Co-Management of Reef Fisheries in Brazil in an Human Ecological Context

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Acknowledgements
Overview

• Co-management processes
• Current state of coastal reef fish
  ❖ Snappers and groupers
  ❖ Length at first maturity
  ❖ Local knowledge
• Co-management of reef fisheries:
  • Payment for environmental services
Co-Management Processes in Latin-America

**Chile**

- **Coastal areas** *(Management Exploitation Areas)*
  - MEABR *(Management and Exploitation Areas for Benthic Resources)*, territorial use rights to artisanal fisher unions.

- 547 MEABR.


**Brazil**

- **Extractive Reserves**

- **Sustainable Reserves** *(Mamirauá Reserve)*

- Fishing agreements

Co-Management: **objectives** and **processes**

- **Linking scientific and local knowledge**
- **Getting Urgent data**
- **Towards Management**

**Processes:**
- Monitoring
- Fishing agreements

- Voluntary transactions
- Well defined environmental service
- Bought by a service buyer
- From a service provider

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Begossi 2008
*Env. Develop. Sustain.*
Importance in Brazil

• **Artisanal fishing** is important in national production
• **Livelihoods** depend upon fish resources

• **High diversity** of species in artisanal fisheries: 70-100 spp.
• **Reef fish** important in artisanal fisheries
Importance of **snappers and groupers** in Brazilian artisanal fisheries

- Target species
- High market value
- Highly appreciated by local consumers

- Many fishing spots are located in islands, which could be important for spawning (no data available)
  
  » [Sadovy 1996: fishing pressure on spawning sites in the Caribbean area]
Some fish even important in local medicine

### Table 4. Contingency tables, using the number of times the fish was cited in interviews.

<table>
<thead>
<tr>
<th>Fish diet</th>
<th>Tabooed</th>
<th>Recommended</th>
<th>$\chi^2$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazonian fish (freshwater)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>748 [sorubim, scaleless fish, catfishes, piranha]</td>
<td>110 [rucunaré, trahira]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O, I, V, D</td>
<td>106 [black prochilodus]</td>
<td>368 [pacu, anchovy, bode, acará, piau, jaraqui]</td>
<td>557.51</td>
<td>&lt;0.001†</td>
</tr>
<tr>
<td>Atlantic Forest coastal fish (marine)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>494 [tuna, sharks, cutlass fish, jack]</td>
<td>129 [grouper, snook]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O, I, V, D</td>
<td>445 [rays, sea catfish, mullet]</td>
<td>778 [kingcroaker, porgy, weakfish, croaker-drum, mullet, sea chub]</td>
<td>76.42</td>
<td>&lt;0.001†</td>
</tr>
</tbody>
</table>

Notes: $H_0$: Fish diet is similar for both tabooed and recommended fish during illness. Fish diet is indicated by O (omnivorous), P (piscivorous), I (invertebrate consumer), D (detritivorous), and V (consumer of vegetal matter or algae). † Significant $P$ values indicate that $H_0$ should be rejected.
Methods:
Periods: 1986-1992 Buzios Island and Sepetiba Bay (3)
2002 to 2009: 11 communities, plus diet and gonads

- Interviews: 585
- Fish landings: 1,761
- Fish collected: 1,453
- Fish species in artisanal catch
  - Diet and gonad [volume and visible eggs] (2007-2009)
- From Ceará (NE Brazil) to Santa Catarina (S Brazil)
- 14 sites

- No Lab needs
- Less time consuming
- Adequate for fishers
Data on fishing spots [available]

Fishing sites and communities

- Northeast Brazil

Mucuripe, CE

Ponta Negra, RGN

Porto Sauípe BA
Fishing communities

• SE and S Brazil

Copacabana, Rio de Janeiro

Búzios Island SP, (Begossi 1996)

Pântano do Sul, Florianópolis, SC
Reef fishes, Brazil
Snappers

L. synagris
O. chrysurus
L. vivanus
L. bucanella
L. analis
Reef fishes in Brazil
Groupers

- *Epinephelus marginatus*
- *Mycteroperca acutirostris*
- *Cephalopholis fulva*

Copacabana, Rio de Janeiro

Mucuripe, Fortaleza, Ceará
Epinephelus marginatus
[garoupa, dusky grouper]

Cronius ruber, Portunidae (cf.)
12 spp. Lutjanidae (Snappers)

16 spp. Serranidae (groupers)
Reef fishes artisanal fishing
12 snappers (Lutjanidae) and 16 (Serranidae)

<table>
<thead>
<tr>
<th>Lutjanidae</th>
<th>Serranidae</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE= 13 spp.</td>
<td>NE= 13 spp.</td>
</tr>
<tr>
<td>SE= 4 spp.</td>
<td>SE= 6 spp, S= 3 spp.</td>
</tr>
</tbody>
</table>

Lutjanidae

- **Lutjanus**
  - 9 spp.
- **Ocyurus chrysurus**
- **Romboplites aurorubens**
- **Etelis oculatus**

Serranidae

- **Epinephelus**
  - 8 spp.
- **Mycteroperca**
  - 2 spp.
- **Alphestes afer**
- **Cephalopholis fulva**
- **Diplectrum**
  - 2 spp.
- **Dules auriga**
- **Paranthias furcifer**
Table 2. Average and minimum length (Total Length) of Lutjanidae caught in artisanal fisheries in NE Brazil (Maceió and Porto do Sauípe) and SE Brazil (Copacabana and Bertioga): comparisons with length at first maturity (TL) (Froese and Pauly, 2010, Begossi and Silvano 2008, Begossi et al 2010).

