fish610.1 Introduction to the Ecosystem Approach to Fisheries Management

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`http://mareframe-fp7.org`

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`http://minouw-project.eu/`

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1 Introduction to Fisheries Management

1.1 Learning Objectives

1.1.1 Details

Learning Objectives 1

- Define fisheries management, single species management, EBFM, and EAFM
- Define ecosystem
- Identify and explain the pros and cons of each fisheries management strategy

1.2 Fisheries Management Overview

- Definition of fisheries management
- Broad objectives of fisheries management
- Two major types of fisheries management (single species management and ecosystem management)

1.2.1 Details

Fisheries Management Definition and Objectives

Due to the complexity associated with managing fisheries a multitude of definitions for fisheries management have arisen. However, FAO has adopted the following definition:

Definition 1: Fisheries Management

"The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries

objectives." Cochrane [Ed.]

In other words, fisheries management is really an assessment of the fish stock followed by the development of regulations in order to meet management objectives.

In an assessment managers take fisheries data and input it into fisheries models to predict how the stock will respond to varying levels of fishing mortality. Thus, the objective of a fishery assessment is to derive scenarios, i.e. the relationship between different fishing pressures and stock attributes. These scenarios are then evaluated for their overall effectiveness in relation to the management goals. Based on the selected scenario regulations are set, such as fishing quotas.

Different fisheries have different management goals based on their ecosystem, social, political, and economic interests. However, the overall goal of fishery management is the same: to maintain long-term sustainable use of the fishery resources. As a result, it is the objective of fisheries managers to balance societal and economic needs with maintaining a healthy ecosystem and fish stock. Thus, the scenarios derived from the assessments are used to determine which fishing pressure/mortality accomplishes the balance between the desired ecosystem/stock health and external pressures (societal, economic, political).

Types of Fisheries Management

One of two management approaches are typically employed: single-species management or ecosystem management. The over-riding difference between these two approaches is inclusiveness. Specifically, single-species management considers the stock assessment of a particular species while ecosystem management considers the stock assessment of a particular species as well as the cascading impacts on other species and the ecosystem as a whole, as well as vice versa.

Definition 2: Single-species Management

Management of a wide-spread, typically commercially valuable species with the goal of optimizing the level of size specific fishing mortality for a particular stock [Mangel et al., 2000].

In a single-species approach, managers focus on optimizing an individual stock, usually of commercial interest. To do this managers assess the state of a stock, i.e. size and reproductive output, and compare this to management goals such as MSY, maximum sustained yield. Thus, their focus is on how an individual species will respond to fishing mortality rather than how fishing mortality of that species will impact other species and vice versa. Thus, the species of interest is largely looked at as a separate entity within the ecosystem.

Definition 3: Ecosystem Management

Fisheries management strategy in which land, water, living resources, and their interactions are considered to promote conservation and sustainable use of the fishery as a whole [Staples et al., 2014].

According to Grumbine [1994], when utilizing ecosystem management fisheries managers are attempting to:

1. maintain a viable population of all native species
2. maintain representation of all native ecosystems within their indigenous range
3. maintain ecological and evolutionary processes
4. maintain a species and ecosystem evolutionary potential
5. integrate human use and needs within management

Thus, ecosystem management focuses on the inter-connectedness of the ecosystem. In turn, fishing mortality for a single-species as well as the cascading impacts on other species and the environment as a whole are considered.

1.3 Single Species Management

- What is single species management
- Management goals of single species management
- Pros of single species management (why is it used)
- Cons of single species management (why shouldn't it be used)

1.3.1 Details

What is Single Species Management and What are its Goals

Single species management is a stock assessment with the goal of following a stock across time in order to accurately determine stock trends and in turn predict future trends from which regulations can be set. Thus, managers use single species assessments to answer:

1. How does the current level of fishing mortality impact the stock?
2. How does the average yield for a stock vary by stock size and fishing mortality?
3. How do the components of net production (growth, recruitment, and natural mortality) vary across time and how might stock size, fishing mortality, and ecosystem changes explain the observed variation?

Pros and Cons of Single Species Management

One of the major benefits to using single species management is its simplicity. This simplicity reduces the amount of data needed for stock assessments. Reducing the data demands reduces data collection costs, however, it also reduces the complexity of the models which can be evaluated. However, in recent years scientists/mathematicians have been able to increase the sophistication of single species models by incorporating uncertainty and in turn these models have better "truthing" capabilities, i.e. one can compare the model output to the historical data. Thus, single-species assessments are especially useful in evaluating potential management actions.

