Report on IIFET Special Session “Fisheries Games and Experiments: Applications for Education, Outreach and Science”
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Theodore Groves, Gunnar Knapp, John Ledyard, James Murphy, and Jörn Schmidt

Summary

There is growing realization of the potential for games and experiments as powerful tools not only for research, but also for education and outreach. Experiments are particularly powerful and useful for fisheries economists because (a) they can vividly illustrate some fundamental concepts and (b) are effective at testing the relative merits of various fishery management proposals. Fisheries economists have developed a wide variety of games and experiments for a wide variety of applications. However, many fisheries economists are unfamiliar with games and experiments and their potential applications. This two-part special session has a pair of complementary objectives: (a) to demonstrate a range of games and experiments to IIFET members who are unfamiliar with these methods so they can understand their potential for education, outreach and research; and (b) to provide an opportunity for existing developers and users of games and experiments to share new ideas for applications in fisheries.

Introduction

There is growing realization of the potential for games and experiments as powerful tools for education, outreach and research in many fields of economics and other sciences, and in particular for issues related to fisheries management.

Games and experiments can be used for:

- teaching economic principles to pupils, students or the general public;
- outreach and communication with stakeholders in participatory assessment or management environments;
- collecting scientific data in controlled research experiments.

Games and experiments can be designed so that players’ or subjects’ incentives parallel those in fisheries. How players or subjects respond to incentives, and how their responses affect other players/subjects’ incentives, can be extremely instructive, leading to insights not easily attained from other approaches such as modelling.

In popular perception, games tend to be viewed as “fun” and experiments tend to be viewed as “serious.” Actually, games and experiments can be the same thing: there is no reason that a fun game cannot also be a serious experiment, or vice versa. The more “fun” a game is the greater the potential to seriously engage participants in thinking about the choices they are presented by the game.

When designing games for educational purposes, the challenge is to structure stimulating and engaging environments that embed learning in ways that the player may not even be aware of the learning objectives, yet learning is a necessary part of the game and a prerequisite for success. The issues related to the objectives and game design targeted towards education are quite similar to those useful when communicating with regulators, policy makers or stakeholders. Participating in a role playing game can foster the
understanding of how different management regimes works, and may facilitate communication in situations where other ways of communication have failed.

In fisheries economics many games have been developed for the use in classrooms and some have even found the way to the public (Fish Banks, Ltd, Meadows 2001), to teach principles and mechanisms, e.g. the common goods problem or game theory. Role-playing games have been developed in the context of participatory management of land use or the use of marine resources (SimParc or ReefGame) and exhibit a strong tool for community based management approaches. Games can also be used to derive strong scientific results, either as a tool (Foldit) or analysing the outcomes of many game sessions of the game (EcoTrade).

Advances in computer technology are vastly expanding the potential to design games and experiments which are both fun and educational for participants and which shed real light on complex and important fisheries management issues, and to provide opportunities for large numbers of people to participate in these games at low cost.

**Theme Session - A: Demonstrations**

The Demonstrations session took place concurrent to the poster session, which gave a relaxed and fun atmosphere in which a large number of IIFET members were able both, to observe and take part in the three games/experiments. It was a great opportunity to introduce fisheries games and experiments to IIFET members who might not ordinarily think of games or experiments as being of interest or relevance to them and who might thus not attend an activity devoted exclusively to demonstrations of games and experiments.

Within the session three games/experiments were on display; one very “low-tech” and the two others very “high tech.” All three games/experiments have a wide variety of potential applications to teaching, communication and research.

In the “low-tech” game/experiment, developed by Professors James Murphy and Gunnar Knapp of the University of Alaska Anchorage, subjects engage in actual “fishing” by scooping beans from a large mixing bowl (Knapp and Murphy, 2010). This extremely simple and low-cost framework is fun for both participants and observers—but it has numerous and surprisingly sophisticated applications for teaching, communication and research—particularly for illustrating the implications of different management regulations. For example, it has been used to demonstrate resource overexploitation in unregulated fisheries (in multi-period experiments, subjects “overfish” the bowl during early periods, sacrificing future harvest potential); cost-driven rent-dissipation through over-capitalization in limited entry fisheries (subjects choose larger but higher-cost scoops in an effort to increase their catch shares); value-driven rent dissipation (subjects forego opportunities to obtain higher value for their fish which take more time and thus reduce their catch shares in competitive fisheries)—as well as the dramatic changes in all of these behaviors which result from the adoption of individual quotas.

