Analytical framework for studying fishers' behaviour and adaptation strategies

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Abstract. Knowledge about fishers' decision-making and adaptation to changes is essential for understanding the implications of fisheries resource management. It is rare that adaptation strategies are taken into consideration, when new regulations are implemented with the result that the regulations may have unintended economic and biological effects. The negative impact can to a larger degree be avoided with a profound understanding of fishers' behaviour. This article is a framework for analysing fishers' behaviour and adaptation on short term (trip basis) and long term. Decision-making in fisheries is influenced by a number of instrumental and non-instrumental factors: the prevalent prices, tax, subsidies, fisheries regulations, the available technology, fish stocks condition, geography, demands on comfort and safety, knowledge and experience, cooperation, legitimacy, personal risk aversion, social pressure and expectations.

Introduction

Understanding fishers' adaptation to changes in regulation, market and social structures is important in designing rules which are accepted by fishers and conserve fish resources. To call on compliance, the outcome of regulations must be compatible with fishing practices and provide some economic benefits for the fishers.

Modern fisheries management is generally based on biological advice applied to individual stocks of particular species. This foundation of resource management, focusing on single species regulations may lack complementarity with the common practice of mixed-species fisheries. Implementations of new regulations can tremendous impact on the characteristics and distribution of fishing activities leading to consequences (economic and biological) unforeseen by managers. Fishers' adaptation to e.g. closed areas or technical mesh size regulations, include moving activity into new fisheries and areas with a different set of economic, geographical, biological and social incentives.

Economic theory suggest that fishing effort will be spatially distributed by the expected economic outcome from fishing in specific fisheries and areas at certain times (Gordon 1954, Warming, 1911). In a simple situation, with a single-species fishery and a homogenous distribution of homogenous fishers and fishing grounds, it may be assumed that the fishing effort is equally and foreseeable distributed as to equalize the profit among fishers. However in

multi-species fisheries, conducted by a heterogeneous fleet (various gears and vessels) the distribution of fishing effort is complex and differentiated. Fishers will plan their fishery from the expected benefits. However, the profit expectation for the same area, the information and experience with specific stocks and grounds, and the risk aversion may be quite different among individual skippers.

This article aim to capture the complexity of fishers' behaviour and develop a tool for analysing fishers' adaptation to biological, economic, regulatory and social changes. The complexity and heterogeneity of most modern commercial fisheries suggest that the problem can be analysed among individual fishers with validation from quantitative studies of fleet behaviour.

Analysing fisher behaviour - short and long term perspective

Conducting studies on the concrete patterns of decision-making and adaptation include studying individuals and group behaviour across space and time. Fishers' decision-making can for that reason be distinguished into two related levels:

- *Short term* (trip basis) - the fishers' concern with where, when and how to fish (fishing tactics)
- *Long term* - the fisher sets the strategy for how and when to invest his capital and fishing effort. Decommission may also be a consideration.

Economic structure

The dynamics of fishers' behaviour (trip basis and long term) is to a large extent determined by the economic cost and earnings of the fishing enterprise – including: prices on fish, fuel, supplies, crew, vessel, fishing equipment, insurance, fishing rights (e.g. Individual Transferable Quotas -ITQ), port services, etc. Also tax restrictions, credit, finance availability and governmental subsidies is setting the scope for fishers' economic decision-making. Less explicit, but still significant, is the rational calculation of whether to comply with the fisheries regulations or to act opportunistic (violate) with the risk of being detected and sanctioned.

Short term - the economic structure of the fishing trip

When initiating a fishing trip the skipper may have a clear or vague idea of where, when, what and how to fish. Undecided, skippers will develop their tactics during the trip as they gather new information (from other fishers or by experimenting). Decision-making varies from one trip to the other and differs between fishers and fisheries. Larger vessels with a high mobility may be away from port for extended periods, which give them different opportunities compared to small-scale boats, which typically operate within a limited area for a shorter period.

Cost and earnings of a fishing trip, are influenced by prices, weather and ocean, but also by the skippers experience with when to leave a fishing ground for another; his skills to operate the technical equipment and to cooperate with his crew.

