Unintended Consequences of a Ban on Illegal Fishing Gear

Evidence from a Field Experiment in Tanzania

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Motivation: Small-scale Fisheries

• Employ the majority of fishers worldwide
  – Approx. 90% of 38 million global fishermen (FAO, 2008)

• Majority in developing countries
  – Often lack the infrastructure and institutions of developed countries
  – Typically open access, unregulated, and/or regulations are poorly enforced

• How individuals act and interact is important for sustainable use of fish stock
Tanzania Small-scale Fisheries

- Tanzania fisheries are primarily small-scale and open access
- Illegal gear use (e.g. dynamite, small-mesh size) prevalent
- Overexploitation, poverty, and environmental destruction
Tanzania: Beach Management Units

- Beach Management Units (BMUs) introduced in 1998
  - Community management organization, tasked with sustainable management of fisheries
- BMUs have not performed as well as expected
Focus Groups with BMUs

• Patrol and enforcement of illegal fishing practices sparse and ineffective

• Comment: BMU revenue (for patrols) and legal authority to enforce illegal ban would improve compliance and fishery performance
Research Question

What is the causal effect of enforcing an illegal gear ban on fishing behavior?
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• Prediction: ability to enforce will increase cooperation and reduce exploitation rates
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• Prediction: ability to enforce will increase cooperation and reduce exploitation rates

• Adds to enforcement/compliance literature
  – Expected effect not clear *a priori*
  – Local context: sample of local fishers in developing country context
  – Focus on both exploitation and compliance rates
Game Design

Designed to capture key features of Tanzania small-scale fisheries

- Dynamic
- Interactive
- Interdependent
- Voluntary compliance

Designed to represent “real-life” fishing

- Players harvested beans from a communal bucket (Knapp and Murphy, 2010)
- Players paid for their harvest in TZ shillings at the end of each game
Round Begins
Stock of beans

Harvest
(30 sec.)

Stock Grows
Add beans

Harvest Only
Round Begins
Stock of beans

Harvest
(30 sec.)

Choose Gear
Legal or illegal
Illegal = 2 x harvest

Remove Harvest
From illegal gear

Stock Grows
Add beans

Harvest Only
Illegal Gear
Round Begins
Stock of beans

Choose Gear
Legal or illegal
Illegal = 2 x harvest

Harvest
(30 sec.)

Patrol
Randomly select player

Reveal Gear
Legal or Illegal

Punish if Illegal

Remove Harvest
From illegal gear

Stock Grows
Add beans

Prob = 0.5
Details

- Players told game lasts between 7 and 15 rounds
  - Avoid “terminal effect”
  - Actually ended between 7 and 10 rounds
- Logistic growth
  - Observed by players
- Practice Rounds

Round Begins
Stock of beans

Harvest
(30 sec.)

Stock Grows
Add beans

Harvest Only
Experimental Design

20 BMUs Randomly Selected:
9 from Ukewere; 11 from Mafia

~20 fishers randomly assigned to treatment arm

Harvest only
9 groups
44 players

Illegal gear
10 groups
48 players

Illegal gear with enforcement
10 groups
48 players

Other

Play same game 3 times (cycles)
Between 7-10 rounds for each cycle

740 group harvest outcomes
3,542 individual harvest outcomes
Evolution of Fish Stock (Average)

Cycle 1

Stock of Beans (g)

Round

"Optimal"  "Enforcement"  "Illegal"  "Harvest only"
Evolution of Fish Stock (Average)

Cycle 1

Cycle 2

Stock of Beans (g)

Round

"Optimal"  "Enforcement"  "Illegal"  "Harvest only"
Cooperation: Within-group variation in harvest

Coefficient of Variation

Harvest | Illegal | Enforcement
--- | --- | ---
1 | 1.5 | 1
2 | 1.2 | 2
3 | 1.8 | 3

A box plot showing the variation in coefficient of variation for different harvest, illegal, and enforcement categories.
Explanation 1: Is a Fine a Price?

No. Very little illegal gear activity.
Explanation 2: Income Maximization?

No major differences in harvest levels.

Individual Harvests: By Treatment and Cycle
Explanation 3: Erroneous Patrol Signal?

Patrols that reveal “cooperative behavior” send an erroneous positive signal of performance.

**Testable prediction 1:** First round harvest (prior to patrols) shouldn’t differ across treatments.
Explantation 3: Erroneous Patrol Signal?

Patrols that reveal “cooperative behavior” send an erroneous positive signal of performance.

Testable prediction 2: Harvest rates should increase after a “positive” patrols.

No evidence of this.
Conclusions

Enforcement of an illegal gear ban results in:

1. Improved compliance (limited evidence)
2. Increased exploitation rates
3. Decreased cooperation

• Mechanism is not clear
  • Crowding out behavior?
  • Multiple potential explanations for results
Conclusions

External validity:

• Do experimental results inform potential effects of illegal gear enforcement in the real world?
• Or are the results simply an artifact of the game?
Conclusions

Bigger Picture:

• Analysis is a slice of a bigger project: what’s the potential role of experiments for improving local management of small-scale fisheries?
• Can a structured experiential learning event improve local governance in the real world?
• Or more generally: Can experiments affect real-world behavior?
Acknowledgements
9 Group Strategies

- exploit-exploit
- exploit-steady
- exploit-save
- moderate-exploit
- moderate-steady
- moderate-save
- save-exploit
- save-steady
- save-save

Stock Remaining (grams)
Explanation 2: Income Maximization?

No. Other strategies are more beneficial.

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<thead>
<tr>
<th>Group Strategy</th>
<th>Average Grams Harvested per Player</th>
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<td>save-exploit</td>
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