Knowledge on Oyster Species Morphology

All Cooperostra members claimed that only one species of oyster existed within the region of Cananéia. However, most individuals distinguished between two different types of oysters (Table 6.1). Smaller, lighter coloured oysters which grow on higher up on mangrove roots (likely *C. rhizophorae*) and larger, darker oysters which grow lower on the mangrove roots near the mud (likely *C. brasiliana*). One individual identified a third type of oyster with a thick brownish-golden shell, which takes an exceptionally long time to grow and remains relatively small.[29] This third type may be *C. gasar* (Table 6.1).

Table 6.1 Different characteristics of oyster types in Cananéia based on fusion of local and scientific knowledge.

	Different Oyster Types/Species		
Characteristics	*C. brasiliana*	*C. rhizophorae*	*C. gasar*
Shell Colouration	Darker	White, Lighter	Brownish/Golden
Substrate	Rocks, lower part of mangrove roots	Mangrove roots, sometimes rock	Rocks, lower part of mangrove roots
Location	Subtidal, Rock	Intertidal, Mangrove Roots and Rock	Subtidal, Rock
Shell Thickness	Average	Average	Thickest
Size	Larger	Smaller	Smallest
Growth Rate	*C. brasiliana* grows fastest in lanterna? *C. rhizophorae* grows fastest in rearing bed?		Slowest Growth Rate

[29] The local leader was the most eager to discuss his knowledge, but he did not provide the most detailed information. When assessing local knowledge, diverse individuals must be contacted. Normally quiescent individuals may contain a wealth of information.

Oyster Sperm Cell Biology to Identify Different Species

Oyster sperm cellular structure parameters are being compared among the three putative species by Introíni and Recco-Pimental, at the Cellular Biology Department at the University of Campinas. Samples for analysis were selected by the Cooperostra member who identified three different types of oysters. Preliminary results suggest that there are three distinct species of oyster in Cananéia; *C. rhizophorae*, *C. brasiliana*, and *C. gasar* (Introíni et al. in progress).

Co-existence of Three Oyster Species with Similar Requirements

How can three species with the similar requirements occupy the same region without competitively excluding one another? *Crassostrea brasiliana* and *C. rhizophorae* have likely evolved through niche partitioning to occupy different environments, the subtidal and intertidal zones respectively. *C. rhizophorae* is better adapted for intertidal zones and *C. brasiliana* is better adapted for subtidal zones. Why has *C. gasar* not been competitively excluded by *C. rhizophorae* and/or *C. brasiliana*? Although, *C. gasar* may be outcompeted spatially by its faster growing relatives, it may have a defensive competitive advantage. The thicker shell of *C. gasar* may help confer resistance to predatory or parasitic attack. The marine worm *Polydora websteri*, regularly parasitizes oysters by boring a hole through the shell (Wakamatsu 1973). Some marine snails, particularly the Oyster Drill "*Thais haemastoma"*, regularly prey on oysters by boring holes through the shell (Wakamatsu 1973). Fish, such as the Black Drum (*Pogonias cromis*) also regularly break oyster shells with their powerful jaws and feed on the soft tissue (Wakamatsu 1973). The abundance of shell penetrating predators in Cananéia would confer a defensive competitive advantage to the thicker shelled, albeit slower

growing *C. gasar*. Such dynamic differences in competitive advantage would explain the coexistence of species with similar physiological requirements.

Implications of Three Co-existing Species in Cananéia

The presence of three co-existing species in Cananéia complicates attempts at complete aquaculture in Cananéia. Complete oyster aquaculture consists of the acquisition of oyster larvae (seed) with special collectors and rearing the larvae to market size. Currently Cooperostra only gathers oysters larger than five centimetres and grows them to larger, more profitable sizes in oyster rearing beds. However, the collection of oyster seed is currently unable to select for species specific oysters. The oyster collectors thus likely contain a variable mosaic of larvae from *C. rhizophorae, C. brasiliana,* and *C. gasar*. It is currently impossible to identify oyster species from oyster seeds. Rearing oyster seed to market size is challenging since each oyster species has different physiological requirements, i.e. *C. rhizophorae* is an intertidal species whereas *C. brasiliana* is a subtidal species. Further work is needed to understand the reproduction of each species. Moreover, laboratory spawning and production of oyster seed may be the best option to complete the aquaculture cycle. The potentially faster growing species could be induced to spawn in laboratories as has been accomplished by the Marine Mollusk Cultivation Laboratory at the Federal University of Santa Catarina, in Florianópolis, Brazil. The seeds may then be distributed to Cooperostra members. Further technical and financial assistance would be essential to develop the technology and methodology to consistently provide Cooperostra members with the potentially fast-growing, oyster seeds.