However, single-species models still lack several key components in their models which reduces their inference and predictive power relative to ecosystem models. Specifically, components such as species interactions, changes in ecosystem structure and function, discards and bycatch, and the habitat impacts of gear, among other things, are not included even though they impact stock yield and recruitment. In other words, key interactions affecting the stock are often missed in single species assessments and in turn the long-term productivity of the stock maybe compromised. An example of this is Odum's ratchet; Odum's ratchet explains that harvesting acts as a selective force against slow-growing species in favor of fast-growing species often at the expense of the slow-growing species Mangel et al. [2000]. In other words,

fishing pressure exerted on one species is often felt on other species. Thus, the biggest drawback to single-species management is the potential for missing key aspects affecting the stock and in turn overestimating the fishing mortality which can be withstood by the stock.

Further Reading

For more information on the goals of single species management see Walters and Martell [2004].

For more information on the pros and cons of single species management see Mace [2001].

1.4 Ecosystem Management

- Definition of ecosystem
- Types of ecosystem management
- Definition of EBFM
- Definition of EAFM
- Pros of ecosystem management
- Cons of ecosystem management

1.4.1 Details

Ecosystems and Ecosystem Management

In order to manage a fishery from an ecosystem perspective one must first understand what an ecosystem is.

Definition 4: Ecosystem

The biotic and abiotic components of an environment and their interactions within a relatively confined area.

Essentially an ecosystem includes all things which interact within a designated area both living (plants, animals, etc.) and nonliving (climate, nutri-

ents, etc.). Thus, utilizing ecosystem management requires the integration of many species (fish and non-fish) and habitat components into a model. As a result, ecosystem assessments are much more complex than single-species assessments. However, the ultimate goal is the same: manage the fishery in such as way as to maintain its long-term sustainable use.

Types of Ecosystem Management

Two major approaches to ecosystem management exist: ecosystem based fisheries management (EBFM) and ecosystem approach to fisheries management (EAFM).

Definition 5: Ecosystem Based Fisheries Management (EBFM)

"EBFM considers both the impacts of the environment on fisheries health and productivity and the impacts that fishing has on all aspects of the marine ecosystem." Staples et al. [2014].

Definition 6: Ecosystem Approach to Fisheries Management (EAFM)

"EAFM is a more holistic approach to management that represents a move away from fisheries management systems that focus only on the sustainable harvest of target species, towards systems and decision-making processes that balance ecological well-being with human and societal well-being, within improved governance frameworks i.e. it is a practical way to achieve sustainable development. It addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems" Staples et al. [2014].

These two approaches share lots of similarities and as a result they are often used interchangeably. However, there are slight differences between them which we will be addressed on the following slide.

Pros and Cons of Ecosystem Management

One of the main objectives of ecosystem management is to balance societal needs with ecosystem needs. The ecosystem approach, unlike single

species management, takes these issues directly into account during the planning, execution, and evaluation phases. Ecosystem management accounts for greater environmental considerations by incorporating stocks of target and non-target species, climatic conditions, and habitat components, to name a few, directly into their stock assessment models. They then present these models directly to stakeholders (individuals such as fisherman and eco-tour guides) to balance the trade-offs between human and ecological well-being. As a result, the process of setting quotas is more transparent which increases political and stakeholder support. Similarly adaptive management is integrated into ecosystem management plans which lends itself to more effective coastal planning.

The inclusiveness of ecosystem management lends itself to more precise predictive power as well as increased societal investment. However, the inclusivity of the stock assessment models requires a much more extensive data set increasing the time and financial commitment. Similarly, the completeness of the data is often lacking resulting in increased uncertainty.

Further Reading

For more information on ecosystem management and its pros and cons see Staples et al. [2014].

1.5 EAFM vs EBFM

- Similarities between EAFM and EBFM
- Differences between EAFM and EBFM

1.5.1 Details

As mentioned in the previous slide, the terms ecological approach to fisheries management (EAFM) and ecological based fisheries management (EBFM) are often used interchangeably. Although they do have many similarities: both include multiple species, habitat components, and climatic components into their assessments, their emphases are slightly different.