In one “high-tech” game/experiment, developed by Professors John Ledyard of the California Institute of Technology and Theodore Groves of the University of California San Diego, a computer fishing game is used designed to acquaint players with (a) overfishing under open access, (b) how quotas (TAC) can rebuild stocks and rents and can be allocated initially in different ways that all lead to rebuilding stocks but with different distributional outcomes, and (c) how with trading of the quotas, greater efficiencies can be achieved. The game is played on laptops or iPads hosted on a laptop with wireless local area network (LAN) connections to the players’ devices. Participants can use their own laptops or iPads. Professors
Groves and Ledyard have demonstrated the game at international fishing industry workshops, and are further refining it for further planned demonstrations for numerous industry groups.

In the other “high-tech” game/experiment, developed by Dr. Jörn Schmidt and colleagues at Christian-Albrechts-Universität zu Kiel, players are fishermen in a sophisticated computer game played on a computer screen in which they observe an “ocean” divided into a large number of “cells.” Within each cell are fishery resources which grow over time and migrate or disperse to adjacent cells according to biological growth and dispersion functions, and which can be depleted by fish harvests. Players in the game control “boats” which can travel across the ocean to different cells and harvest fish with harvest rates and cost functions reflecting rates of travel and fish densities. Hands-on demonstrations of the game at a special exhibition in the German Museum in Munich attracted extraordinary public interest. Fascinating pictures and video of the game are available at www.ecocean.de. As is immediately apparent to fisheries economist viewers, this sophisticated game has extremely powerful potential applications for education, communication and research about issues ranging from overfishing to marine protected areas to bycatch reduction.

All three of these games attracted very high interest from IIFET participants and stimulated much discussion about their potential applications and further development for teaching, outreach and research. It also formed a good basis for the second session the next day.

**Theme Session - B: Discussion**

The purpose of Part B (Discussion) was to provide an opportunity for IIFET members who have developed fisheries games and experiments to discuss the games and experiments and their applications. In contrast to the Part A demonstrations, the objective of Part B was to provide an opportunity for developers and users of games and experiments to share new approaches for applying games and experiments to fisheries issues. The Part A demonstrations attracted additional audience members interested in learning more about the potential for games and experiments.

Part B had presentations about the three games/experiments demonstrated in Part A and a panel like discussion with the audience on further applications and other games in use. The questions raised with answers from the presenters are listed below.

**Session Presentations**

**ecoOcean - games in Fisheries education, communication and science**

Jörn Schmidt, Michel Magens, Dennis Nissen, Rudi Voss, Martin Quaas, Till Requate

Games as tools for the mediation of learning contents, board games or computer games are not a novel idea. However the full potential of games and experiments as powerful tools for education, outreach and research especially in fields related to fisheries management has not fully explored yet.

Games and experiments can be used for:

- Teaching economic principles to students or the general public;
- Outreach and communication with stakeholders in participatory assessment or management environments;
- Collecting scientific data in controlled research experiments.
Games and experiments can be designed so that players’ or subjects incentives parallel those in fisheries. How players or subjects respond to incentives, and how their responses affect other players/subjects’ incentives, can be extremely instructive, leading to insights not easily attained from other approaches such as modelling. The use of role-playing games can foster the understanding of different perceptions and mediate communication, especially in situations where other ways of communication have failed.

Role-playing games have been developed in the context of participatory management of land use (SimParc) or the use of marine resources (ReefGame) and exhibit a strong tool for community based management approaches. In fisheries many games have been developed for the use in classrooms and student courses and some have even found the way to the public (Fish Banks, Ltd, Meadows 2001), to teach principles and mechanisms, e.g. the common goods problem or game theory. Games can also be used to derive strong scientific results, either as a tool (Foldit) or analysing the outcomes of many sessions of a game (EcoTrade).

