fish610.4 Discard Considerations of EAFM

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1 Introduction to Discards

1.1 Learning Objectives

1.1.1 Details

Learning Objectives 1

- Explain what discards are
- Explain why discards occur

1.2 What are Discards

- Definition of discards
- What's considered a discard
- Examples of discards

1.2.1 Details

Definition 1: Discards

'The proportion of total organic material of animal origin in the catch which is thrown away or dumped at sea, for whatever reason.' FAO fisheries glossary

Thus, discards are the unwanted or unintentional catch. As such, discards can be of any species including undersized target species, species of low or no market demand, or fish for which the fishermen do not have a quota or have already met their quota.

1.3 Why Discards Occur

- Why are discards caught
- Why are discards are released

1.3.1 Details

Why Discards Occur

Generally speaking, discards occur because fishermen reject a segment of their landed catch. Throwing back a portion of their landed catch can occur for several reasons:

- regulatory reasons
  - individuals of the target species are too small
  - the fishermen do not have adequate quota to keep the fish
  - the species is protected
- economic reasons
  - the species of fish is not of economic value
  - the size of the fish is not of economic value
  - the fish were damaged during the catching process and so are not of economic value
- storage reasons
  - there is not enough space in the storage containers

2 Discards, By-catch, and Slippage

2.1 Learning Objectives

2.1.1 Details

Learning Objectives 2

- Define by-catch and differentiate it from discards
- Define slippage and differentiate it from discards
- Compare and contrast discards, by-catch, and slippage

2.2 What is Bycatch

- Definition of bycatch
- What's considered bycatch
- Examples of bycatch

2.2.1 Details

Definition 2: Bycatch

The portion of catch which is unintentionally taken while fishing for another species.

Thus, anything which is caught that was not directly being fished for is considered bycatch. For example, catching dolphin while fishing for tuna.

2.3 What is Slippage

- Definition of slippage
- What is considered slippage
- Examples of slippage

2.3.1 Details

Definition 3: Slippage

Unintentional catches from seine net fishing or pelagic species which are never landed.

Slippage, or slipping, is done by releasing a portion of the seine net catch after the drying-up period but before landing the catch. During this process many of the small species may escape. This method is commonly done when fishing for mackerel in the UK and sardines in Portugal in order to reduce landings of unwanted species [Stratoudakis and Marçalo, 2002].

2.4 Similarities and Differences

- Species included
- Landing of undesired individuals
- Alive vs. Dead when released
- Reason for releasing in relation to quotas
- Environmental impacts

2.4.1 Details

	Discards	Bycatch	Slippage
Types of species	Target and non-target	Non-target	Target and non-target
Care of undesired species	Landed	Landed	Not landed
State of released individuals	Usually dead	Usually dead	Usually alive
Relationship with quota	Over quota, no quota, or not related to quota	Not related to quota	Done not to exceed quota
Environmental Impacts	Disrupts species interactions, may cause species cascades, provides food for seabirds, provides food for benthic organisms	Negatively impacts elasmobranch species, can include the catch of endangered species, can affect nutrient flow	Primarily impacts small fish which can cause bottom-up trophic cascades

Further Reading

For more information on bycatch see Hall et al. [2000]. For more information on slipping see Tsagarakis et al. [2012]

3 Ecosystem Impacts of Discards

3.1 Learning Objectives

3.1.1 Details

Learning Objectives 3

- Explain the impact of discards on commercial stocks
- Explain the impact of discards on non-commercial stocks

3.2 Ecosystem Impacts of Discards

- Background on ecosystem impacts
- Components of the ecosystem most affected

3.2.1 Details

The ecosystem impacts of discarding are largely related to nutrient and energy flow. As such species are affected both directly and indirectly resulting in ecosystem wide impacts. Or, in other words, both target and non-target species are impacted and species can be both positively or negatively impacted.

Although the responses to discarding tend to be situationally and species dependent several "rules" tend to hold true. First, species which are k-selected tend to suffer greater impacts than r-selected species especially when the target species is r-selected [Alverson et al., 1994]. Secondly, discarding of smaller fish tends to result in greater ecosystem impacts due to higher rates of discard mortality [Alverson et al., 1994].

Generally speaking the ecosystem components of greatest concern are population size, predatory/prey dynamics, species structure, aquatic conditions, and benthic communities. As a result, the lectures within this tutorial will focus on these impacts.

3.3 Population Level Impacts

- Impact of undersized target species discards
- Impact of no or low economic value species discards

3.3.1 Details

Undersized discards

Discards of undersized target species have been shown to negatively impact the population size of the target species. The resulting decline in population size has been attributed to the high mortality levels within the subadult population. More specifically, undersized target species tend to be subadults and discarding tends to result in very high mortality rates. Thus, when the subadults are discarded they are mostly dead decreasing the number of individuals becoming adults and in turn decreasing the number of reproductively active individuals and subsequently the number of offspring produced. As a result, the population size of the targeted species tend to decline.

Case Study 1: Haddock and Whiting in the North Atlantic

The North Atlantic mixed fishery contained minimum landing size for cod, haddock, and whiting resulting in the discarding of undersized individuals. The associated discard mortality rate by age was:

Age	Haddock	Whiting
1	20%	15%
2	81%	15%
3	54%	15%
4	16%	15%

The high levels of subadult mortality from discarding was attributed to the decline in total population size for all three species.