The major difference between EAFM and EBFM is the emphasis or importance placed on socioeconomic concerns. EAFM, unlike EBFM, weighs ecosystem considerations equally with socioeconomic considerations. Whereas EBFM, considers socioeconomic considerations as part of the ecosystem and

thus does not place as much "weight" on it. As a result, the role of stakeholders is different between the two approaches. In an EAFM framework, stakeholders play a vital role in the planning, execution, and evaluation of the selected management plan whereas in EBFM stakeholders are not integrated into the processes outside of the planning stage. This difference is a result of how humans are perceived within the ecosystem. In an EAFM framework, humans are perceived as a separate entity from the ecosystem whereas in EBFM humans are considered part of the ecosystem.

2 Introduction to EAFM

2.1 Learning Objectives

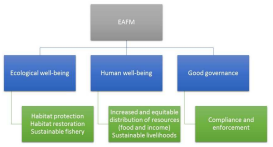
2.1.1 Details

Learning Objectives 2

- Identify and define the 3 components of EAFM
- Identify, define, and explain how the ecological aspects are assessed
- Identify and define the 8 aspects of human well-being
- Explain what good governance is and the role of stewardship within an EAFM framework

2.2 What is EAFM

- What is EAFM
- 3 components of EAFM



The three components of EAFM (figure adapted from Staples et al. [2014]).

2.2.1 Details

EAFM is the application of ecosystem management to a fishery by integrating the socio-ecological system. Thus, within an EAFM framework managers work to balance human well-being (food, income, livelihood, etc.) and ecological well-being (biodiversity conservation, ecosystem structure and function, etc.). To obtain this EAFM maintains three primary components: ecological well-being, human well-being, and good governance. These primary components are the building blocks of all EAFM management plans. More specifically, these three components are looked at as the foundation of EAFM and therefore must be balanced in order to achieve true ecosystem management. As a result, EAFM uses good governance, or rules and regulations, as a way of balancing ecological well-being and human well-being. More detail on the 3 primary components will be addressed in the following slides.

Further Reading

Much of the information in this lecture is adapted from Staples et al. [2014]. However, Staples et al. [2014] goes into much more depth on the 3 components of EAFM then what will be covered in this course.

2.3 Ecological Features of EAFM

- Definition of ecological well-being
- 5 major ecological features of EAFM
- How to assess the 5 major aspects
- Ecosystem health indicators definition, use, and examples

2.3.1 Details

What is Ecological Well-Being

Definition 7: Ecological Well-Being

"The state of the ecosystem in terms of health, biodiversity, supportive structures and habitats and food webs." Staples et al. [2014]

Ecological well-being can be broken down into five major aspects. These aspects, listed below, are the benchmarks, or ecosystem components, which must be maintained for an ecosystem to be considered healthy, i.e. have high ecological well-being.

- Maximize the goods and services provided by an ecosystem by maintaining its ecosystem health
- Increase ecosystem resilience by maintaining biodiversity
- Maintain supportive ecosystem structure and habitats such as watershed corridors
- Maintain the health of oceans, coastal areas, and watersheds
- Increase primary production diversity to maintain healthy food webs

How is Ecological Well-Being Assessed: Ecosystem Indicators

To determine the ecological well-being of an ecosystem, indicators are used.

Definition 8: Ecological Indicators

A variable, point, or index used to measure current conditions of selected ecosystem components.

Indicators are measurables, i.e. indicators can be measured and compared to pre-determined benchmarks to evaluate the state or health of the ecosystem. Specifically, indicators are used to determine the current state of an ecosystem and in turn determine management objectives, i.e. if the level of a particular indicator is below its benchmark then specific management actions can be set to try and meet the benchmark. Similarly, indicators can be used to determine if management actions are working within an adaptive management framework, i.e. are the indicators getting closer to the management goals/benchmarks.

Within the EAFM framework, 3 major indicators are used:

- Presence/absences of key ecological processes

  - Example: absence of blue-green algae blooms

- Area of the zone of human impact
  - Example: decrease in the area of sewage nitrogen
- Extent and connectedness of critical habitat
  - Example: seagrass meadows increase in connectedness, i.e. are more homogeneous

As stated above, indicators are used in the planning, i.e. determining management objectives, as well as the evaluation, i.e. adaptive management, stages of an EAFM management plan.

2.4 Human Well-Being Features of EAFM

- Definition of human well-being
- 8 aspects of human well-being

2.4.1 Details

Definition 9: Human Well-Being

"The state of society in terms of health, education, food security, political voice and influence, living environment, and economic security and safety." Staples et al. [2014]

Within the definition of human well-being eight major aspects became apparent:

1. Health
2. Education
3. Basic life necessities (food and financial security)
4. Personal activities (recreation and work)
5. Political voice and influence

6. Living environment
7. Social connectedness
8. Economic security and safety

These eight aspects outline the basic requirements needed by an individual to have a healthy and productive life. As a result, it is important within an EAFM framework to include all eight aspects and not just income.