Here we will present a simple first game for the education of the broad public, ecoOcean and a conceptual framework for more complex games, which might be used for scientific experiments as well as for stakeholder communication.

**Fishing for Beads: Simple Games, Serious Insights**
**Gunnar Knapp, Jim Murphy**

A lot can be learned from observing behavior in simple, straightforward environments. The beads game is a simple, hand-run experiment that highlights the three sources of rent-dissipation in competitive fisheries. Resource-driven rent dissipation results from overharvesting; cost-driven rent dissipation arises from excess use of inputs (over-capitalization) to harvest a fixed quantity; and value-driven rent dissipation occurs when there is a lack of careful handling which degrades quality and reduces prices. A primary goal in designing the beans game was simplicity, both in terms of understanding the rules and in deciding a strategy. The game begins with a fixed quantity of beads in a bowl that is easily reached by all players. Each player can harvest beads into his/her own cup using a standard set of measuring spoons. Revenue is based on how many beads were harvested. In some variations of the game, the cost of the spoon (or harvesting technology) is deducted from the revenue. The beads game has been successfully tested with children as young as 6 years old, university students, and representatives from the fishing industry. The robustness of the game comes from its real-time, transparent, and highly competitive environment. In demonstrations and research experiments, it is clear that participants are having fun while learning about fundamental concepts in managing fisheries.

**Quota: From Experimental computer Game to Fishery Management Education Tool**
**Theodore Groves, John Ledyard**

*Quota*, a computer-based simulation game, originated as an experimental game for testing alternative multi-resource management regimes or systems. Highly flexible, it allows specification for a standard common-property, open-access fishery with user-specified bio-economic fishery growth model and multiple sized producers with individual harvest and cost functions. In addition to demonstrating overfishing under open-access, various forms of Property Rights Systems can be implemented, including the setting of an overall Total Allowable Catch (TAC) and further allocation of the TAC to individual producers -- Individual Quota Rights (IQR) -- that may be based on historical catch during initial periods of Open Access fishing or equal shares or shares determined by bargaining amongst the players (producers). Subsequent trading of IQRs is also implemented using a highly developed computerized trading game. Recent use of the game have been as an educational tool in university classes on resource economics and in the
field at meetings of Regional Fishing Management Organizations that govern the major tuna fisheries around the world.

Session Discussion

Real world fisheries are more complex and normally more than one assumption changes at a time: how to deal with that in a game context?

Gunnar Knapp, Jim Murphy
This is a challenge for any approach to modelling human behavior in a fishery, whether it’s developing a theoretical model, analysing data from an existing fishery, or developing a fisheries-related experiment. By keeping the game simple, we can focus on the key questions at hand without adding unnecessary complexity that could introduce confusion. If we think the complexity is a crucial element, then this could be added to the design and tested. No single experiment, and no single analysis of existing data will be sufficient to provide definitive answers to complex questions. Instead, research is an incremental process in which our understanding grows with each new study.

Theodore Groves, John Ledyard
While our game may be made more “realistic”, it would come at the cost of obscuring simple lessons. When useful (e.g. for showing how uncertainty about the stock can lead to unanticipated stock collapses, even when operating under a TAC), a particular “realistic” detail can be added to the game. The point of the game is not to mimic reality, but to isolate features of reality and explore their implications for fishery management.

Jörn Schmidt
Of course you could envisage a game with a complexity near to reality. However, if you want to test for specific effects of changes, you need to restrict the changes within the game. If you play through a series of scenarios you can also imagine changing combinations of several assumptions at a time, e.g. like a setup of choice experiments.

What about “unobservable” activities like illegal fisheries? Could you implement this in games?

Jörn Schmidt
Of course! You can leave it open to the player to obey to restrictions like Total Allowable Catch or temporal or spatial closings. You can also include measures like probability of being caught by a control or chance to be seen by other fishermen. The latter might be specifically interesting to investigate the effect of social peer pressure.