This case study was adapted from Alverson et al. [1994].

No or Low Economic Value Discards

The mode of population impacts from discarding low or no economic species varies greatly amongst species. However, the resulting impact tends to be the same...population decline.

Economically unimportant species tend to be either low trophic level species, such as those obtained in the tropical shrimp fishery, or high trophic level species such as sharks and sturgeon. The high discard mortality rates for low trophic level species tends to result in bottom-up trophic cascades as they are typically important prey species. While the high discard mortality rates for high trophic level individuals tends to result in top-down trophic cascades.

The high mortality rates of these species can also result in their own population decline especially for k-selected species. In the case of sharks, for example, the removal of a few individuals via incidental catch and subsequent discarding was enough to harm their population [Alverson et al., 1994].

3.4 Species Assemblage Impacts

- Impact on species assemblage
- Impact on energy flow

3.4.1 Details

Species Assemblage

Fishing mortality resulting from discarding can shift species assemblages and impact predator-prey dynamics [Alverson et al., 1994]. More specifically, the resulting decrease in population size of the discarded fish can result in the increase of another species potentially altering the predators or prey that are available. These shifts can change foraging patterns and in turn potentially foraging behavior. These patterns are especially apparent when the discards are of non-targeted species.

Case Study 2: Asian Shrimping

In Thailand and Malaysia the families of *Leiognathidae, Ariidae, Carangi-*

dae, Nemipteridae, and *Pomadasyidae* dominated the system prior to the introduction of shrimp trawling. However, with the onset of shrimp trawling, the abundance of *Leiognathidae* dropped sharply due to its high discard mortality rate while pelagic species increased in abundance.

This case study was adapted from Alverson et al. [1994].

Energy Flow

Discarding undersized target species tends to result in a decline in juvenile predatory abundance as well as prey abundance [Browder, 1981]. Specifically, reducing prey abundance through non-target discarding shifts predation patterns. Thus, given limited options predators focus their efforts on the remaining prey species further reducing their population levels. While the reduced prey abundances further decreases predator abundances.

3.5 Environmental Impacts

- Impact on benthic community structure
- Grounds poisoning

3.5.1 Details

Benthic Communities

Benthic community structure is impacted directly by being discarded and indirectly from increased predation. During the trawling process benthic species can be brought to the surface. Landed benthic species are then discarded with very high rates of discard mortality resulting in population declines. However, for the individuals that survive the landing process their redistribution into surface waters results in high predation rates [Alverson et al., 1994].

Ground Poisoning

Discarding non-target catch and processing waste has also been found to result in grounds poisoning or spoiling.

Definition 4: Ground Poisoning/Spoiling

Oxygen depletion resulting from the decomposition process consuming oxygen.

Thus, ground poisoning occurs when the discarded waste, whether fish or fish waste, sinks to the sea floor initiating the decomposition process. During the decomposition process the oxygen is consumed by decomposing bacteria creating anaerobic conditions.

Ground poisoning tends to be highest when large quantities of discards are released from a stationary ship.

Case Study 3: New Zealand Hoki

Along the west coast of New Zealand, 47.800mt was discarded from a hoki (*Macruronus novazealandiae*)fishery resulting in a projected oxygen saturation reduction of 45-55%.

This case study was adapted from Alverson et al. [1994].

3.6 Impact on Scavengers

- Benefits to scavengers
- Negative impacts on scavengers

3.6.1 Details

Benefits to Scavengers

Like most things the ecological impacts of discarding are not exclussively negative. In fact, for scavengers especially seabirds, sharks, dolphins, and benthic scavengers the impact can be rather positive. Infact, some seabird population increases have been attributed to discarding [Bellido et al., 2011].

The positive response from discarding can be attributed to increased forage. Specifically, discarding fish and fish waste brings food supplies from lower depths and makes them available at the surface. As a result, seabirds and other surface scavengers now have the opportunity to forage on species they would otherwise not have access to. However, they are unable to scavenge all of the discards allowing some to move through the water column making them available to midwater scavengers such as sharks. Eventually the discards reach benthic scavengers like fish, crabs, shrimp, and other invertebrates [Bellido et al., 2011].

Negative Impacts

Although discarding increases food availability it also simultaneously increases the probability of these scavengers being caught by the fishery. More specifically, scavengers feeding on discarded material are more likely to be accidentally caught by fisherman than individuals not feeding on discards.

4 Economic Impacts of Discards

4.1 Learning Objectives

4.1.1 Details

Learning Objectives 4

- Explain how discarding economically impacts commercial and non-commercial fisheries as well as was to mitigate these impacts
- Explain the economic impact of illegal fish discards and monitoring/prevention costs as well as ways to reduce these impacts

4.2 Background to Economic Impacts

- Costs associated with the act of discarding
- Costs associated with the monitoring and prevention of discarding

4.2.1 Details

The economic impact of discarding can be attributed to 2 major areas:

- the costs associated with the act of discarding

- the costs associated with monitoring and preventing discarding

Act of Discarding

The economic costs associated with the act of discarding itself deal primarily with the economic losses attributed to target species population declines and impact on quotas. Thus, the costs directly associated with discarding are typically felt by those harvesting, processing, marketing, and/or consuming the fish [Alverson et al., 1994].