Local Knowledge

Oyster Species Identification

When Cooperostra members were asked about different types of oysters potentially being different species, the response was:

> "*Oysters are like people. They grow at different rates...and come in different colours and sizes. We are all the same species…just as oysters are.*"
> - Cooperostra member, May 2005

The existence of a single species of oyster in Mandira local knowledge is reaffirmed by Sales and Moreira (1996). They reported that the Mandira community members rarely harvested the larger, constantly submerged oysters (i.e. *Crassostrea brasiliana*) since they are considered to be "mother-oysters." Because of their larger size, "mother-oysters" are considered to produce copious larvae to replenish the oysters harvested from the mangrove. The "mother-oysters" are reasoned to be larger since their constant submersion allows them to feed continuously and thus grow larger. These larger, submerged oysters are more difficult to access and the Mandira community feels that the harvest of these submerged oysters should be prohibited to maintain oyster stocks (Sales and Moreira 1996). However, if those large oysters are *C. brasiliana*, and there is complete reproductive isolation between *C. brasiliana* and *C. rhizophorae*, then such conservation efforts would only protect *C. brasiliana*. Such measures are not sufficient, to prevent over-exploitation and extirpation of *C. rhizophorae* within the region.

Influence of External Knowledge on Local Knowledge

Some Cooperostra members also knew the Latin name of the oyster, quoting *Crassostrea brasiliana*. Adoption of such external knowledge likely greatly influenced the decision for the conclusion of one species of oyster. Fisheries Institute scientists were

unsure but assumed that there was only one species of oyster in Cananéia, with *C. brasiliana* and *C. rhizophorae* being synonyms. The differences in appearance and size were accounted for by environmental parameters, depending on where the oyster larvae settled. If the oyster larvae settled in the intertidal zone it would be smaller than if it had settled in the subtidal zone. Similarly, the oyster would develop differently depending on the substrate, i.e. rock vs. mangrove root. Cooperostra members were thus taught that the oysters may look different but are one species.

The platform of respect established between external support staff and Cooperostra members facilitated the adoption of external ideas into local knowledge. The Cooperostra members have a great deal of trust in the scientists from the Fisheries and Forest Foundation and eager to learn more about oysters. Especially considering that the oyster harvesters do not have a long tradition of oyster harvesting, they gave up the traditional farming practices and began to harvest oysters only thirty years ago. For example, Bastos (1997) recorded that initially some members of the Mandira community believed that oysters were capable of moving from to a different mangrove root or tree. However, now they understand that oysters are not capable of moving themselves. External knowledge has greatly influenced and been incorporated into the knowledge of Cooperostra members. Furthermore, oyster harvesters that do not belong to Cooperostra, which have not been influenced by external scientists, identified two different species of oysters the smaller, lighter intertidal species (*C. rhizophorae*) and the larger, darker subtidal species (*C. brasiliana*). Cooperostra knowledge on oyster morphology and growth rates is a heterogenous body of information, which has been greatly influenced by external knowledge.

Lack of Biodiversity Indicator

There have been limited studies quantifying the actual impact of Cooperostra's endeavours, such as the use of rearing beds, on surrounding biodiversity. The effect of oyster rearing beds on other biota has not been studied, but is likely negligible. Unlike large-scale aquaculture operations, mangrove forest does not need to be cleared to provide rearing space since the oyster rearing beds are placed in shallow lagoons and water ways. Rearing beds occupy only a small number of lagoons and waterways within the entire estuary. Rearing beds also only occupy a small portion of the lagoon or waterway and thus do not completely disrupt tidal flow or the movement of mangrove organisms. Oyster rearing beds may actually enhance the biodiversity and productivity of the mangrove by increasing the surface area for fauna and flora to grow on, thereby serving as an artificial reef. Numerous Cooperostra members have observed fish schooling around the rearing beds and obtaining sustenance from biota on or around the rearing bed. Furthermore Cooperostra members observed that fish yield and physical size have also remained relatively constant over the past several years and that small-scale/recreational shrimp harvests have increased dramatically.[30]

Summary

Interventions to achieve conservation goals rely on several key assumptions. It is assumed employment interventions based on biological resources will cause people to conserve resources important for their main livelihood. However, as in the case of

[30] Increased shrimp harvest is a consequence of effective enforcement of legislation passed in 2004 banning dragnets to capture shrimp.