Theodore Groves, John Ledyard
In our game, fishermen are allowed to violate their individual catch limits, but are penalized for doing so. We can easily introduce a degree of uncertainty about whether or not their overfishing will be detected and then penalized. Also, we can design into the model any particular degree of “leakage” due to illegal and undetected fishing. What would be more difficult would be to introduce another decision variable to specify the level of enforcement activity that might be collectively agreed upon and undertaken.
Gunnar Knapp, Jim Murphy

In our beads game, it would be easy to modify the rules to create the possibility of “illegal” activities such as violating restrictions on gear choices, harvest quotas or bycatch, with some probability of getting caught and fined.

What about auctioning and the effect of different auction designs?

Jörn Schmidt
We have not yet included auctioning of quota in our game.

Theodore Groves, John Ledyard
This is a major goal of our game, namely to implement the auctioning of quota under different auction designs. It will be incorporated into the game within the next few months. Currently an internet-server based version of Quota does allow for experimenting with different auction designs, although it relies on accessing another software program. We are integrating this feature in our current, self-contained Mac, PC, iPad hardware platform.

Gunnar Knapp, Jim Murphy
Auctions are not the focus of our experiment, but it would not be hard to modify the game to auction the rights to individual harvest quotas.

Could you implement the effect of politics in games?

Jörn Schmidt
Maybe not in the games we presented here, but you can think of role-playing games, where you have to defend a specific position, e.g. stakeholders like fishermen or environmental organizations, you could also think of politician, e.g. representing different countries, as a role. I think it might be especially interesting to confront the player as a decision maker with different needs or demands of stakeholders to communicate the need of trade offs and the difficulty in decision making.

Theodore Groves, John Ledyard
Another enhancement of Quota that is currently under development is the flexibility to halt the game to allow for periods of negotiation over details of the management system (e.g. the level of the TAC and how it is to be distributed). These negotiation sessions would occur off-line and could be highly structured or completely unstructured. The outcome of the negotiations would be a new set of parameters or specifications that would then be inputs to the paused game, which would be resumed under the new configuration. One can imagine all kinds of role-playing scenarios that could be specified for the negotiation phase that might reflect, more or less, real-world political issues. But, while compatible with the game, per se, these considerations are not strictly embodied in the game and would require anyone using the game to design their own (or borrow from others) rules for the negotiations. This might be considered a “feature”, though, and not a “bug”!

Gunnar Knapp, Jim Murphy
Our experiments were not designed to study the effects of politics in fisheries. It’s likely that our experiment could be modified to test hypotheses about the political process, but this is not something we have considered.
What about interaction between the people? They tend to change the behaviour when they can communicate?

Jörn Schmidt
That is absolutely true. But you can actually design the game to test this, by prohibiting talking or by even separating the people spatially from each other.

Theodore Groves, John Ledyard
For experimental uses, the amount of communication permitted is tightly controlled and typically no communication is permitted, although for testing how communication may affect the outcome, various controls may be implemented. For the kinds of educational uses of Quota that we have tried, we have not restricted communication at all, although it is naturally limited by the proximity of players and by time limits in which to make their game decisions. Insofar as we can observe, say, the coordination of decisions by players in a game, we are thus able to comment on this during the end-of-game discussion.

Gunnar Knapp, Jim Murphy
It has been well-documented that communication is incredibly effective at inducing cooperation in social dilemmas such as these. Typically we discourage pre-play communication, but we have also conducted experiments in which people are allowed to talk before the harvesting begins. In nearly all cases, the group develops a set of rules to minimize the competitive frenzy and maximize earnings. Defections from these voluntary agreements are incredibly rare.

How are choices and behavior influenced by the set up of teams? Friends vs. strangers, are there consistent results?

Jörn Schmidt
This is of course related to the previous question. However we have not tested this so far in our game.

Theodore Groves, John Ledyard
We have played the game with single person and multi-person teams, but this is more a matter of helping to overcome lack of familiarity with computer games. We have not explored the effect of team composition. This might be an interesting thing to do in the laboratory, however, before worrying about it in the field for educational purposes.