These aspects are incorporated by looking at the interaction between them and the ecosystem. From a management perspective, EAFM is concerned with how the eight aspects of human well-being impact the ecosystem and vice versa. These interactions are then maintained through the use of good governance. Specifically, using the principles of good governance (see the good governance slide) rules and regulations are set in order to ensure that a healthy balance is maintained within these interactions.

2.5 Good governance features of EAFM

- Definition of good governance
- Role of stewardship within an EAFM framework

2.5.1 Details

Definition 10: Good Governance

Governance which includes consensus, participation, accountability, transparency, and follows the rules of the law, and is responsive, equitable, inclusive, efficient, and effective [Staples et al., 2014].

In action, good governance refers to setting and implementing rules and regulations utilizing the principles of inclusivity to ensure that all agreed upon rules and regulations are just and equitable. In order to do this good stewardship must be implemented.

Definition 11: Stewardship

Using responsible planning and management of the resources for which one is responsible for.

Combining these definitions, one can see that within an EAFM framework, good governance refers to including all individuals who are involved with a particular resource into the decision making process. This increases transparency and investment and in turn ensures that all parties view the decided upon regulations as just. Thus, the individuals who utilize the resource are more likely to adhere to the regulations and in turn enhance EAFM's ability to balance human and ecological well-being.

3 Principles of EAFM

3.1 Learning Objectives

3.1.1 Details

Learning Objectives 3

- Identify, define, and explain the key principles of EAFM
- Define and provide examples of stakeholders
- Explain the role of stakeholders
- Explain how adaptive management and the precautionary approach are integrated into EAFM

3.2 Key Principles

- The formation and role of the key principles
- What are the key principles of EAFM

3.2.1 Details

Prior to the development of EAFM, FAO's Code of Conduct for Responsible Fisheries (CCRF) was largely viewed as the guiding document for sustainable fisheries. Specifically, within the CCRF ten principles were outlined to ensure

that conservation, management, and development of the worlds fisheries were done in a sustainable manner. These ten principles were:

Fishery and Ecosystem Based Principles	**Social-Economic Based Principles**
Fishery resources should be maintained for current and future generations	Conservation and management actions should be based on the best known scientific data
Prevent overfishing and excess fishing capacity by ensuring that fishing effort aligns stock production	Ensure all individuals involved with fishing have access to just livelihoods
Utilize the precautionary principle whenever possible	Promote fisheries as an avenue to reduce food security issues
Protect all species in the ecosystem	
Protect and restore critical habitat	
Ensure coastal management zone planning incorporates fishing interests	
Ensure environmental assessments and monitoring are being used to ecological, economic, and social integrity	

Upon the formation of EAFM, the ten CCRP principles aided in the formation of EAFM's overriding principles. From these ten principles, EAFM developed seven guiding principles to sustainable fisheries.

The seven principles of EAFM are:

Key Principle	Explanation
Good governance	Setting and implementing rules and regulations using an inclusive process to ensure all agreed upon rules and regulations are just and equitable
Appropriate scale	The extent and inclusivity of the area being managed by a particular EAFM management plan
Increased participation	Incorporation of stakeholders
Multiple objectives	Balancing socio-ecological issues
Cooperation and coordination	Government, society, and agency working together
Precautionary approach	Full inclusion of the precautionary approach principles whenever possible

The following slides will explore the seven principles of EAFM in more detail.

3.3 Good Governance

- What is good governance
- Characteristics of good governance

3.3.1 Details

What is Good Governance

Definition 12: Governance

The making of new rules/regulations.

Thus, when one is describing good governance they are referring to the way in which new rules/regulations are formed. Specifically, they are interested in whose involved in the discussions, whose impacted by the decisions, and how fairly the impacts of the decision are distributed. Thus, when good governance is instituted all individuals impacted by the proposed rules are included in the discussions and are justly treated by the regulations.

Characteristics of Good Governance

In order to ensure that good governance is occurring EAFM outlines 8 key characteristics of good governance. The eight characteristics are:

1. Consensus orientated

Policies should be agreed upon by broad consensus to increase policy acceptance.

2. Participatory

Stakeholders of all types should be consulted to foster ownership and increase support for policies.

3. Rule of law

Laws should be transparent in their enforcement.

4. Effective and efficient

Governing bodies should produce high quality educational materials and public services that are financially responsible and adhere to management goals.