Cooperostra, it is difficult to implement interventions that distribute benefits equally among participants and do not exclude certain groups.

It is also assumed that education on the importance of conservation will change attitudes and modify behaviours to reduce conservation threats. However, the immediate wellbeing of resource users and their families will always take precedence over long-term conservation goals. Nevertheless, Cooperostra members now understand the importance of maintaining healthy mangroves to sustain oyster stocks. Cooperostra harvests about 2,500 dozen oysters per month, which represents 10% of the region's monthly oyster harvest (Pereira et al. 2000c) and 4.2% of the estimated maximum sustainable yield (Pereira et al. 2000b).

Another assumption in the pursuit of conservation goals is that unsustainable use of common property resources can be prevented by granting exclusive access rights, since resource users are expected to conserve resources for future use. Exclusive access rights to oysters were granted to the Mandira community within the 1,700 ha Mandira Extractive Reserve. The Mandira Extractive Reserve was co-executed along with the development of Cooperostra. However, extractive reserves require external support to devise and enforce regulations and develop and sustain livelihoods.

Another assumption in conservation interventions is that increasing production of agriculture/aquaculture operations reduces the need to rely on threatened biological resources. In Cooperostra's case, aquaculture intensification is difficult since cytological, molecular, physiological, and morphological evidence strongly suggest more than one species of oyster co-exist within the region. The impact Cooperostra and/or the Mandira Extractive Reserve have had on biodiversity has never been examined.

CHAPTER 7
CONCLUSIONS

Introduction

This chapter provides key lessons learned from Cooperostra on the reconciliation of conservation and development. Specific recommendations are then provided, categorized under the three pillars of sustainable development; economics, environment and social sectors. I conclude the chapter by highlighting future research needs at a macro level, to assist other conservation and development projects, and at a micro level, to address Cooperostra's needs.

Lessons Learned

Livelihood Improvement is Critical for Conservation Interventions

Project members need consistent organizational support to secure economic futures, since securing rights and active control over resources is necessary but not sufficient for sustainability. For example, rubber tappers in Amazonian extractive reserves are empowered with rights and control to their resource but are still at the mercy of highly fluctuating international rubber prices (Brown 2002). To keep conservation goals an option and attain them successfully, basic needs must always be sufficiently met. Consistent organizational support is necessary to assist with value adding efforts and marketing to help secure economic viability.

Middlemen are Not "Bad" and Can Play Key Role in Market Development

The role of middlemen as active members of the community and distributors is often overlooked in narrowly focused attempts to quickly increase wages for

project/community members. Middlemen possess knowledge and valuable contacts with local markets which could be harnessed to help with marketing initiatives. Middlemen could be trained to upsell (i.e., convince current clients to buy certified oysters for health reasons) and thus assist in establishing and maintaining linkages with market networks. With some training and provision of materials such as pamphlets, middlemen could help educate their client network on health risks associated with eating uncertified, non-depurated oysters. However, it may be difficult to integrate middlemen into the process, as sellers, since they have always been in an exploitation role (cultural).

Development and Conservation Initiatives Require Commitment and Time

Simultaneous biodiversity conservation and poverty alleviation requires time and strong commitment of participating members. Strong commitment is required throughout successive reiterations of the project - in its planning, implementation, and evaluation (Rudel 2000). Such successive iterations of the project better address the complexity of natural and social systems (Brown 2003). The complexity and unpredictability of natural and social systems make it virtually impossible for any project to be perfect. However, with strong commitment and over time, problems and challenges encountered by the project may be sequentially overcome. Commitment levels should also be increased gradually. By starting with short-term easy objectives, a winning environment can be created, empowering individuals to tackle more difficult long-term challenges (Moore and Brooks 2000).

Development and Conservation Progress in Small Incremental Steps

It is not realistic to assume that impoverished people with limited education can be empowered within a few years to deal with all aspects of a business, from supplying quality products to marketing and selling goods. Cooperostra members do not have enough time to partake in complete management of the resource. In addition, they have limited capacity to take part in highly competitive markets, such as the restricted oyster market in São Paulo. Development needs to occur in small incremental steps over several years; colossal steps with major changes are prone to numerous setbacks. Integration of biodiversity conservation and poverty alleviation needs consistent organizational support for incremental, capacity development. Such projects particularly need vital business capacity development and/or fair business partnerships to attain a competitive advantage in today's markets to succeed.