Fuel represents a significant trip basis expenditure in most modern fisheries, particularly in large-scale fishing (e.g. > 200 Gross Ton[1]), despite governmental fuel subsidies in e.g. the EU (Raakjaer Nielsen and Mathiesen, 2002). If quotas are reduced, the improvement of profits may come from increasing the fishing effort in other fisheries, but also from reducing fuel consumption by minimizing travelling and hauling distances per catch volume. On a long term, modernization of the vessel construction, engine, propeller and fishing gear will contribute to a considerable reduction in fuel consumption (Jes Hansen, 1986). While expenditures on fuel, crew, ice and supplies is related to the specific *trip*, the rigging of the gear (trawl, gill net Danish seine, etc.) is often a *medium term* decision, made per week, month or season (Squires and Kirley, 1999).

Where to land the catch is determined by fish prices, sailing distance and the demand with fish dealers/processing firms. However, high fish prices do not necessarily attract landings, as fishers may prefer supporting local fish dealers (auctions) and service enterprises of their homeport. Expenditures on port services, varies with vessel size, economic relation to the port and time spent in port.

Long term - investment behaviour

The state of over investment in commercial fisheries is well documented in the fisheries literature (Lynge, 1998, Charles 1983, Hilborn, 1985), however the underlying empirical problems are less analysed in research. Fishers' investments in vessel and fishing equipment follow fluctuations in fish stocks, market, regulations and the individual ability to catch fish. In times of boom in the fisheries economy, fishers increase their investments, perhaps encouraged by venture capital (banks) and/or governmental subsidies (Vedsmand et al., 1998). However, high investment and mortgaging increase the vulnerability of the enterprises in case of resource declines and market busts. Investments in fishing vessels have very few, if any alternative uses. During times of busts capital may only be removed from the harvesting sector (to non-fishery) through depreciation or buy back governmental programs. The impact of this is demonstrated in numerous examples of boom and bust developments leading to overcapacity and overcapitalisation succeeded by bankrupts, illegal fishing, social problems and depopulation of coastal communities (Jentoft, 1993; Hamilton, 2003).

[1] An example of how to scale fisheries is Danish fisheries: small scale is below 50 Gross Ton (GT); medium scale is 50-199 GT; large scale is >200 GT; very large scale is > 1000 GT (Accountance Statistics for Fishery, 2000).

In times of bust (quota reduction or profit loss) fishers adapt in various ways: They may e.g. shift (invest) from large to medium or small scale operations (Vedmand et al., 1998; Hect and Vestergaard, 1987, Maurstad, 1998); purchase new gear to achieve higher flexibility in choice of fisheries or invest in storage and processing facilities on board as to increase the value of the catch.

Several regulatory attempts can be made to direct investments in fisheries, including capacity reduction programs, modernization subsidies, tax regulations, fishing effort regulation and out put regulations (minimum size fish). The subsidies programs are designed to assist individuals and the fleet as whole in adapting to changes and surviving crisis. An adverse effect of this is, however, a postponement of economic collapses while expanding vessel capacity with externally encouraged investments. Venture capital of banks and private investments may also extend a boom development beyond the economic carrying capacity. In the reverse situation the lack of venture capital will delay the start up of a boom because of the resignation of e.g. banks because of the uncertainty of fisheries (Vedsmand et al., 1998).

Most major fisheries problems are caused by over investment (Hilborn, 1985), which partly is because policy makers do not fully consider the fishers' incentives to invest. Competition among fishers and the aim to maximize profits and minimize loses (economic and social) encourage the entrepreneur to invest in fisheries in the strive to stay ahead or keep up with his competitors. This fundamental incentive may be reinforced or played down, dependent on the political will to regulate subsidies, taxes, credit availability and to encourage investments to businesses outside fisheries.

Regulations

Fishers vary in their decision-making depending on the technology in use (vessel, gear) and the respective fisheries. However, fisheries regulations (quotas, technical measures, fleet structure programs) and the economic balance (debt, prices, subsidies) are crucial factors influencing decision-making.