<table>
<thead>
<tr>
<th>Species or Site</th>
<th>Mean Length of fish caught (mm) Artisanal Brazil</th>
<th>Minimum Length caught (Lmin) (mm) Artisanal Brazil</th>
<th>Length at first maturity (FP), size at first reproduction (GO) (Lp)/(mm)</th>
<th>Vulnerability** (IUCN Red list status)</th>
<th>Vulnerability** (Cheung et al. 2005)</th>
<th>Status of the stock (Lessa 2006)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutjanidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutton snapper <em>L. analis</em> (n=36)</td>
<td>434</td>
<td>390</td>
<td>520**(1) 400**(2)</td>
<td>Vulnerable</td>
<td>Moderate to high (47%)</td>
<td>overexploited</td>
</tr>
<tr>
<td>Lane snapper <em>L. synagris</em> (n=54)</td>
<td>379</td>
<td>240</td>
<td>253**(2) 180**(3)</td>
<td>Not evaluated</td>
<td>Moderate (38%)</td>
<td>overexploited</td>
</tr>
<tr>
<td>Silk snapper <em>L. vivanus</em> (n=37)</td>
<td>328</td>
<td>180</td>
<td>500**(2)</td>
<td>Not evaluated</td>
<td>- High to very high (68%)</td>
<td>Near the maximum limit</td>
</tr>
<tr>
<td>Tenualua snapper <em>O. chrysurus</em> (n=66)</td>
<td>388</td>
<td>320</td>
<td>237**(3) 250**(4)</td>
<td>Not Evaluated</td>
<td>High (59%)</td>
<td>overexploited</td>
</tr>
<tr>
<td>Vermilion snapper <em>R. aurorubens</em> (n=22)</td>
<td>336</td>
<td>250</td>
<td>200-230**(2)</td>
<td>Not Evaluated</td>
<td>Moderate to high (50%)</td>
<td></td>
</tr>
<tr>
<td>Serranidae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corey <em>Cephalopholis fulva</em> (n=170)</td>
<td>255</td>
<td>165</td>
<td>160**(5)</td>
<td>Least concern</td>
<td>Moderate to high (51%)</td>
<td></td>
</tr>
<tr>
<td><strong>Dusky grouper</strong> <em>Epinephelus marginatus</em> (n=59)</td>
<td>409</td>
<td>240</td>
<td>470**(5)</td>
<td>Endangered</td>
<td>High to very high (72%)</td>
<td></td>
</tr>
<tr>
<td>Combgrouper <em>Mycteroperca acutirostris</em> (n=37)</td>
<td>404</td>
<td>310</td>
<td>320-360**(5)</td>
<td>Least concern</td>
<td>High (58%)</td>
<td></td>
</tr>
</tbody>
</table>

L. synagris (M)

L. analis (C)

L. vivanus (M)

L. vivanus (PS)

M. acutirostris (C)

E. marginatus (B)

E. marginatus (C)

Percent of fish below $L_m$

E. marginatus, dusky grouper
L. vicanus, silk snapper
L. analis, mutton snapper
Reproduction, Diet, and Local Knowledge
Table 3. Visible eggs and sperm in snappers and groupers collected in artisanal fisheries in South and North Brazilian coasts.
Source for snappers: Begossi et al. (2010b).

<table>
<thead>
<tr>
<th>Species and Site</th>
<th>Site (number of individuals)</th>
<th>Month with visible egg (%)</th>
<th>Month with sperm (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. analis</em></td>
<td>Copacabana (n=32)</td>
<td>April (12%)</td>
<td>May (11%)</td>
</tr>
<tr>
<td>*L. synagris,</td>
<td>Bertioga and Macié (n=44)</td>
<td>May (50%)</td>
<td>June (13%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>September (20%)</td>
<td>December (100%)</td>
</tr>
<tr>
<td><em>L. vivanus,</em></td>
<td>Porto Sauípe (n=29)</td>
<td>July (29%)</td>
<td>January (73%)</td>
</tr>
<tr>
<td><em>O. chrysurus,</em></td>
<td>porto Sauípe (n=66)</td>
<td>October (73%)</td>
<td>January (27%)</td>
</tr>
<tr>
<td><em>R. aurorubens,</em></td>
<td>Porto Sauípe (n=16)</td>
<td>October (67%)</td>
<td>October (22%)</td>
</tr>
<tr>
<td><em>C. fulva</em></td>
<td>Mucuripe (n=171)</td>
<td>October (8%)</td>
<td>October (42%)</td>
</tr>
<tr>
<td><em>M. acutirostris</em></td>
<td>Bertioga and Copacabana (n=37)</td>
<td>January (5%)</td>
<td>March (3%)</td>
</tr>
</tbody>
</table>
Table 4. Data on the diet of species of Serranidae according to local fishers, based on interviews performed with fishers 40 years old or up, 25 years living and fishing in the site. (2005-2006) (Number of citations).