Gunnar Knapp, Jim Murphy
Our general impression, from watching many different groups of players, is that relationships do affect behaviour, including how aggressively players compete with each other. This is, of course, what we would expect in “real-world” fisheries as well. In fact, it would be interesting to formally test the effects of relationships among players upon their behaviour and strategies in the game, but this has not been implemented so far.

What about introducing things like lobbying, small vs. large-scale fisheries and gender?

Jörn Schmidt
We have not included it in our game at the moment.
Theodore Groves, John Ledyard
While we have not explored any of these issues, in principle they can each be investigated although probably best in the experimental laboratory setting rather than in the field.

Gunnar Knapp, Jim Murphy
There already is a large literature in experimental economics which focuses on gender differences in competitive environments that would be relevant to our game. For example, one study in the Quarterly Journal of Economics by Muriel Niederle and Lise Vesterlund shows that although there are no gender differences in performance in a competitive environment, men are twice as likely to select a competitive compensation scheme rather than a noncompetitive scheme. In our beans game, it would be straightforward to test whether men are more likely to remain in a competitive derby fishery, rather than switch fishery managed with noncompetitive individual harvest quotas.

Big Question: Who needs to learn what and how? Eg. do resource managers need to learn about the common pool resource?

Jörn Schmidt
That is really a big question. I don’t know if resource managers need to learn about the common pool resource, but I am sure that the general public needs to learn about the complexity of fisheries and also the difficulty of making decisions. A game or simulation can also better inform the resource manager together with other stakeholders about possible effects of management measures. Rather then just assuming those effects you can play through possible scenarios and get the possibility to discuss them together.

Theodore Groves, John Ledyard
A very good question, indeed! Our hypothesis (and justification for developing the game for educational use in the first place) is that all stakeholders in fisheries need to know the basic economic principles of: (a) the “tragedy of the commons”, i.e. open-access competitive fishing leads to overfishing, depleted stocks, and disappearing rents, (b) that limiting catch can, if done properly, restore fish stocks and increase fish rents, (c) that creating property rights in catch shares is an efficient way to manage fisheries and that by judicious design through open, transparent, and fair negotiations property rights can be defined to protect all interests, and (d) that allowing for trading of property rights can, if properly conditioned, improve the values of all fishery stakeholders. In general, we would like the game to convince all those needing convincing that institutional design of fishery management systems matter and that by drawing on the lessons of economics (and fishery biology) better management systems can be designed to lead to healthy, sustainable fisheries.

Gunnar Knapp, Jim Murphy
We agree that fishery managers and stakeholders need to understand the principles listed above by Theodore Groves and John Ledyard. What we would add is that there are different levels of learning and understanding. It is one thing to understand these concepts theoretically. What the games do is to help players (and observers) understand the concepts on a more immediate and fundamental level through experiencing them directly. When players see themselves dramatically “overfishing” and dissipating rents in competitive fisheries, and when they see how dramatically their own behaviour changes when the game rules change to create catch shares, they really begin to “get it.” Playing the game helps them understand better not only the theory they may learn in classrooms or from books, but also what they observe in real-world fisheries.
Where are links broken between what they should know and what they really do?

Jörn Schmidt
I think a broken link is always the communication between all people involved in fisheries, fisheries science and decision-making. To find alternative ways to support communication might, at least sometimes, be a way forward.

Theodore Groves, John Ledyard
We economists frequently take for granted that everyone understands basic economic principles. This, we are often reminded in many important instances, is just not the case. Unfortunately (in our view) there are fishery managers, government officials in charge of fisheries, and even fishermen themselves who do not understand the basic bio-economic realities of the fisheries in which they are engaged. As a result, they rely on political, customary, and traditional ways for managing and operating in their fisheries, leading to unsustainable fisheries – both biologically and economically. See our answer to the previous question for what we think they should know.

Gunnar Knapp, Jim Murphy
People often think they know what they “should know” because they have studied it, or can even explain it. But they many not really understand it unless they have experienced it. The games help to provide that kind of experience. This is particularly the case with some of the more subtle ways in which competitive fisheries may dissipate economic rents. Most people really do understand that overfishing a fishery is inefficient and how and why competitive fisheries may be overfished. But most people don’t understand instinctively how competitive fisheries can lead to rent dissipation through excess costs and foregone value. The experience of playing or observing the games helps to fix these “broken links.