Resource scarcity and strict quotas provoke a more stringent focus on optimising profit (Jentoft, 1998; Maurstad, 1998). With the risk of facing even smaller quotas in the following ration period and not utilizing the full catch volume of the present quota, fishers react to restrictions by having more days at sea and use more gear and more efficient gear. Others adapt by e.g. investing in storage and processing equipment as to optimise the value of the catch on board. Further increase of value may be achieved from discards of target species beyond the volume of the quotas and/or illegal discards of less valuable fish, non-target species (high grading).

Mesh size restrictions aim to promote the use (invest in) of gears with strong selectivity. Restrictive changes in gear regulations, which impose the buying of

alternative gears, is a nuisance to fishers and a considerable expenditure to particularly small scale fishers.

Owners of medium and large-scale vessels with greater flexibility may choose to target other species and/or other areas to compensate from their loss (Raakjaer Nielsen and Mathiesen, 2003). With measures, like closed areas, fishers are incited to move their activities into different areas and fisheries which most likely are already oversubscribed. The impact of an increased fishery in “new” area may be uncertain to managers. When (if) no-fishing zones are reopened, vessels are likely to rush back into the area with an increased number of trips as to gain most from the accumulated stocks (larger individuals, higher concentration of fish) (Rijnsdorp et al, 2001).

Technology in use – gear and vessel

By the time the vessels have left port and decisions are made on where and when to fish, the technical choices are limited by the given vessel and the gears on board. How well the skipper and his crew manage to operate and maintain this technology is the scope within they can produce alternative options.

Technical regulations are implemented as to limit vessel sizes, engine power, mesh sizes, length of nets, days at sea, number of trawls etc. Fishers will either comply with regulation, move into other fisheries, stop fishing or violate regulation to compensate for loss of income and time (Sutinen et. al., 1990).

Restrictions on e.g. vessel length or engine sizes in inshore fisheries is appreciated by coastal fishers who dependent on these resources, however, it creates incentives with the imposed fishers to “legally” circumvent the law either by investing in more efficient gear, build wider boats, buy up fish from local fishers or perhaps simply break the law. Limitations on e.g. mesh size may be relatively easily decided on, however being difficult to monitor. If fishers participate in several fisheries with different legislation and for that reason keep various types of gear on board, it can be extremely difficult to monitor compliance, without costly on board monitoring. Regulations on e.g. safety facilities and communication equipments (radio) can be quite an expense in small scale fisheries, why general legal demands regarding this, may be in conflict with the budget and needs of small scale fishers.

The vessel size, engine and hold, determines the duration and radius of action. A modern engine can increase the operation speed and perhaps give access to a new resources and markets e.g. through daily landings of fresh fish, even from distant fishing grounds. The engine power determines the ability to operate in rough weather and influences the ability to steer the trawl across the bottom and be selective in targeting the stocks. Modern vessels with processing, freezing and cooling facilities on board, give ability to land higher quality products with better prices.

Not having efficient modern facilities on board, clearly limits the options. To stay dynamic and competitive, the skipper must either invest in new gear and/or increase his skills and knowledge base.

Crew members increasing demand for good payments and more time with their family and friends and the physical risk of fishing is reducing the number of potential fishers in some regions (Mathiesen et al. 2003). Increased competition to attract (competent) crew members insists that the vessel owners invest in safety and comfort on board. A skipper may be left out from certain fisheries and potential profits if one cannot recruit the crew to do the job.

Fish resources and geography

Particularly, in small or medium scale fisheries (<24 meter), the weather is a crucial factor. Small vessels may be limited to inshore waters during seasons of strong wind and high sea. Even with mild seasons, the fisher must relate on day-to-day changes in weather. Operating in high sea increase the fuel cost and the workload on crew members. Despite this, a number of small boats challenge the hard weather if the given fish quotas are only available in these periods – e.g. fortnight quotas in the stormy season. Large-scale vessels, like in the pelagic (mackerel and herring) fisheries in the Norwegian and Greenland sea (North Atlantic), are less dependent on weather and a nearby harbour. In certain fisheries, it is also argued that larger vessels fish better than smaller because of their greater momentum that allows for operating the gears more effectively.