<table>
<thead>
<tr>
<th>Site (No. fishermen)/</th>
<th>Diet Duskygrouper</th>
<th>Diet Snowy grouper</th>
<th>Diet Comb grouper</th>
<th>Diet Coney</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Red grouper</td>
<td>Cheme</td>
<td>Black grouper</td>
<td>Piranúa</td>
</tr>
<tr>
<td></td>
<td>Garoupa</td>
<td>*E. marginatus (SE/S), E. morio (NE)</td>
<td>*E. niveatus</td>
<td>Badejo (Sirigado in Mucuripe), M. acutirostris (SE), M. bonaci (NE).</td>
</tr>
<tr>
<td>NE: Mucuripe, Fortaleza, Ceará (14)</td>
<td>Fish=13</td>
<td>Fish=6 (many do not know)</td>
<td>Fish=14</td>
<td>Fish=13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Anything=2</td>
</tr>
<tr>
<td>NE: Natal, Rio Grande do Norte (28)*MA</td>
<td>Fish=26</td>
<td>--</td>
<td>Fish=23</td>
<td>Fish=21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shrimp=14</td>
</tr>
<tr>
<td>NE: Itacimirim, Bahia (15)</td>
<td>Fish=15</td>
<td>Fish=5 (most do not know)</td>
<td>Fish=14</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>--</td>
</tr>
<tr>
<td>SE: Copacabana, Rio de Janeiro (10)</td>
<td>Fish=6</td>
<td>Fish=7</td>
<td>Fish=8</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shrimp=5</td>
<td></td>
<td>--</td>
</tr>
<tr>
<td>SE: Bertioga (11)</td>
<td>Fish=8</td>
<td>Fish=6</td>
<td>Fish=4</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Anything/dead=7</td>
<td></td>
<td>Anything/dead=4</td>
<td>--</td>
</tr>
<tr>
<td>S: Pântano do Sul, Florianópolis (11)</td>
<td>Anything/dead=11</td>
<td>Fish=5</td>
<td>Fish=11</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Fish=8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (89)</td>
<td>Fish=71</td>
<td>Fish=32 (out of 61)</td>
<td>Fish=74</td>
<td>32 (out of 42)</td>
</tr>
</tbody>
</table>

**Literature**
- Froese and Pauly, 2010 (FP) and Begossi and Silvano, stomach contents (BS)

|                                       | *E. marginatus*      | Fishes, gastropods, cephalopods, and brachyuran crustaceans |
|                                       | Crabs, octopi, and fish*PP | Crabs and fish BS |
|                                       | E. morio             | Fish and invertebrates*PP |

| This study (stomach contents)           | --                   | --                  | *M. acutirostris* |
|                                        | (n=39)               | Empty= 16           | (n=170)          |
|                                        | Fish=12              | Shrimp=3            | Fish=5           |
|                                        | Shrimp=5             | Undefined=8         | Shrimp=4         |
|                                        | Undefined=11         |                     | Undefined=11     |

Stomach contents of comb grouper: *M. acutirostris* (n=39)

<table>
<thead>
<tr>
<th></th>
<th>Empty</th>
<th>Fish</th>
<th>Shrimp</th>
<th>Undefined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>16</td>
<td>12</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>

Interviews with fishers, n=74 comb grouper and black grouper

Fish | shrimp | Anything |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


*M. acutirostris* (comb grouper)
Probably feeds on plankton^{FP}
Juvenile feeds on crustaceans (100%, n=30, 240-328g)^{G}

*M. Bonaci* (black grouper)
Fish (adults), crustaceans (juveniles)^{FP}
Possibilities of co-management collaboration: local knowledge

**Mature Gonads (visible eggs)**

- Spring \([L.\ synagris, L.\ vivanus, O.\ chrysurus]\)
- Summer \([L.\ synagris]\)
  - Fishermen and direct observation
    » October field work

**Diet (observed and interviews)**

- General concordance literature and fishers (fish and shrimp eaters)
  - Except crabs (literature and fishers)
Possibilities of co-management and of collaboration

- Knowledge on reproduction
- Knowledge on fish biology [example of diet]
- Make conservation interesting to local fishers
  » Including local knowledge into management
  » Through payments for environmental services
    Monitoring of islands, for example.
    Systematic collection of data
Next Steps

• Projects in Paraty Rio de Janeiro (Fapesp and IDRC)
• Collaborative research
  • Collecting data
  • Training

• Management
  • Fishing agreements
  • Payments for Environmental Services

Thank you!