5. Accountable

All rules and regulations should have clearly-defined and agreed upon objectives which are socially sustainable for present and future generations.

6. Transparent

Governing bodies should open decision-making processes to the appropriate parts of government, society, and outside institutions and governments when appropriate.

7. Responsive

Governing bodies should be flexible, adapting to changes in society and adjusting rules and regulations in accordance when necessary.

8. Equitable and inclusive

During the decision making process all those impacted by the proposed rules/regulations should be involved including the most vulnerable sectors of society and minorities.

By utilizing good governance the balance between human and ecological well-being should be achievable. However, for balance to be obtained and maintained accountability by policy makers must be a priority. Maintaining accountability can be achieved through transparency and easy access by all involved individuals to accountable information.

3.4 Appropriate Scale

- Definition within EAF
- Types of scale
- Selecting the correct scale

3.4.1 Details

When developing an EAFM management plan an important initial step is to determine the area to be covered by the management plan, or the fisheries management unit.

Definition 13: Fisheries Management Unit (FMU)

The area (ecosystem and/or fisheries) included within an EAFM management plan.

When selecting an FMU it is important to consider the aim and goals of the fishery being managed as the boundaries should reflect the management goals. To incorporate management goals into the FMU managers often look at scale.

Within an EAFM framework 4 major FMU scales exist:

1. Ecological scale
2. Socio-economic scale

3. Political/governance scale

4. Temporal scale

Ecological Scale

When applying ecological scaling, managers are concerned with ecosystem features and the boundaries between different ecosystems. In order to accomplish this, managers look at four different ecological components: the distribution and behavior of target species, large scale ecological features such as the location and path of boundary currents, small scale ecological features such as habitat distribution and estuarine plumes and deltas, and food web processes.

Case Study 1: Northwest Atlantic Cod

Northwest Atlantic cod, *Gadus morhua*, covered the entire northeastern continental shelf of North American until their collapse in the early 1990s. After the collapse, cod eggs and first year juveniles were only found along the coast line where suitable habitat exist. Thus, the cod were confined by their habitat requirements. As a result, managers were able to define the area of their FMUs based on the location of suitable habitat.

This case study is adopted from Schneider [2001]

Socio-Economic Scaling

One of the key components of a successful EAFM management plan is the identification and inclusion of stakeholders. In order to identify which stakeholders are included socio-economic scaling is often used. Socio-economic scaling is concerned with the communities present along the coastline, the ports which fish the area, and the fisherman (large and small scale) which fish the area.

Case Study 2: Northern South China Sea

The FMU for the Northern South China Sea occurs along the continental

shelf at depths less than 200m from 106°53'-119°48'E to 17°10'-25°52'N. This area comprises the Exclusive Economic Zone of the People's Republic of China, Taiwan, and part of the Gulf of Tonkin in Vietnam. The selection of this area as the FMU was largely based on fishing economics. Specifically, this area encompasses the 3 provinces which have experienced the greatest increase in fishing effort. As a result, community stakeholders as well as the main fishing stakeholders would be included within EAFM discussions.

This case study is adopted from Cheung and Sumaila [2008]

Governance Scaling

Governance scaling addresses which governing bodies are included within the FMU. When addressing governance scaling two major issues arise: the size/level of government needed and which governments should be included. Often times, many small governing bodies such as municipalities are incorporated to ensure adequate voice for large and small fisheries is maintained.

Case Study 3: Philippines

Within the Philippines four ecologically important areas (Danajon Bank, Calamianes Islands, Lanuza Bay, and Tawi Bay) were all experiencing significant over exploitation. Much of which was a result of lack of controls and regulations. Thus, governance scaling was used to determine which municipalities were responsible for enforcing regulations within each ecological area. These municipalities were then grouped into alliances governed by a council in order to increase communication and enforcement efficiency.

This case study is adopted from Staples et al. [2014].

Temporal Scaling

Within temporal scaling EAFM is concerned with the balance and adaptivity of short-term and long-term management goals. Specifically, when considering a management objective it is important to consider how often monitoring needs to occur to adequately evaluate the effectiveness of specific

management actions. It is also important within temporal scaling that adaptive management principles are applied. For example, management goals addressing global climate change are likely long-term; however, they should be monitored frequently enough to allow for necessary changes in the short term.

Selecting the Appropriate Scale

Selecting the perfect FMU is often very difficult if not impossible. However, when selecting an FMU one must ensure that the scale of the FMU coincides with the fishery of interest and that all types of fishing gear, i.e. large and small scale, are included, while maintaining "meaningful ecological boundaries".