When fishing, gill net fishers must relate on ocean currents when setting their nets as to optimise the press of the gear in regard to ocean currents, bottom and fish stock behaviour (horizontal and vertical position). Slacken nets may be an advantage when stocks are calm and the reverse when stocks are active. The effectiveness of trawl and purse seine gears is also influenced by ocean currents.

As demonstrated, quota regulations may be in conflict with the fishing practice if it does not complement with the optimal weather of the season (Raakjaer and Mathiesen, 2003). E.g. in the cod fisheries in the Baltic sea, the fishery are for regulatory reasons (quotas) most active during the winter when weather conditions are hard. During 2-3 months of the summer period this fishery is closed for conservation reasons, which is of great annoyance to particular small scale fishers who argue that this is a good time for fishing and that the impact of small scale vessels is not a threat to the stocks (Mathiesen, et al. 2003).

Knowledge

Fishers are constantly evaluating, calculating and observing others as to adapt to external changes. Competition, fishing quotas and uncertainty of market development keep the fisher locked into a stringent aim of optimising economic benefits and minimizing potential loses. However the difficulty in finding fish and the risk of investments stimulate the individual fishers to communicate and cooperate in these actions (Wilson, 1990; Holland and Sutinen, 2000).

Fishers with successful catches in a certain area are often imitated by others, as the cost of searching for fish in new areas can be high. Skippers tend to avoid seeking high catches with low probability and instead seek high probabilities of a reasonable catch (Palsson and Durrenberger, 1982). The existence of a core of successful fishers being skilled in finding and catching fish is recognized in empirical fisheries research be several scholars (Abrahams and Healey, 1990; Wilson, 1990, Squires and Kirkley, 1999). Even local fishers operating in the same area all year may stand out as less skilled in fishing in their chosen area compared to successful fishers moving from one area to another. Profound knowledge on a specific fishing ground is often very valuable to local fishers, why regulatory closures of these areas can result in significant decoupling of resource information.

In designing regulations, managers must relate to the complexity of the fleet (varying vessels sizes and gears) and the fact that fishers differ in skill and experience. Fishers adapt differently to regulatory changes, which mean that low income or illegal behaviour for some fishermen, cannot be taken as evidence that the fleet is generally doing poor. Successful fishers might still be having profitable catches in times of resource scarcity.

Norms

Fishing is clearly a commercial and highly competitive business. However, even strict economic transactions are embedded in social structures that influence the decisions and behaviour of economic agents (Granovetter, 1985). Commercial fisheries are binded together by non-monetary relations: practical knowledge, norms, kinship, and traditions. Norms in the sense of typical behaviour/attitudes and expectations about the actions and opinions of others can have a tremendous influence among fishers and may work as social pressure, creating positive or negative sanctions (Giddens, 1984; Goul Andersen, 1998).

Locating a profitable fish stock may be kept a secret from competing vessels. However, fishers also enjoy the social recognition when making the good catch (once the news gets out). The acknowledgement from fellow fishers is an

incentive for putting hard work into being successful and making extraordinary catches when possible (McGoodwin, 1990).

With resource scarcity and quota restrictions determining the overall catch, some fisheries increasingly resemble agricultural harvesting. However, most fishers consider themselves hunters driven by the game of finding the best fish before the competitors - competition is a hallmark among fishers (Vestergaard, 1996). If the fishers do not have the opportunity to legally land a "golden catch" they feel loss of freedom, which disincentive taking risks, seeking new fishing grounds, trying new gears and develop new products (Raakjaer Nielsen and Mathiesen, 2003). Rigid regulation, which does not complement with the dynamics of marine resources and the fishers' strive to make a good catch, will almost certainly be circumvented by an always inventive group of fishers.

Because marine fish are difficult to bound, cultivate and subject to ownership rights, privatisation is tremendously difficult. The fishing vessel, being the sole private ownership to fishers, thus becomes the prime target for investments – for increasing production. A vessel with modern equipment is also a sign of success and pays off with social recognition (admire, respect, envy, cooperation, etc.) from fellow fishers. When fishers have new vessels, constructed, they often put great pride in showing their new possession to their peers - see e.g. Danish Fishing News (2003).