The indirect economic impacts associated with discarding can be attributed to 1)the impact of discarding commercially valuable species on other fisheries, 2) discarding non-legal individuals, and 3) discarding economically unimportant non-target species. Thus, the remainder of this lecture will dive into more detail on each of these areas.

Control and Monitoring

The economic cost of controlling and monitoring discards is largely attributed to enforcement costs, gear modification costs, and altering fishing behavior to reduce by-catch. As a result, the economic impact is largely imposed on fishermen and the agencies responsible for enforcing regulations.

Within the subsequent lectures we will explore the costs associated with gear changes, closing areas to fishing, and observer costs.

4.3 Commercially Valuable Discards

- What is included in this category
- How the cost is accrued
- Solutions

4.3.1 Details

What's Included

Fish included in this category are fish which are of commercial value but not the target species for the fishing vessel. In other words, fisheries exist for the landed species yet they were caught by another. In this situation much of the financial strain is placed on the fishery of the harvested species rather than the fishery which caught it.

Cost Accruement

The economic impact of discarding a commercially valuable, non-target species is expressed via population reductions. In other words, accidental catches tend to result in mortality reducing population size and in turn the number of fish available for harvest. Thus, the economic impact in this situation is largely affecting the fishery of the non-target species via reduced harvests.

Solutions

A variety of solutions are available for discards of non-target, commercially valuable species including:

- vessel specific incentives or quota systems
- altering fishing behavior, i.e. changing when a fishery is open or where it is allowed to fish
- increasing gear selectivity

However, the major concern when deciding on a solution is selecting one which is economically feasible for the fishermen. Thus, the solution needs to not only reduce by-catch but also be financially beneficial for the fishermen otherwise fishermen are not likely to adhere to the policy.

4.4 Illegal Species Discards

- Explanation of what is included in this category
- Current economic impact
- Methods for reducing economic impact

4.4.1 Details

What's Included

Fish included in this category are individuals of the target species who are not legal to keep. The discarded individuals are either under size, of the wrong sex, or are obtained after quota has been met. Thus, the economic impact is accrued by the fishery itself.

Loss Accruement

Economic loss in this situation, like the last, is largely attributed to decreases in population size from decreases in the number of individuals reaching sexual maturity and from direct mortality. However, cost can also be accrued if the fishery alters its gear in order to avoid harvesting these individuals.

Solutions

One of the major issues with this type of discard is that it is not included in mortality calculations. Specifically, until recently the discard of non-legal or sub-optimal individuals was not included in fishing mortality calculations. As a result, fisheries could continue to fish until their tonnage of legal/optimally sized individuals was reached. Thus, fisheries would continue to fish even though they would have to potentially discard individuals [Alverson et al., 1994]. Therefore, a reasonable solution is to require fisheries to include these "sub-optimal" individuals in their tonnage limits.

4.5 Low Commercial Value Discards

- Why low or no commercial value species still have an economic impact
- Methods for reducing economic impact

4.5.1 Details

Loss Accruement

Although this group of discards does not have economic value in and of themselves, their discarding does result in economic losses. Economic losses can be accrued from the processing of the landed fish. For example, catching, sorting, and discarding the fish all require manpower and therefore incur expenses which are not regained. Similarly, for at-sea processors, lower factory throughput efficiencies and higher labor costs from having to remove the undesired species results in economic losses [Alverson et al., 1994].

Economic loss can also be attributed to compound impacts, i.e discard mortality affecting other potentially economically beneficial species. For example, if the discarded species is a prey species its decreased population size from discard mortality may result in reduced growth, survival, and reproduction for its predatory species which are often commercially valuable.

However, discard mortality can also result in economic gain if the discarded material results in increase prey availability for commercially valuable species. For example, discarded fish can increase forage for cephalopods and shrimp resulting in increased abundance.

Solutions

One way to reduce the economic, and environmental, problems associated with the discarding of economically undesirable species is to create/find a market. Although these species may not be exportable their may be a local market or alternative market, such as fishmeal, which can be exploited to provide economic benefit. For this to work, however, the economic gain has to be more beneficial than discarding.

4.6 Monitoring and Prevention Costs

- What's considered in monitoring and prevention costs
- Costs associated with prevention
- Costs associated with monitoring

4.6.1 Details

What's Included

Included in the cost of monitoring and prevention are management and enforcement costs as well as costs associated with altering fishing gear and behavior to reduce by-catch. Therefore the costs included within this category include such things as:

- observer costs
- disposing of old gear and purchasing new gear
- reduced fishing times/locals

These costs can be divided into two categories: costs associated with preventing discards and the costs associated with monitoring discards.

Prevention Costs

Prevention costs are the costs accrued by the fishing operation to reduce the likelihood of obtaining discards. A common preventative cost is altering gear to be more selective. Gear alteration can incur cost by 1) the cost of purchasing new equipment and/or 2)the lost financial gains when alternative gear is not obtainable [Alverson et al., 1994].

