Cooperation, Externalities, and Spatial Property Rights: Implications for Small Scale Fisheries Management

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Top-down, market based management difficult
Territorial use rights fisheries (TURFs)
  Effective alternative (Hilborn, et al., 2005)
  More than 40 countries (Auriemma, et al., 2014)
TURF challenges
  Resource mobility → spatial externalities
  Internal organization (i.e. communal management)
    • Most TURFs communal (Afflerbach, et al., 2014)
Introduction and motivation

- **Standard TURF story**
  - No interactions within TURFs
  - Design ‘large’ TURFs or target immobile species

- **This paper**
  - Spatial scale (size of the TURF)
  - Species dispersal
  - Fisher interactions within and across TURFs

- Message: *standard TURF conclusions do not hold with internal interactions*
### Biological model

- Spatially explicit model with 2 patches
- Implicit larval and adult life stages
  - Common pool larval production
  - Density dependent larval settlement
  - Adult migration based on relative densities
- 4 dispersal cases

<table>
<thead>
<tr>
<th>Adult dispersal</th>
<th>Larval dispersal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>On</td>
</tr>
<tr>
<td>High</td>
<td>Off</td>
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</table>

- Low adult dispersal
- Source-sink
- High adult dispersal
- No larval dispersal
Multi-person game over the amount of fishing effort to invest within a patch

Two stage game theoretic model

- Stage 1: fishers agree on cooperative effort level within each patch; jointly maximizes profits to all fishers
- Stage 2: each fisher chooses individual effort level, e.g. ‘cooperate’ or ‘defect’
Result 1 A

*Standard TURF story:* TURFs most effective with immobile species.

*Finding:* Profits with common pool larval dispersal and cooperation within each patch greater than with immobile species.
Result 1 A: internal cooperation

*Profits with larval dispersal and internal cooperation greater than with immobile species*

Per Capita Profits Relative to Spatial Independence

- Low adult dispersal
- High adult dispersal
- No larval dispersal
- Source-sink

Spatial scale where both patches more profitable

Patch 1 Size

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

0% 50% 100% 150% 200% 250%
**Result 1 B**

*Standard TURF story*: TURFs most effective with immobile species.

*Finding*: when every fisher defects, profits under species dispersal always **less** than immobile case.
Result 1 B: internal non-cooperation

Without cooperation, profits always lower than immobile case.
Result 2

*Standard TURF story*: design TURFs to ‘internalize’ species dispersal

*Finding*: challenges to internal cooperation highest when adult mobility is ‘low’
Result 2: incentives to defect

Challenges to internal cooperation highest when adult mobility is ‘low’

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Spatial Property Rights and Small Scale Fisheries
Result 3

*Standard TURF story*: sole ownership

*Finding*: when internal cooperation fails, significant local costs and neighboring costs (spatial externality)
**Result 3: costs of a defection**

*With low adult dispersal, cost of a defection largely borne locally*

*With high adult dispersal, cost of a defection shifts to neighbor*

With low adult dispersal, cost of a defection largely borne locally.

With high adult dispersal, cost of a defection shifts to neighbor.

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**Graph:**

- **Low adult dispersal:**
  - Relative losses greater *within* TURF
  - Graph showing relative losses as a function of patch size, with a curve indicating higher relative losses within TURF.

- **High adult dispersal:**
  - Relative losses greater *outside* TURF
  - Graph showing relative losses as a function of patch size, with a curve indicating higher relative losses outside TURF.

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Fishery outcomes depend critically on scale and biological connectivities.

Likelihood of internal cooperation depends on dispersal:
- Inform enforcement costs to maintain durable cooperation.

Distribution of costs and benefits in TURF networks can be complex.
Informing design

- Are there conditions we can identify ex ante that correlate with successful communal management?
- What costs are necessary to maintain durable cooperative arrangements in TURFs?

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Biological model

Patch 1 larval settlement: \( \left(1 - \frac{x_1}{m}\right) \)

Larval pool production:
- \( ((1 - \alpha_1)x_1 + (1 - \alpha_2)x_2) \)
- \( ((1 - \alpha_1)x_1 + (1 - \alpha_2)x_2) \)

Patch 2 larval settlement: \( \left(1 - \frac{x_2}{1-m}\right) \)

\[ b \left( \frac{x_2}{1-m} - \frac{x_1}{m} \right) \quad \text{Adult dispersal} \quad b \left( \frac{x_1}{m} - \frac{x_2}{1-m} \right) \]

Patch 1 size = \( m \)

Patch 2 size = \( 1-m \)
References