The technology frontier

Jörn Schmidt
The technology is already quite advanced. Calculating even complex models is relatively fast and the degree of complexity within games can be very high. Also the possibilities with respect on how to interact, e.g. even mobile phones or pads.

Theodore Groves, John Ledyard
The ubiquity of low-priced-high powered computing hardware presents an interesting trade-off. On the one hand, it is becoming easier and easier to deploy advanced powerful technology in the field. On the other hand, many of our “clients” (government fishery officials, fishermen, etc.) may not have had the opportunity to acquire the knowledge and sophistication in using advanced laptop computers, iPads, etc. This presents a challenge to us in attempting to use our game in some settings. It can mean that we have to spend a fair amount of limited time just acquainting players with the basics of computer games. Too much technological sophistication in the equipment and software can be self-defeating, if one is not careful!

Gunnar Knapp, Jim Murphy
Advanced technologies present wonderful new opportunities for fisheries games. That is why we are so excited to learn about our colleagues’ games. But the downside of technology is the cost of the equipment, programming and set-up time for the game. All of these are minimal for our “low-tech” game, and
we can easily and quickly improvise new game variations. And there is no mystery for the participants about what is going on: they see exactly how everything works. So we feel that there is great opportunity and benefit in both pushing the technology frontier as well as in playing “low-tech” games.

How far can we go in gaining insights?

Jörn Schmidt
I am convinced that you can gain great insights. If you develop an online strategic game version with a high level of complexity and a high number of players, you can impose management measures and record the change in behaviour. But the players will also gain insight in the system and implicitly learn facts and processes. If you use it to play with specific focus groups you can also see if there are differences between different reference groups or if some behaviour is universal.

Theodore Groves, John Ledyard
We see no limits in how far we can go in developing insights, in general. The only limits we have are the time and resources required to develop and modify our tools (viz. our Quota game) to enable us to demonstrate or teach the insights to others. For ourselves, the ability to use the game in experiments provides opportunity for gaining insight that is limited only by our own imagination.

Gunnar Knapp, Jim Murphy
We can go a long way. In theory we could mimic real-world fisheries better by developing more “realistic” hands-on games—for example with remote-controlled toy boats fishing for real (small) fish in water tanks. While fun to imagine, it is questionable whether the additional insights of going this far would be worth the cost. Ultimately, while we can make games much more realistic, games can never teach us everything we need to know about fisheries. Real fisheries will always be more complicated and the players will face more complicated incentives.

How can we get those people who just like to mess up everything engaged?

Jörn Schmidt
This is always a challenge and it will depend on the situation. If you refer to online games, sometimes the only opportunity is to throw them out of the game, which is a common procedure in most online games. If it is in a focus group like situation and you really want to achieve a solution or common understanding then it might depend on your ability to facilitate.

Theodore Groves, John Ledyard
Of course, in attempting to show folks lessons about fisheries using our game, there may be some players who do not become engaged and play “randomly” or worse, attempt to cause mischief of one kind or another. Fortunately, if such players are relatively few, they have limited scope within our game to cause any problem and are easily identifiable. Depending on the situation, peer pressure can be used to shame such individuals or deter them from destructive behaviour. Or they can just be ignored without much loss. Fortunately in our experience, this kind of extreme behaviour is extremely rare. Almost everyone finds the game great fun and willingly gets into the spirit of the game.
Gunnar Knapp, Jim Murphy

We do observe that some participants don’t understand the games, or don’t take them seriously. However, this occurs relatively rarely. Peer pressure seems to be effective in stopping most bad behaviour, as well as the fact that usually the participants are volunteers.

Reference to the webpage “games economists play”

The webpage “games economists play” was mentioned as a general repository for small classroom games, which teach economic principles. The site is at:
http://www.marietta.edu/~delemeeg/games/

References


Annex 1: List of participants/speakers in theme sessions

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