Another preventative cost is the potential reduction in catch from area and seasonal closures. For example, the Bering Sea multi-species groundfish fishery shifted their start date from January to November [Alverson et al., 1994].

Monitoring Costs

Much of the monitoring cost is attributed to observers.

Definition 5: Observer

Independent specialists who work on ships to ensure regulatory adherence.

Observers are individuals paid to ensure that all rules and regulations regarding discards, among are things, are being adhered to. Although the cost of observers is substantial, it is much more tangible than other methods [Alverson et al., 1994].

5 Mitigation Methods

5.1 Learning Objectives

5.1.1 Details

Learning Objectives 5

- Explain how governmental regulations are used to reduce discards
- Explain how discard bans work
- Explain how general fishing regulations are used to regulate discarding
- Explain the EU's methodology for reducing discards

5.2 Regulatory History of Discards

- International regulatory history
- Regulations of historical interesty

5.2.1 Details

International Regulatory History

The regulatory focus of the fishing industry has seen a dramatic shift over the last 50 years. Traditionally, fisheries management centered on avoiding population crashes in order to ensure optimal catches [Kelleher, 2005]. During this time, discard research and regulation focused largely on optimizing mesh size to reduce unwanted catch while maximizing profitable catch. In other words, discards were looked at as a nuisance rather than an ecosystem issue.

The focus on optimizing catch carried into the 1980s. Infact, it was not until the 1990s that discards, especially by-catch of marine mammals, became of interest to fisheries managers. However, this interest was largely isolated to the United States. It wasn't until the late 1990s early 2000s that the international fishing community began expressing concern about the ecosystem impacts of discarding. However, it was not until the mid 2010s that the European Commission began implementing strict discard regulations (see "The EU Approach" for more information).

In general, the shifting interest in discards was largely driven by the U.S. via a socio-conservation movement. Specifically, conservation NGOs began pushing congress to adapt legislation that would reduce the bycatch of marine mammals, sea turtles, and sea birds. In 1972 the marine mammal protection act was passed which protects cetaceans, pinnipeds, sirenians, sea otters, and polar bears within U.S. waters. This act was followed up by the Endangered Species Act in 1973 which made it illegal to "take" any federally listed species and the Magnuson-Stevens Fishery Conservation and Management Act (1976) which expanded U.S. jurisdiction from 12 to 200 nautical miles.

Once regulatory standards were established, the U.S. began requiring imported fish to meet the same requirements. This brought by-catch, and ultimately discards, to the forefront of international policy talks.

Since then a variety of discard regulations have been used. There are two primary ways of implementing a management regime focused on reducing discards, 1) a discard ban or 2) set generic fisheries regulations which are aimed at reducing discards.

Regulations of Interest

The following are international multilateral initiatives which have impacted discarding. The table is modified from [Kelleher, 2005].

Year	Initiative	Impact on Discards
1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Under CITES, marine mammals, turtles, and seabirds and some fish species are listed under Appendix I (species threatened with extinction that are or may be affected by trade), and Appendix II (Species threatened with extinction unless trade is subject to strict regulations). CITES listing may have a significant effect on fisheries that catch such species
1979	Convention on Migratory Species	The convention has provided a forum for the development of legally binding regional agreements on marine mammals and turtles
1982	Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea (UNCLOS) relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (United Nations Implementing Agreement [UNIA])	...minimize...discards,..., catch of non-target species both fish and non-fish species, and impacts on associated or dependent species, in particular endangered species...
1992	Convention on Biological Diversity	Discards affect biodiversity along at least three axes: species numbers, species densities and species dispersion. These impacts are not well understood, particularly with regard to benthos
1995	The Rome Consensus on World Fisheries adopted by the FAO Ministerial Conference on Fisheries	...reduce bycatches, fish discards
1995	Code of Conduct for Responsible Fisheries (CCRF)	...collect information on discards...,...take account of discards (in the precautionary approach)...,...develop technologies that minimize discards...;use of selective gear to minimize discards;...
1997	International Plan of Action (IPOA) on seabirds	Prevention of seabird capture and realease of seabirds
1998	International Plan of Action (IPOA) on sharks	Minimize waste and encourage full use of dead sharks

5.3 Discard Bans

- What are discard bans and what is their purpose
- Types of discard bans and how they work

5.3.1 Details

Background to Discard Bans

Discard bans or "no-discard" regimes are used by a variety of regulating bodies to eliminate, or reduce, discarding.

Definition 6: Discard Ban

Discard bans made it illegal, under most circumstances, to discard any landed biological material.

Essentially, discard bans change the way fishermen fish and managers manager. Fisherman switch from choosing between landing unwanted fish and discarding them or selling them on alternative markets to catching and not catching unwanted fish. This in turn alters where and how fishermen fish. It eliminates highgrading and stops fishermen from fishing in areas where they know they will land unwanted individuals.

Definition 7: Highgrading

Discarding of low value target species to make room for higher valued individuals [Vestergaard, 1996].

From a managers perspective, it changes the focus from landings to gross catches and from production to total fishing mortality [Kelleher, 2005]. Thus, within a no-discard regime fishing is more closely monitored via on-board observers and more responsibility, i.e. obligation to move or stop fishing, is placed on the fishermen.