Prolonged Support is Necessary to Develop Self-Sufficient Enterprises

Since development occurs in small, incremental, time-consuming steps, donor organizations need to consider whether to spread support over numerous endeavours or concentrate their efforts into a few promising initiatives. Self-sufficiency will rarely be attained within three to five years of consistent support; longer time frames of ten to twenty years must be accommodated to produce long-lasting effects (Cramb and Culasero 2003; Bolger 2000). Consequently, it may be better to support one group to self-sustainability than to spread financial support thinly amongst numerous groups for a limited time with limited opportunities for beneficial, long-term changes. Consistent support from donor organizations would also help reduce bureaucratic delays in securing financial resources, speeding the learning process and thereby helping to better achieve

simultaneous biodiversity conservation and poverty alleviation.[31] However, exit strategies for external support have been poorly implemented and developed (Franzel et al. 2004).

Fair Distribution of Benefits is Key to Sustainability

Numerous development projects are challenged by local elites or privileged usurping disproportionate amount of benefits (Richards et al. 2003; Oliveira 2002). An unfair distribution of benefits leads to internal conflicts, which threaten the sustainability of the project. Within organizational structure, mechanisms need to be established that increase transparency and accountability to ensure a more just distribution of profits and benefits to help reconcile conservation and development goals.

Diverse Livelihood Options Are Important for Sustainability

Development projects cannot be too narrowly focused on one sole initiative since socioeconomic or ecological changes might compromise the success of one particular activity. However, benefits from new market opportunities through diversification need to be weighed against increasing efficiency of current operations. For example, Browder (2002) viewed some development projects in Rondônia, Brazil as being spread to thin between numerous activities. If these diverse activities had been reduced in number and well-integrated to become more efficient, better results may have been attainable (Browder 2002).

Diverse Institutions Act as a Safety Web

Attempts to integrate biodiversity conservation with poverty alleviation require extensive and diverse institution building (Kellert et al. 2000). New institutions for

[31] Nevertheless, reliance on diverse mechanisms to distribute funds is best to maintain resiliency.

conservation and development must be adaptable, capable of managing complex ecosystems, and accommodate diverse stakeholder interests (Brown 2003). These institutions must work across various spatial, social, and organizational scales (Brown 2003). Access to diverse institutions, just as access to high levels of biodiversity, confers resilience. The diverse institutions acted as a safety web that helped Cooperostra better adapt to socio-economic changes. This safety web of institutions is crucial in socio-economic climates of developing countries, such as Brazil, which have relatively frequent fluctuations in politics and economics. Nevertheless, in stable environments, it might be more efficient and effective to rely on fewer, more secure, organizations.

Fusion Knowledge Needed to Address Complexity

To address complexity and uncertainty for development and conservation interventions, potential contributions of knowledge from both scientific and local sources need to be determined. However, the mere dissemenation of information between sources is not enough (Carlberg 2005). Fusion knowledge, developed by a mutual exchange of external scientific and local experential knowledge, would help adaptation by creating new opportunities in a constantly changing world to develop win-win solutions for conservation and development (Brown 2003; Schusler et al. 2003; Campbell 1998; Agrawal and Gibson 1999).

Principal Consortium of Institutions Required to Maintain Tight Feedback Loops

With such a diverse array of institutions, the maintenance of consistent tight feedback loops between the resource, resource users, and supporting institutions need special attention. Sustainable natural resource management can only be achieved by

institutions that are close to the resource, flexible, and open to feedback from the environment (Berkes 2002). The Forest Foundation and Fisheries Institute (both governmental agencies) worked simultaneously, in a "tag-team" effort, to keep other organizations closely connected to the resource users and resource base.

Leadership Key for Development and Conservation Initiatives

Amidst the complex interactions of development and conservation projects, individuals can play key, influential roles. Strong leadership that provided guidance, offered a vision, and sustained during crises has been a key element in institution building for poverty alleviation and biodiversity conservation. Local leaders that worked extensively with external scientists for devising locally adapted solutions also played instrumental roles. Such local leaders can act as agents of change, helping improve acceptance of beneficial interventions for poverty alleviation and biodiversity conservation (Frahm et al. 1996).