Setting an FMU boundary, however, does not stop externalities. Thus, governance scaling should be used to address these external influences and reduce their negative impact on the fishery/ecosystem. However, jurisdictional boundaries are often difficult to manage across. Thus, it is recommended that a FMU follows jurisdictional boundaries whenever possible.

3.5 Increased Participation

- Definition and examples of stakeholders
- Explanation as to why stakeholders are included

3.5.1 Details

What Are Stakeholders

One of the key elements to an effective EAFM management plan is increased participation. In order to achieve this EAFM relies upon stakeholders. FAO defines stakeholders within EAFM as follows:

Definition 14: Stakeholder

"Any individual, group, or organization who has an interest in (or a "stake"), or who can affect or is affected, positively or negatively, by a process or management decision." Staples et al. [2014]

Thus, stakeholders are individuals with an invested interested in the management of a particular fishery. Examples of stakeholders include: fisherman, fish processing plants, eco-tourism groups, local communities, etc..

Why Stakeholders are Included

Stakeholders are included for several reasons: increase understanding of controversial issues, increase transparency in policy/regulation formation, fill in knowledge gaps (reducing model uncertainty), and increase relations among stakeholders and managers. Accomplishing these things will hopefully, ultimately, result in increased understanding among groups and intern investment in both the sustainability of the fishery and the regulations set to maintain its sustainability.

Case Study 4: Spain/FAO Regional Fisheries Livelihoods Program

A sardine fisheries management plan was created by the Spain/FAO Regional Fisheries Livelihoods Program (RFLP) for the Sulu-Celebes Sea in the Philippines, Malaysia, and Indonesia. The creation of this plan required the participation of stakeholders at the local, national, and international level (several of which had pre-exisisting conflicts).

The stakeholders were used to identify local needs and issues related to the fishery (such as conflict between small-scale fishers and commercial trawlers). Once the needs and issues were identified stakeholder groups met with managers to provide input on regulations. One set regulation was the seasonal closing of the fishery; within the East Sulu Sea in the Phillipines the sardine fishery is closed from November/December to February/March each year for 3 years. In order to maintain stakeholder investment in the new regulation, the exact dates of the closure are reviewed by the stakeholder committee each year before becoming legally binding.

This case study is adapted from Staples et al. [2014].

3.6 Multiple Objectives

- Why multiple objectives arise
- How multiple objectives are addressed
- Examples of multiple objectives

3.6.1 Details

Each fishery encompasses its own set of ecological, economic, and social objectives. These differing objectives, if attempting to meet them all, could result in conflicting management goals and actions. As a result, it is the responsibility of the stakeholder groups and managers to address these conflicting objectives and balance them. In order to accomplish this the different stakeholders need to commit to compromising. For the compromises to work long-term political support (financial and regulatory) is needed along with short-term economic and social support. These compromises, however, need to maintain the overall goal of EAFM: long-term sustainability of the fishery for current and future generations.

Case Study 5: The English Channel Fishery - UK Component

The UK component of the fishery in the English Channel is characterized by 3 competing management objectives: conservation, economic, and allocation and awareness issues between stakeholders. Within each management objective several key components exist:

- Conservation
  - Fishery environment: Noncommercial species and sustainable yields of commercial species
  - Quality of the marine environment
- Economic
  - Safety and labor conditions
  - Employment: Employment in fisheries and employment in regional communities

  - Profits
- Allocation and awareness issues between stakeholders
  - Onshore/offshore
  - Towed/fixed gears
  - Geographical groups

In order to balance the multiple objectives a key objective was identified: employment. This key objective then carried more weight throughout the planning process to ensure that the employment opportunities were on par with need for employment in the area. Specifically, many of the other objectives were viewed through the lens of "employment". For example, in order to maintain long-term employment within the area sustainable yields of commercial species must be maintained, which is a key component of the conservation management objective.

This case study was adapted from Mardle et al. [2002].

3.7 Institutional Cooperation and Coordination

- Examples of institutions included
- Cooperative or coordinating activities: what they are and why they are included
- How cooperative or coordinating activities achieved

3.7.1 Details

What are Institutions

Within the EAFM framework an institution is...

Definition 15: Institution

Any agency or group involved with the planning, execution, monitoring, or enforcement of the EAFM management plan.

Examples of institutions which would be involved in an EAFM management process include: local, regional, and national governments; non-governmental organizations; fishery management agencies; fisherman; etc..