Implementing Discard Bans

There are three systems through which discard bans can be implemented: total allowable catch (TAC), individual non-transferable quotas (INTQs), and individuals transferable quotas (ITQs).

Definition 8: Total Allowable Catch (TAC)

Total allowable catches are annual, or biannual for deep sea stocks, catch limits which are divided up for a particular stock via quotas. TACs are measured in tonnes.

Within a TAC system quotas, or tonnes of fish caught, are given by species for each fishery. When a discard ban is implemented within this system the quota contains a designated tonnage for "undesirable" individuals. In other words, the quota is divided into two categories 1) tonnes of target species and 2) tonnes of undesirable biological material.

From a regulatory perspective, once the quota is met the fishermen must stop fishing and the fishery is closed. Remember, the quota is set at the fishery level rather than the individual level.

Definition 9: Individual Non-transferable Quotas (INTQs)

Tonnage quotas are imposed on the individual, i.e. fishing vessel, and are not allowed to be traded amongst vessels.

In an INTQ system, quotas, set as tonnage of biological material, are assigned to each vessel, rather than the fishery as in TAC. The quotas in this case can also not be traded, or sold, amongst vessels. Thus, once a vessel has reached its quota it must stop fishing even if the fishery has not yet reached its quota.

Definition 10: Individual Transferable Quotas (ITQs)

A system in which tonnage quotas are applied at the individual vessel level and can be traded.

Individual transferable quotas function in the same way as INTQs in that the quota is set to the individual vessel. However, in an ITQ system, unlike an INTQ system, quotas can be traded or sold amongst or within vessels depending on the regulations. Trading amongst vessels is conducted within a fishery whereas trading within a vessel is done across species. For example, in Iceland fishermen are allowed to purchase additional tonnage from other vessels when their quota for a particular species has been met. In Norway, however, quotas are divvied up based on species ratio. Thus, once their quota for one species is met they are able to substitute it for a portion of their quota for another species as long as they maintain their assigned ratio.

5.4 Generic Fishery Regulations

- What are generic fishery regulations for discards and what is their purpose
- Types of regulations and how they work

5.4.1 Details

Background to Generic Fishery Regulations for Discards

A second approach to reducing discards is to set forth regulations aimed at altering fishing behaviors. In other words, regulations are set which ultimately decrease discarding without directly regulating discarding. Some areas which may be regulated include:

- fishing effort
- landing composition
- gear
- fishing closures

Implementing Generic Fishery Regulations for Discarding

As mentioned above, there are a wide variety of regulations which can be implemented in the hope of reducing discards. Many of these regulations are aimed at reducing a particular category (i.e. species, size, sex, etc.) of discards. These regulations, however, do not directly regulate discarding and therefore may not actually reduce total discards but may rather shift discarding from one species to another [Kelleher, 2005]. However, their overall goal is to reduce discarding. Thus, for each of the regulation types we will address what they are and how they intend to reduce discards.

Fishing Effort Regulations targeting fishing effort include reducing fleet capacity and/or days at sea as well as implementing closed seasons. They are based on the notion that a major contributor to discarding is overfishing. Thus, by reducing the amount of fishing you will in turn reduce the need for discarding.

Landing Composition Some countries, such as Senegal, regulate some of their fisheries via landing composition, i.e. Senegal's shrimp fishery is required to have at least 15% of the landings be shrimp. If these regulations are tied with a discard ban, i.e. fishermen are not allowed to discard unwanted species, then they can aid in reducing bycatch. In the case of Senegal's shrimp fishery, the fishery has a discard policy as well as the minimum landing percentage of 15% shrimp, if the composition regulation is not adhered to it can actually result in loosing your fishing license. Thus, landing composition requirements 0teamed with no-discard policies help to ensure that fishing practices target the desired species by negatively reinforcing discarding.

Gear Gear regulations focus on increasing selectivity via minimum mesh size and bycatch avoidance additives regulations, among others. Mesh size regulations aim at reducing discards by reducing bycatch. For example, by increasing the minimum mesh size allowed one can reduce the number of undersized individuals caught. However, this does not necessarily reduce bycatch of unwanted species. Thus, Kelleher [2005] recommends that all minimum mesh size requirements be accompanied by rigging restrictions as rigging methodology can significantly impact selectivity. Bycatch avoidance additives also reduce discards by reducing bycatch. With bycatch avoidance additives equipment is added to the fishing gear to reduce the likelihood of catching unwanted species. Examples of bycatch avoidance additives include TEDs, turtle exclosure devices; SSDs, seal saver devices; and BRDs, bycatch reduction devices.

Closures Fishing closures come in two main forms: seasons and areas. Seasonal closures aim at reducing the likelihood of catching juveniles. Specifically, fisheries managers may alter start dates or temporally close fishing when juvenile abundance is particularly high and then reopen the fishery once they are either less active or the proportion of adults:juveniles is greater. Area closures may occur for the same reason. Although, area closure may also occur when abundances of an undesired species are particularly high in a specific location.