Equator Prize Raises Pride and Helps Increase Commitment

Like Cooperostra, many development projects have high financial costs because of the time-consuming and ongoing adaptive and learning process (Brown 2003), which requires many consultations and high transaction costs (Rudel 2000). However, more effective participation in consultations and better solutions to reduce costs may be motivated with recognition for belonging to a "winning" project. Better satisfied, happier individuals are more cooperative; they are more willing to help others and more likely to take risks in assisting others (Frey and Stutzer, 2002). Moreover, formal public recognition has also been proven in community-based social marketing theory to help

individuals commit to long-term goals. Recognized individuals feel an obligation to uphold to the general public (Frahm et al. 1996). The promotion and visibility of formal recognition also reminds individuals that they are part of a larger social movement, helping them stay committed to the process (Moore and Brooks 2000). Consequently, formal recognition, such as the Equator Prize, may help other communities/organizations commit to conservation and development goals under adverse conditions.

Equator Prize Helps Increase Local Institutional Support

In addition to helping aid commitment, recognition from the Equator Prize also increased the fame of Cooperostra and increased number of studies on the cooperative. These studies help inform the project and assist in horizontal learning with other local efforts around the world. However, cooperative members have also expressed that they feel slightly annoyed by some studies being conducted, particularly when there is limited or no return for Cooperostra. The Equator Initiative fame also brought about several organizations interested in being connected to the fame of the project, i.e. the state land institute. Publicity and fame from winning the Equator Prize may help generate more studies of the project that help the project better adapt, however, caution must be exercised to avoid excessive studies with little return to the community or organizations wanting to claim the success as part of their own.

Horizontal Learning Key to Increase Scale and Sustainability

Vertical learning, with open exchange between external expert participants and local participants, is important to transfer new, potentially beneficial technology and indigenous knowledge for integrated conservation and development projects. However,

horizontal learning is also an important aspect for the reconciliation of development with conservation goals. Horizontal learning, i.e. learning from one's neighbour, may actually be more beneficial than vertical learning since a common language is used and a more realistic or practical approach is taught. Furthermore, horizontal learning facilitates acceptance and empowerment by demonstrating that individuals, under similar situations, are capable of learning and using new technologies.

Legislative Measures Key in Mangrove Regions and for Oyster Enterprises

Legislative measures such as the designation of exclusive property rights, size restrictions for harvest, closed seasons, allocating quotas, and minimizing ecosystem degradation are proposed help conserve oyster stocks (Table 7.1). The Brazilian environmental agency IBAMA is currently assisting the Mandira with enforcement of extractive reserve regulations, by providing officers and signs to clearly demarcate the reserve. Government assistance is necessary since the enforcement of conservation regulations, such as quotas and harvest bans, is particularly difficult within the vast maze of mangroves. Mangroves are difficult to navigate hence enforcing laws is time-consuming and costly. Extractive reserve residents need reliable government support to effectively deal with activities that threaten the sustainability of the reserve's resources.

Legislation is also needed to help better ensure social and environmental justice amongst various oyster-producing enterprises. A framework for equitable distribution of oyster regulations among different scales of oyster enterprises is presented in Table 7.2 (Machado 2004). Such a distribution of regulations ensures that enterprises usurping greater proportions of the oyster resource have the greatest harvest restrictions and must contribute most to replenishment of stocks.

Table 7.1 A summary of state and local approaches to help conserve oyster stocks in Cananéia.

Property Rights	Designation of exclusive property rights to local community i.e. as in a Brazilian Extractive Reserve
Minimizing Ecosystem Damage	Using ecosystem without altering ecosystem structure and function (i.e. minimize cuts to mangrove roots while harvesting oysters)
Harvest Quotas	Oyster stocks need to be monitored periodically to ensure that current harvest is not depleting oyster stocks. If oyster stocks start to decrease, total oyster harvest must be reduced (adaptive resource management).
Size Restriction	Oysters < 5cm not harvested since more profitable at larger sizes. Oysters >10cm not harvested since high reproductive value.
Closed Season	No harvesting of oysters during peak reproductive season, (i.e. Dec-Feb in southeast Brazil).

Table 7.2 Distribution of conservation regulations for different magnitudes of oyster harvesting enterprises (Machado 2004).