What and How of Cooperative or Coordinating Activities

In order to balance multiple objective cooperation and coordination needs to occur among institutions. Within an EAFM framework, cooperative and coordinating activities can include such things as: open communication; data and information sharing; harmonized or complementary work plans, budgets, and goals; and developing interagency arrangements. In order for cooperative or coordinating activities to occur institutions/sectors which do not usually interact must work together. Thus, from a planning perspective, much of the initial workload is determining which institutions are involved and which institutions should be working together on particular issues. One tool often used to aid in this process is formalized memorandums of understanding, or binding agreements which help establish cross-sector collaboration.

Case Study 6: Gulf of Mannar Biosphere Reserve in India

The following case study demonstrates what can happen when cooperative or coordinating activities are not used.

The Gulf of Mannar includes the southern tip of mainland India, the southeast coast of Tamily Nadu State, and the northwest coast of Sri Lanka. In 1988, under governmental order, a reserve was created which encompassed 21 coral islands and a 10km land and water buffer zone. Within the reserve, several hunderd villages and towns also exsist which have a large number of artisan and commercial fisherman.

Under governmental order, the management of the reserve was the responsibility of the Forest Department. Which was charged with protecting marine habitats and the species which reside within them as well as encouraging alternative livelihood options. However, at the same time, the Fisheries Department was given the task of maximizing fisheries development through the use of subsidies and increasing the welfare of fisherman. Thus, the Forestry Department and Fisheries Department had conflicting management objectives and in turn issues arose. Some

of the issues were dealt with by creating village specific regulations such as banning the collection of protected species. However, village specific regulations are not recognized by the federal government and therefore have reduced enforcement capabilities.

This case study was adapted from Staples et al. [2014].

3.8 Adaptive Management

- Definition of adaptive management
- Why adaptive management would want to be used within an EAFM framework
- How adaptive management would be applied within EAFM

3.8.1 Details

Definition 16: Adaptive Management

The continual improvement of management policies and actions through a systematic process. The steps of the process are 1. implement a management action, 2. monitor the actions effectiveness, 3. analyze the data, 4. adapt the management action based on the data analysis, 5. communicate necessary changes and their rationale. Staples et al. [2014]

In other words, adaptive management is a continuous learning process in which all decisions are based off of the best known scientific data. By implementing adaptive management, managers have the ability to assess their current management and make changes over time to meet the current needs of the ecosystem, society, and economy.

One of the advantages to using adaptive management is its flexibility. Specifically, by using this approach managers have the ability to initiate management actions without complete data. Then, once all the data is available they can easily manipulate the management action to align with the new data. This process allows for reduced uncertainty across time.

3.9 Precautionary Approach

- Definition of precautionary approach
- Why the precautionary approach would want to be used within an EAFM framework
- Application within EAFM in regards to UN documentation

3.9.1 Details

Definition 17: Precautionary Approach

"States shall be more cautious when information is uncertain, unreliable, or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures." Lévy and Schram [1996]

The precautionary approach (PA), according to Staples et al. [2014] is the backbone of EAFM. The application of PA within EAFM solidifies the need for management even when data is insufficient ensuring that even new or not well understood stocks are sustainably managed.

The precautionary approach often works in tandem with adaptive management. The PA is applied when data is lacking for a particular stock that stock is then monitored and as new data arises the management of the stock is re-evaluated and the necessary changes in management strategy are made.

The inclusion of the PA within EAFM adheres to the EAFM's goal of sustainability as well as aligns EAFM with the Rio Declaration on Environment and Development [Declaration, 1992],the FAO's Code of Conduct for Responsible Fisheries [FISHERIES, 1995], and the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks [Lévy and Schram, 1996]

4 Benefits of EAFM

4.1 Learning Objectives

4.1.1 Details

Learning Objectives 4

- Explain how an EAFM framework benefits fisheries, society, and the economy

4.2 Fishery Benefits

- Benefits to fisheries
- Case study example

4.2.1 Details

Some of the benefits of applying EAFM from a fishery perspective include:

Benefit to fishery	How it's incorporated into EAFM
Reinforces the link between fisheries and ecosystems	Ecosystem components are included in stock assessments
Enables large-scale, long-term planning (i.e. implications of global climate change, globalization, etc.)	Applies adaptive management and precautionary approach principles
Helps protect the fishing sector from the impacts of other sectors	Includes a broad array of stakeholders and works with other sectors to create a balance