5.5 The European Union's Ban

- What is the ban
- How the ban will work
- Implementing the ban
- Enforcing the ban
- Incentives

5.5.1 Details

Case Study 4: EU Discard Ban

As part of the 2013 Common Fisheries Policy (CFP) the European Union pledged to gradually eliminate discarding via a landing obligation. The landing obligation requires that all landed commercial species be counted towards quota. The landing obligation states that undersized individuals must be retained but may not be used for human consumption while illegal species, such as the basking shark, may not remain on board and therefore must be returned to the sea. All illegal species returned to the sea must be recorded [ec2].

Implementing the Ban

The proposed ban will be implemented incrementally between 2015 and 2019. The ban affects all commercial fisheries, including species regulated by TACs and minimum size, which fish in European waters or European vessels which fish in the high seas. Specific species regulations will be documented in temporary discard plans. Temporary discard plans will include information on: species covered, documenting requirements, minimum conservation reference sizes, as well as exemptions. Each plan is in effect for 3 years after which time it will be incorporated into a Multi Annual Plan [ec2].

The ban works such that each year between 2014 ad 2016 a new set of fisheries must comply. In 2014 pelagic species must adhere to a no discard policy followed by demersal species (cod, hake, and sole) in 2015 and all species in 2016 [ecC].

Enforcing the Ban

The general guidelines for the ban state that species which have high discard survival rates are to be identified and released live while species with low discard survival rates are to be landed and counted towards quota. However, the ban identifies specific handling guidelines for undersized fish, fish caught outside quota limits (both individual and national), and effort management systems.

Undersized fish Size limitations will be set based off of the species biology and will be used to improve gear specificity. Undersized individuals can only be sold for fish meal or pet food production and thus only cover the landing costs without providing financial gain. Enforcement of undersized individuals will be conducted at the regional level via regionalization.

Individual quota All fish, even those caught after the quota has been met, must be landed. Once landed it is the fishermen's responsibility to obtain, i.e. trade or buy, the necessary quotas from other ships.

National quotas If a national fishery exceeds a years quota it is the member state's responsibility to ascertain the necessary quota elsewhere. Excess quotas may be obtained from historically unmet quotas or by trading with other member states. If the quota cannot be met, the overage amount will be deducted from the following years quota.

Effort management systems Effort restrictions are to be allocated and not exhausted. In the event that effort supersedes the allocated amount commercial species above the minimum size may not be sold on market.

In order to enforce these rules all vessels must have:

- electronic logbooks

- vessel monitoring systems (VMS)
- underwater cameras (CCTV)
- observers

The required equipment, however, is fluid in that as new technologies emerge the requirements will change. This is particularly true for tracking, reporting, and analysis tools [ecC].

Incentives

Incorporated into the plan are incentives for increasing selectivity and landing. Specifically financial incentives are available for technical or organizational innovation, gear selectivity improvements, and by-catch reduction improvements. Financial incentives are also available for participating in on-board research.

Financing is also available for improving product labeling and marketability.

Member states also have the ability to apply quota incentives. For example, if a particular vessel has significantly lower by-catch the member state can increase its quota at the cost of another vessel [ecC].

6 Economic Effects of Discard Bans

6.1 Learning Objectives

6.1.1 Details

Learning Objectives 6

- Explain the economic losses(fishermen and non-fishermen)
- Explain the economic gains (fishermen and non-fishermen)

6.2 Economic Losses

- Costs associated with sorting, landing, and transportating the previously discarded material
- Costs associated with quotas
- Costs associated with gear selectivity

6.2.1 Details

The economic losses associated with the European discard ban were summarized by Catchpole et al. [2014] as:

- losses due to the extra sorting, landing, and transportation costs from the otherwise discarded material
- losses from counting discards towards quota
- losses from counting undersized, non-marketable fish towards quota (i.e. can no longer sell these fish on the more profitable human market)
- losses from increasing gear selectively

Sorting, Landing, and Transportation Costs

The landing, and in turn, handling of previously discarded species has been found to result in increased vessel costs [Catchpole et al., 2014]. Landing previously discarded species increases the time needed to sort through the catch which may slow fishing operations. Ultimately, the increased sorting time may reduce the amount of fishing time available to a particular vessel. The increased load and variety of species may also affect the sorting processes, i.e. sorting methods/efficiencies may need to be altered to accommodate the new dynamics. In order to compensate some vessels may hire extra staff, thus decreasing profit margins. Similarly, extra storage containers may be needed to handle the extra discard load both on vessel and in port.

From a transportation perspective, vessels are expected to see an increase in transportation costs as the previously discarded material now needs to be delivered to processing plants. Currently, there are two major economic issues associated with transportation 1) transportation efficiency and 2)processing plant location. The biologic material is shipped to processing plants in storage bins, which under normal circumstances would not be shipped unless they are completely full; however, in the case of discards are often shipped below capacity. Thus, the cost per unit is higher even though product value is lower. This issue, however, may be resolved once all fisheries are fully obliging to the landing obligation. The cost inefficiency issues are exacerbated, compared to marketable species, because the distance between ports and fishmeal processing plants are typically greater than the distance between ports and commercial markets.

Costs Associated with Quotas

The most substantial economic cost is the economic loss due to filling quotas with economically subpar material. The cost of filling quota with lower valued species can be especially detrimental in the case of choke species.

Definition 11: Choke Species

A species which, even at low quota, can cause a fishing vessel to have to cease fishing even if they have not met quota for other species.