Scale of Oyster Enterprise	**Conservation Regulations**
Low-scale	**Low impact harvest** ▪ minimal quota restrictions
Mid-scale	**Rearing beds required** ▪ moderate quota restrictions
Large-scale	**Aquaculture required** ▪ severe quota restrictions

Limited Benefits for Obtaining Health Certification in Brazil

The current institutional arrangements in Brazil are incapable of monitoring and enforcing legislation for the marketing of oysters (José 1996). It is difficult for Cooperostra to sell their high quality oysters along the coast since there is very weak enforcement of health regulations. Moreover, most Brazilians are indifferent to health certification and not willing to pay more for certified oysters since cheaper oysters may be readily purchased on the black market.

Impact Assessment of Conservation Intervention Lacking

The impact conservation and development projects have on biodiversity needs systematic analysis. However, quantification of diverse biodiversity measures in tropical regions is particularly difficult due to the overwhelming diversity of living organisms and lack of taxonomic knowledge to adequately identify all taxa (Brandon et al. 2005). Most research centered on development discusses biodiversity in superficial terms, without any actual quantification of a biodiversity measure at either the genetic, species, or landscape level. Without quantification measures it is difficult to measure success of interventions and consequently provide strong arguments for continued support. Alternative approaches to measuring conservation efforts are available that are cost-effective in the developing world context. For example, conservation success can be more efficiently defined and measured by using the Threat Reduction Assessment (TRA) developed by Salafsky and Margoluis (1999). The TRA approach does not measure specific biological parameters but uses threat reduction to assess conservation impacts.

Aquaculture More Suitable for Farmers than Small-Scale Fishermen

With the drastic reduction of current fishing stocks, aquaculture is booming as means to capitalize on insatiable markets and also serve as an important source of protein for poor rural communities. Even though fishermen and marine gatherers may be more familiar with the ocean environment, they are accustomed to reaping benefits immediately. Consequently, crop farmers may be better suited culturally for aquaculture assuming that the farmers are comfortable in the ocean environment. Moreover farmers are accustomed to regularly tending livestock and crops, as is required in the aquaculture

rearing process. Emerging aquaculture projects need to consider the cultural context of potential project members for development and conservation success.

Three Oyster Species in Cananéia Complicate Aquaculture Potential

There are possibly three co-existing species of oyster, *Crassostrea rhizophorae*, *C. brasiliana,* and *C. gasar* in Cananéia as supported by molecular (Ignacio et al. 2000; Lapegue et al. 2002), karyological (Lapegue et al. 2002), and cytological (Itroíni et al. in progress) studies. Strong evidence for the existence of three different types of oysters was also determined from a local knowledge source based on morphological, ecological, and growth rate parameters. The presence of three co-existing oyster species has critical implications for oyster aquaculture in Cananéia. Threats to oyster stock depletion may be greatly reduced if oyster aquaculture technology was developed to allow for complete aquaculture of oysters from captured larvae, severing the need to harvest oysters from the mangrove. However, attempts to improve aquaculture methods have yielded mixed results in growth which is likely due to physiological differences among the three different oyster species found in the region (Ignacio et al. 2000; Lapègue 2000, Itroíni et al. in progress).

Recommendations

The recommendations are categorized based on the three pillars of sustainable development; economics, environmental, and social sectors. There is some overlap in some recommendations among the three categories, however, recommendations are categorized under the sector that they are likely to have the greatest impact.

Economic Dimensions

- Stop selling oysters at cost to the cooperative, particularly along the Santos Bay coast
- Enforce stricter regulations and greater enforcement required to reduce/penalize market for non-depurated, illegally harvested oysters
- Work with middlemen to capture greater market for Cooperostra and more equitable distribution of profits between Cooperostra members and middlemen
- Implement quality control along with reward and punitive measures to encourage Cooperostra members to turn in highest quality oysters
- Require innovative processing (i.e. freezing) and marketing (i.e. oyster carts) to help increase sales
- Improve management, use external funds to temporarily hire an external manager while Cooperostra youth are being trained for management responsibilities
- Secure markets in major cities where more people are willing to pay for high quality oysters and economies of scale will help reduce net transportation costs
- Pay debts to government immediately, using external funds if necessary, to avoid further fees and other penalties
- Construct and deploy small oyster carts along coastal beaches to increase sales and promote Cooperostra[32]
- Develop an exit strategy for external financing and become self-sufficient

[32] Oyster carts equipped with ovens, to serve baked or fresh oysters, have been very profitable in Espirito Santo, Brazil (Dr. Littlepage 2004 pers. comm.)