Case Study 7: Discards and the Mixed Whitefish/Nephrops Fishery in the North Sea

Within the North Sea the *Nephrops*, Whitefish, and cod fisheries all occur in overlapping areas but by different fishing fleets. The overlapping fishing efforts result in extensive Whitefish discarding by the *Nephrops* fishery. Despite large amounts of discards the *Nephrops* fishery was largely viewed as healthy. However, Whitefish fisherman began complaining to the managing bodies about the negative impact the *Nephrops* fishery on the health of the Whitefish population. Utilizing an EAFM framework, i.e. incorporating multiple species into their as-

sessment models and bringing the fisheries (stakeholders) together, the managers were able to set in motion changes to reduce the impact on the fishery. Specifically, gear specificity alterations were made as managers attributed much of the high discard rates to changes in gear selectivity by the *Nephrops* fishery to reduce their impact on the cod fishery (the species of greatest management concern at the time).

This case study was adapted from Connolly [2008].

4.3 Societal Benefits

- Benefits to society
- Case study example

4.3.1 Details

Some of the ways society benefits from the application of EAFM include:

Benefit to society	**How EAFM obtains the benefit**
More effective coastal resource planning	Coastal communities are included in EAFM discussions
Increased equality of resource use	Increased stakeholder participation
Greater recognition of cultural and traditional values in decision-making	Increased support for better governance
Identifies and addresses conflicts among divergent societal objectives	Human-wellbeing is a buildling block of EAFM

Case Study 8: The Coral Triangle Initiative

The Coral Triangle Initiative (CTI) is a six country initiative in Asia-Pacific's Coral Triangle region. This region encompasses 76% of the world's coral and 37% of the world's reef fish along with a population of over 360 million people of which 1 in 3 rely on the coastal resources for food security. The region, however, is experiencing extensive population growth and increasing demand for its marine resources. As a result, widespread coastal deforestation along with unsustainable shore-

line development is occurring resulting in increased pollution. Similarly, the fisheries are experiencing over-exploitation along with destructive fishing practices.

To curb the problems associated with the increase resource demand, the CTI was formed. Utilizing an EAFM framework the CTI developed 5 regional goals:

1. Designate priority seascapes and manage them effectively
2. Fully apply EAFM
3. Establish and effectively manage Marine Protected Areas (MPA)
4. Ensure climate change adaptation measures are achieved
5. Improve the status of threatened/endangered species

Although, ecosystem management was a key component, the CTI was extremely concerned with ensuring food security for the people of the region. Specifically, as the demand for the area's fishery resources increase the economic benefit of exportation increases resulting in increased cost locally, which may increase food insecurity for those not benefiting from the increased exportation profit. To address this the CTI Regional Plan of Action calls for investing in large-scale fisheries in areas which are particularly dependent on the coastal fishery for income while increasing the area in an MPA. The belief is that by increasing the amount of area in an MPA the increased fish population with the MPA will spillover to the fished areas thus increasing economics and in turn reducing food security.

This case study was adapted from Foale et al. [2013]

4.4 Economic Benefits

- Benefits to the economy
- Case study example

4.4.1 Details

The economic benefits of using an EAFM framework include:

Economic benefit	How EAFM obtains the benefit
Increased access to financial resources	Increased cooperation and coordination releasing more funding sources
Decreased data collection costs	Increased data sharing reduces data replication
Decreased fishing fines	Increased regulation investment by fisherman increases compliance
Decreased enforcement costs	Increased cooperation and coordination reduces enforcement overlap

Case Study 9: Western and Central Pacific Region

The primary fishery within the Western and Central Pacific Region is tuna. Within the tuna fishery many of the fisherman purchase their boats and licenses on borrowed funds. Purchasing boats and licenses in this manner has several economic consequences including decreased profit and increased likelihood of bankruptcy both of which can negatively impact the fisherman as well as the surrounding community. As a result, when an EAFM management plan was being developed for this region reducing the amount of fisherman in debt was a priority.

To improve the fisheries economics, a set of management actions was set in place. The management actions included: providing educational materials and training opportunities on business planning as well as creating multi-agency working groups to minimize the community impact of bankruptcy. To evaluate the effectiveness of these actions the number of boat/license owners going bankrupt as well as the amount of turnover in boats/licenses are monitored.

This case study was adapted from Fletcher [2006].

5 Further Reading

5.1 Further Reading

5.1.1 Details

A large portion of the material found within this tutorial was adapted from Staples et al. [2014]. However, Staples et al. [2014] went into more depth on many of the subjects covered, thus, for further information or detail please refer to their EAFM manual.

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