The biggest choke species threat is from species that do not have a TAC. Thus, if a species without a TAC is caught it could theoretically halt all fishing.

Economic losses associated with quotas can also come in the form of missed future gains. More specifically, if undersized species are caught and cannot be discarded the vessel is missing out on the opportunity on catching them at size. This results in the vessel having to sell the fish as fishmeal rather than to the more profitable human market.

Gear Selectivity

Vessel operators can experience economic loss due to gear selectivity by 1) cost of new gear and 2) potential loss from increased selectivity. Specifically, in order to avoid the capture of quota limited species, i.e. undersized individuals, fishermen may purchase new gear incurring the gear's cost. Although this may limit the capture of undersized species it may also reduce the capture of non-limited and non-quota species which could be sold.

6.3 Economic Gains

- Benefit from bait market
- Benefit to alternative markets
- Benefit to fishermen (increased quotas)

6.3.1 Details

The economic gains associated with the European discard ban were summarized by Catchpole et al. [2014] as:

- decreased bait costs
- increased product/profit for non-human consumption outlets
- inflated quotas to compensate for counting discards
- increased work and in turn profit for transportation companies

Bait Costs

Under previous regulations it was illegal to use undersized individuals as bait in pots. However, under the landing obligation, some vessels maybe able to use some of their undersized fish as bait which is much more lucrative. This new market could provide economic gains due to the higher market value relative to fishmeal and the elimination of transportation costs. However, the market is currently rather limited.

Alternative Markets

Currently there are several markets for previously discarded fish including: fishmeal, pot bait, pet food, and animal feed. Each of these markets do provide some financial gain. However, the financial gain of these markets is dependent on handling and transportation costs and may vary seasonally. Even at low input costs the profit margins are expected to rather low.

Inflated Quotas

The largest potential economic gain is associated with the increased quotas. In order to compensate for counting the economically undesirable fish towards quota managers have increased quotas. Therefore, if a vessel is able to maintain relatively low landing rates of undesirable individuals they could potentially land more economically desirable individuals thus increasing their profit margins.

7 How to Measure Discards

7.1 Learning Objectives

7.1.1 Details

Learning Objectives 7

- Explain the type of data currently used to estimate discard rates
- Explain the issues with the current data
- Identify solutions to the data issues
- Explain how the data is incorporated into assessments

7.2 Types of Data Used

- How the data is collected
- Types of data collected
- Discard database
- Discard calculations

7.2.1 Details

Data Collection

Discard data is typically collected in one of four ways: 1) on-board observer records 2) on-board fisher records, 3) interviews with fishers, or 4) through a comparison of landings with a known profile of total catch. According to Kelleher [2005] observer data is consistently the most accurate and complete data source. However, it is also the most expensive to collect.

The collected data should include location, fishing gear used, and target species as well as tonnage of landings and discards. The data should then be input into the discard database.

Discard Database

The discard database is an international depository of all discard data. As of 2005, the database contained over 2000 records of which 1275 contain quantitative information on either landings or discards [Kelleher, 2005]. However, only 788 records contain both the landings and discards for a given fishery.

Discard Calculations

Discard data is typically converted to discard rate and is calculated on the fishery level.

Definition 12: Discard Rate

The proportion, percentage, of the total catch which is discarded [Kelleher, 2005].

Definition 13: Fishery

A fishery is comprised of all fleets which fish the same area, using the same gear, and are targeting the same species.

Thus, discard rate provides the amount of discards in relation to the total catch. However, typically a weighted discard rate is used. The weighted discard rate is calculated from complete entries, i.e. contain both the tonnage of target catch and tonnnage of discards, for each fishery using

$$Weighted\ discard\ rate(\%) = \frac{Summed\ discards(tonnes)x100}{Summed\ discards + summed\ landings(tonnes)}$$

Another common calculation is average discard rates.

Definition 14: Average Discard Rate

Average of the individual discard rates for a set of fisheries [Kelleher, 2005].

7.3 Data Collection Issues

- Issues with data inclusiveness
- Variability issues
- Correlation issues
- Sampling issues
- Solutions

7.3.1 Details

Some of the major issues associated with discard data are:

- non-existent or incomplete data
- discards have high variability
- discards are difficult to correlate with other data
- discard data are not randomly sampled

Data Inclusiveness

Probably the largest issue facing discard data is the lack of data. Although discards have been identified as an important part of the fishing industry many of the fisheries do not collect complete discard data. According to

Bellido et al. [2011], the lack of complete discard data can be attributed to the monitoring and research effort needed to collect this type of data. As a result, much of the collected data is for a limited time period and typically not available for the entire fishery (only some fleets collected the data). Infact, Kelleher [2005] found that only 788 of the more than 2000 entries in the discard database contained quantitative data on both landings and discards.

Variability Issues

Typically, the best and most complete data is compiled from on-board observers. One of the major issues, however, with on-board observer data is the high spatial and temporal variation shown within discard patterns [Bellido et al., 2011]. This variability can be attributed to changing fishing behavior due to catch composition, season, area, gear, fish marketability, port, quotas, trip duration, and regulation differences. For example, inter-annual variation may be linked to the abundance of smaller, less marketable fish, i.e. at times when smaller sized yearclasses are more abundant the discard rate will be higher [Kelleher, 2005].