Legitimacy and compliance

As already stressed, in situations with resource scarcity and strict regulations fishers will find ways to bypass regulations if they do not accept them. Violations take form of non-reporting of catches, misreporting to other areas or species or various circumventions of technical regulations (e.g. illegal gear rigging, breaking by-catch rules). Research in compliance behaviour (Kuperan and Sutinen, 1998, Sutinen et al, 1990; Raakjaer Mathiesen, 2003) has identified several important factors influencing rule compliance with fishers: 1) The economic gains to be obtained from compliance or non-compliance; 2) The risk and impact of being detected and sanctioned, 3) the level of compatibility between regulations and fishing practice; 4) the conservational efficacy of imposed regulations and 5) the norms among fishers (expectations and typical behaviour)

The lack of compliance in fisheries, despite increased enforcement activities, has drawn the attention to the importance of legitimacy of fisheries management. Legitimacy is considered as a normative phenomenon linked to a political authority (system). David Easton (1958) defines legitimacy as: "*Legitimacy exists when the members of a society see adequate reason for feeling that they should voluntarily obey the commends of authorities*". Jentoft (1989:139) emphasizes that four factors have important influence on the existence of legitimacy: 1) content of the regulations; 2) distributional effects; 3) making of the regulations and finally 4) implementation of the regulations,

where the hypothesis is, that *"the more directly involved the fishermen are in installing and enforcing the regulation, the more the regulation will be accepted as legitimate".*

The analytical framework – framing the dynamics of fisheries

Fishers' decision-making is a complex matter with several interacting factors at play. The framework illustrated in figure 1, segments what can be seen as the most important factors in commercial fisheries. To what extent the various elements influence the individual decision-making and adaptation may change over time and differ among fishers, fleets, and vessels in regard to the respective fisheries.

The factors that influence decision-making and adaptation on short term (trip basis) and long-term basis (investments) are:

- *Economic structure*: prices on fish, vessel, gear, fuel, ice, supplies, port services, insurance, fishing rights, expenditures on crew, conditions for subsidies, tax, credit/finance and cost/benefit of rule compliance
- *Technology in use*: gear, vessel
- *Regulations*: technical measures, fishing rights, rations/quotas, fleet structure programs
- *Fish resources and geography*: fish resources (availability and quality), weather, ocean, spatial distribution of fishing grounds and ports.
- *Comfort and safety*: work load, days at sea, safety, comfort
- *Knowledge*: skipper skills (experience/education), cooperation and imitation with fishers
- *Norms and moral*: social status, personal risk aversion, legitimacy of regulations: compliance behaviour of others (social pressure, expectations), personal moral.

Conclusion

When changes occur in regulations or market conditions fishers will react as to benefit from this and compensate for potential loses in monetary and social profit. From an analytical perspective the continuous and interactive decision selectivity of fishers may be divided into two levels: trip basis (tactical) and long term (strategic). Tactical decisions are influenced by regulations, market fluctuations, the technology in use, skipper skills, natural resource conditions, expectations, habits, the behaviour of other fishers and legitimacy of regulations. Strategic behaviour concerns vessel and gear investments or disinvestments or even the option of leaving the business (e.g. decommission). How fishers perceive their future possibilities is influenced by a complex of their present economic situation, market conditions, long-term expectations, government subsidies, regulations, age, experience, risk aversion and the behaviour of others.

The importance of understanding fishers' behaviour is emphasized by the enduring conflict between fisheries management, regulations and the practice of fishing. Resource managers may assume that continuous adjustments of the regulations and the appropriate level of enforcement will govern the behaviour of fishers. However, the European and North American experience show that fisheries management does not work as intended because fishers rarely accept and agree with the regulations. Inventive circumventions and dissatisfaction with the management system is part of the daily routine. The conflict is likely to persist as long as the behaviour and the incentives of fishers are not fully understood by managers. Fishers are aware of resource overexploitation and the problems of over investments but are locked into a competitive system and choose to act short sighted. If regulations are in great conflict with fishing practices or are less manageable from an enforcement perspective, the impact of regulations may remain far from intended.

FIGURE 1 HERE!! DIAGRAM OF ANALYTICAL FRAMWORK

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