Social Dimensions

- Cooperostra members and government technicians need to investigate and resolve the individual debt of former cooperative members imposed by Cooperostra
- Decision-making process must be further decentralized
- Greater transparency and more equitable distribution of incomes required among Cooperostra members
- Conflict resolution required to mediate minor grudges among Mandira residents and other Cooperostra members
- Further development of cooperative thinking required since too many Cooperostra members still thinking individualistically
- Need to diversify livelihoods within the Mandira Extractive Reserve to ensure residents are not usurping resources outside of the reserve, which creates tension among the reserve's neighbours
- Restaurants and supermarkets need regular monitoring to ensure that they only sell oysters with SIF certification; punitive and incentive mechanisms need to be established to help enforce compliance

Environmental Aspects

- Greater enforcement of environmental laws
    - Monitoring and enforcement of Mandira Extractive Reserve boundaries
    - Oyster harvest regulations (size and banned periods)
- Systematic oyster stock monitoring required to observe trends in oyster populations and adapt harvest regulations in response to changes

- Rearing beds not being used to full potential; oysters sometimes merely stocked right before banned season providing insufficient time for oysters to grow to significantly larger sizes
- Use Threat Reduction Analysis (Salafsky and Margoluis 1999) to periodically assess conservation impact of project and help identify critical areas for improvement
- Identify ideal oyster species suitable for rearing and marketing by Cooperostra
    - Explore laboratory production of oyster seed for distribution among Cooperostra members to reduce extractive pressure on oyster stocks

Further Research

Macro Level: To Assist Conservation and Development Projects

Exit Strategies for External Support

Exit strategies for external support have been poorly implemented and need further development (Franzel et al. 2004). If possible, what is the best way to remove external financing to nurture self-sufficient conservation and development projects? Which requirements must be sufficiently met to consider removing part or all of the external financing? What are the implications of 'excessive' external support?

Resource Use Impacts of Connecting Local-Level Enterprises to Larger Markets

What are resource use outcomes of connecting local-level resource users to larger markets with greater demands? If the resource is high in demand, how can the increased

pressure on the resource use be mitigated from previous resource users and newly arrived individuals wanting to capitalize on the resource?

Options to Help Small-scale Enterprises Attain Certification

Meeting the stringent paper work and other costly requirements of certification is often not possible for small-scale enterprises. How can the certification process be mitigated to increase the viability of certification for small-scale enterprises? Other than securing external support, are there any other options to help small-scale eneterprises achieve certification? How can triple bottom line accounting be operationalized for small-scale enterprises?[33]

Micro Level: To Assist Cooperostra

Oyster Processing - To increase marketability of oysters

Processing oysters to provide a diverse range of products (i.e. frozen and canned oysters) that are more durable, will help increase sales significantly. What are cost effective processing methods that have great market demand?

Marketing - To help increase Cooperostra sales

Research needs be conducted on the best methods for Cooperostra oysters to penetrate markets in major cities. What are the best methods for Cooperostra to network with potential consumers and establish a larger clientele base? What are the ideal payment and transportation options for Cooperostra and its clients?

[33] Triple-bottom-line accounting provides a framework to assess an organization's economic, environmental, and social performance to help ensure organizations pursue economic devlopment with social and environmental justice.

Oyster Species Identification - To facilitate oyster aquaculture development

Determining the number of oyster species in Cananéia is critical for future aquaculture development. How many species of oysters are present in Cananéia? Do these species represent reproductively isolated species or are they part of a complex species assemblage?

Develop Oyster Aquaculture - Reduce extractive pressure and supply increased demand

Complete aquaculture, rearing oyster larvae to market size, will greatly reduce extractive pressure and provide a means to supply increasing market demands without compromising sustainability. Which oyster species is ideal for aquaculture? What are ideal methods to obtain oyster larvae from this species? What is the best way to raise ideal species oyster seed to market size, i.e. use continuously submerged mesh oyster cages or use rearing beds that are exposed at low tide?

Appendix A - Sample of Basic Questions for Organization Representatives

1. What year did your organization get involved with Cooperostra?

2. How did your organization come into contact with Cooperostra?
   a) Was your organization contacted by a Cooperostra member? Who?

   OR

   b) Was your organization contacted by another organization? Which organization? Who represented the organization? What is their title of within the organization?

   OR

   c) Did your organization contact Cooperostra? How did your organization become aware of Cooperostra?