If the variability is not properly taken into consideration it can significantly bias discard rates.

Correlation Issues

A suggested solution to address the variability issues is to collect more auxiliary data. Specifically, the collection of environmental, biological, regulatory, and market data have been suggested. However, the ability to correlate these data with discard rates is typically unsuccessful due to fishermen being driven by game theory rather than the previously mentioned parameters [Kelleher, 2005].

Sampling Issues

On-board observer data also faces two other issues: 1) altered fishermen behavior due to the presence of the observer and 2)non-random sampling.

Because on-board observers are typically used to ensure the adherence to discard regulations, it is suggested that fishermen will alter there discard behavior while observers are on-board. Thus, on-board observation data may provide artificially low estimates of discards.

Also, the observers are not randomly placed among ships or even fleets. As a result, the estimates provided may not be representative of the fleet or fishery as a whole.

Solutions

As previously mentioned, one solution is to determine a set of auxiliary parameters which can be used to backcalculate discard rate when incomplete data is present. This, would ideally be able to reduce variability while increasing sample size, i.e. reducing the number of incomplete data sets. The data needed to adquately adjust for variation and fill in missing information will most likely have to be fishery specific [Bellido et al., 2011]. In other words, the data needed to reduce variability and increase sample size will vary across fisheries.

Another solution is to combine on-board and shore-based sampling methods. This provides a way to compare estimates while also providing insights into the correlation between landings and discards.

In order to reduce obsever cost and observer related behavioral changes on-board cameras have been suggested. The cameras would be deployed on the deck and could be compared with port information to provide a more realistic idea of discard rates.

7.4 Issues Associated with Discard Rate

- Discard rate assumptions
- Issues with the landing/discard correlation
- Issues with data resolution

7.4.1 Details

Discard rate assumptions

As previously discussed, discard rate is the proportion, or percentage, of discarded biomass relative to the total amount of landed biomass and it is typically calculated as a weighted average across a fishery. Inorder to accomplish this several assumptions have to be made:

- the relationship between landings and discards are linear at the aggregate level
- discard rates are similar across all vessels within a fleet or fishery
- similar fisheries have similar discard rates

These assumptions, however, are associated with some nuances when calculating fishery level discard rates.

Landings/Discards Correlation

As previously mentioned, it is often assumed that the relationship between landings and discards for a particular ship is linear. Ultimately, this assumes that the total quantity of discards can be derived from landings data. This relationship, however, does not necessarily hold true at the individual trip/gear level or to landings of the target species [Kelleher, 2005]. This issue is exacerbated when scalling up as will be discussed on the next slide.

Data Resolution

Calculating discard rate is typically completed on the fleet level while discard data is collected on the vessel level. However, discard data is typically not available for all of the vessels within a particular fishery. As a result, known discard rates are applied to similar vessels whose data is lacking. As previously discussed, however, significant variation can exist across similar vessels making this assumption problematic.

7.5 Extrapolation Issues

- Ways to extrapolate or raise the data
- Extrapolation issues
- Solutions

7.5.1 Details

Extrapolation Methods

In order to obtain fishery or fleet level estimates of discards the data, which are often on the sample level, must be extrapolated or raised to the fishery or fleet level. Extrapolating can be accomplished using one of two methods, 1) extrapolate as a function of effort or 2)extrapolate as a function of total catch for the fishery. However, effort data is often times non-existent and catch data is often derived from landings data. Thus, both methods have associated problems.

Extrapolation Issues

Because effort data is typically nonexistent, extrapolating from landing data is more common. This often means that discard estimates are raised as a function of a single target species' landings data. However, target species landings and discards tend to be very loosely correlated, if at all. Kelleher [2005] attributes this weak correlation to target species landings being more closely related to the distribution and availability of the target species rather than the temporal or spatial distribution of discarded species.

Solutions

Kelleher [2005], suggests using complex models which contain information on catch composition, minimum landing sizes, year classes, seasons, and/or market prices as they are more likely to be related to discard rates than target species landings alone.

7.6 Incorporating Discards into Assessments

- Why discards should be incorporated
- Incorporation into stock assessments

7.6.1 Details

Why Include in EAFM

According to Bellido et al. [2011], EAFM should include discards because:

- discards directly affect the balance, diversity, and functioning of the ecosystem
- discards could negatively impact fisheries
- discards are perceived as wasteful and ineffective
- discard regulations often have reduced compliance

Incorporation into stock assessments

One way discards should be incorporated into EAFM is via stock assessments. Within a stock assessment, discards should be incorporated into mortality estimates as their exclusion could result in underestimating fishing mortality. The problem with including this information, however, is the lack of reliable data. Using unreliable data could potentially bias the results leading to inaccurate population estimates and ultimately could impact quotas.

On the other hand, including discards could provide insight into strong year classes. Punt et al. [2006], found that incorporating discards into south-eastern Australian fisheries assessments detected strong year-classes prior to appearing in landing data. This suggests that excluding discard data could result in biased assessments.

Further Reading

For more information on discards see Kelleher [2005] and Alverson et al. [1994]. For examples of discards being included within an EAFM framework see Punt et al. [2006].

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