   OR

   d) Did your organization initiate Cooperostra? Where did the idea for Cooperostra come from? How did you obtain support of potential cooperative members?

3. What other organizations play key roles in Cooperostra? What are the main roles of each organization? How did these other organizations become involved?

4. How does your organization assist Cooperostra?
   A) Provision of technical assistance? How do you educate Cooperostra members?
   B) Provision of financial assistance? How much and for how many more years will this financial support continue?
   C) Any other type of assistance?

5. Approximately how many other projects is your organization currently involved with other than the Cooperostra? Is Cooperostra a priority project?

6. How often is contact made between Cooperostra and your organization?

7. Were there any obstacles in the past that hindered your organization's support for Cooperostra? What were they? How were the obstacles effectively dealt with?

8. Are there any obstacles that your organization is currently encountering in assisting Cooperostra? What needs to happen to overcome these obstacles?

9. Has involvement with COOPEROSTRA led to significant impact on your organization? How?

10. Do you have any additional comments about Cooperostra or your organization?

11. Do you have any comments, questions, or concerns about this interview or research?

Appendix B – Sample of Basic Questions for Cooperostra Members

Background

Location

Where is your family originally from?
Where do you live now?
Why did your family choose to live here?

Family

How many family members? How old are they? How old are you? How many males and females?
What is the education level of each family member?
Where do you think your children will live in the future?
What career would you want your children to pursue?
What are other livelihood activities that members in your household pursue to earn money or for subsistence?
Do you work only harvesting oysters? What are other activities that you pursue (i.e. fishing, hunting, working for the government, etc.)?

Economic Assessment

Do you own or rent your home?
What is your house made from (i.e. brick, wood, mix?)
What is the main flooring in your home?
How many rooms in your house?
If you need money, do you obtain a loan from a bank or borrow from somebody?
Do you own any of the following consumer goods: [TV] [Refrigerator] [Telephone] [Cell. Phone] [VCR] [DVD] [Satelite] [Radio] [Boat] [Boat Motor] [Motorcycle] [Car] [Stove] [Fishing Equipment] [Other _____]

COOPEROSTRA

Economic Aspects

Do you only sell the oysters you collect to Cooperostra? If not, what percentage of oysters do you sell to Cooperostra?
Are other Cooperostra members selling oysters to middlemen?
How much do middlemen pay per dozen oysters?
How much does Cooperostra pay per dozen oysters?
What was life like before Cooperostra compared to what it is today?
How are Cooperostra's current sales? Will sales improve in the future?

Ecological Impact

Have oyster stocks improved as a result of the implementation of Cooperostra/ Mandira Extractive Reserve?
Have other renewable resources improved?
Do the rearing beds impact the waterways or ecosystem negatively? Do you see fish and other animals feeding or seeking shelter among the rearing beds?

Do you cut mangrove roots to harvest oysters?

Aquaculture Aspects

How many rearing beds do you own?
Are there any other techniques to raise oysters?
Do you have any suggestions on how enhance oyster production?
How many types of oysters have you seen in the region? What is the difference between these types? Are the different types of oyster different species?

Organizational Aspects

How did you get involved with Cooperostra?
What is your role in Cooperostra?
Do you feel well respected in Cooperostra?
How many Cooperostra meetings have you attended?
What do you like best about Cooperostra meetings?
Do you feel comfortable suggesting ideas in Cooperostra meetings?
Do you feel that you are an active decision-maker in Cooperostra?
How is Cooperostra managed?
What is the best thing about Cooperostra?
How can Cooperostra be improved?
On a scale of 1 to 5, are you satisfied to be a Cooperostra member ([1] totally unsatisfied [2] slightly unsatisfied [3] indifferent [4] happy [5] very happy)?

Is there anything else you would like to add or I should know about Cooperostra?

Learning

Why is it important to conserve mangroves and Atlantic Forest?
What is necessary to conserve oyster stocks?

Vertical

What have you learned directly from the Forest Foundation? Fisheries Institute? NUPAUB – University of São Paulo? Cooperostra itself? Any other institution?

Horizontal

What have you learned, i.e. about oyster aquaculture/conservation, from your family, peers, and others that are not government extension workers?
Do you prefer to learn from government extension workers or from “other” people with experience? Why?

Social Networks

Do you now have more contacts to other people and organizations since becoming a Cooperostra member? Please explain.
Are you connected to other cooperatives? Which ones and through whom or how?

Do you have any additional comments or questions?

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