Module 4:
Renewable Resource Economics 1

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Overview

This module examines different renewable resources throughout the circumpolar North and how their harvest and use affects northern economies. Initially the importance of northern resources to the global economy and the meaning of sustainability will be assessed.

Learning Objectives

Upon completion of this module, you should be able to:

1. Characterize the global role of renewable resources in the circumpolar North.
2. Analyze the potential for circumpolar regions to sustainably compete in the global economy.
3. Summarize the essential nature of the fishing industry in the circumpolar North.
4. Classify boreal forests resources.

Required Readings (including web sites)

Wilen, J.E., (2000). *Renewable Resource Economics and Policy: What Differences Have We Made?* **Journal of Environmental Economics and Management.** 39(3):306-327.
http://eva.universidad.edu.uy/pluginfile.php/420564/mod_resource/content/0/Wilen_2000_Journal-of-Environmental-Economics-and-Management.pdf

World's Boreal Forests: Management and Sustainability. Accessed via:
http://www.borealforest.org/world/world_management.htm

Key Terms and Concepts

- Boreal Forest
- Common Property
- Effective Supply
- Market Failure
- Open Access
- Opportunity Cost
- Production Function
- Property Rights
- Subtractable
- Supply
- Sustainability
- Taiga

Learning Material

4.1 Introduction to the Global Role of Renewable Resources in the Circumpolar North

Renewable resources are growing in global importance as the world's population and demand for non-renewable resources, such as oil and gas, increase. The circumpolar North is rich in both types of resources. The **effective supply** is rising through rapid advancements of technologies that permit resources to be accessed and harnessed, and due to global economic conditions that make it efficient to do so.

For many years the North has been treated as the final frontier with respect to natural resources. Economic development has often proceeded in the circumpolar North as if resources were unlimited because the region has relatively low human populations, vast expanses of uninhabited land and a range of natural resources. With few human settlements, the environment has often been used as a "dumping ground" causing lakes and rivers to become polluted as a result of resource extraction.

Today there is more pressure on Arctic resources to serve the needs of the growing world population currently estimated at 6.7 billion according the World Bank and projected to increase to between 8 and 10.5 billion by 2050 (see World population clock at http://www.worldometers.info/population/). Not only has demand increased for northern forest and fishery resources, but rapid developments in technology make it possible to travel farther, drill deeper and increase harvest rates in formerly inaccessible areas. Increasing global demand for energy is a large part of the demand for renewable resources used to produce alternative energy. The price of oil (with a record high of $147 in 2008) makes investment in **substitutes** more attractive and innovation affordable.

All aspects of globalization have pushed exploration, development and extraction or harvest to new levels in the circumpolar North. While this often brings prosperity to local communities such development is not without problems. How can development of renewable resources be approached in a way that ensures sustainability?

4.2 Sustainable Competition

What is the definition of **sustainability**? At its most basic, it is the ability to exist forever or continue unabated. Sustainability often first brings to mind the natural environment in which society is concerned with preserving ecological systems such as forests and watersheds. The biological definition has to do with preserving or conserving a biome over time such that it continues to produce environmental goods and services indefinitely. Environmental sustainability cannot be achieved without considering society and economies. This is not the only type of sustainability. Social sustainability refers to the perpetuation and diversity of society in terms of culture, security and equity. It is the preservation and continuance of social norms. Economic sustainability, in contrast, considers wealth, the ability of a community to prosper and achieve a higher standard of living.

Achieving sustainability in its broadest sense requires the pursuit of all three definitions of sustainability in balance. Without environmental sustainability the ecosystem cannot produce resources to ensure social and economic sustainability. Similarly, if people are starving and unable to access resources or support themselves through responsible use of natural resources, resources are often overexploited leading to extinction or environmental degradation eventually causing societies to collapse or falter.

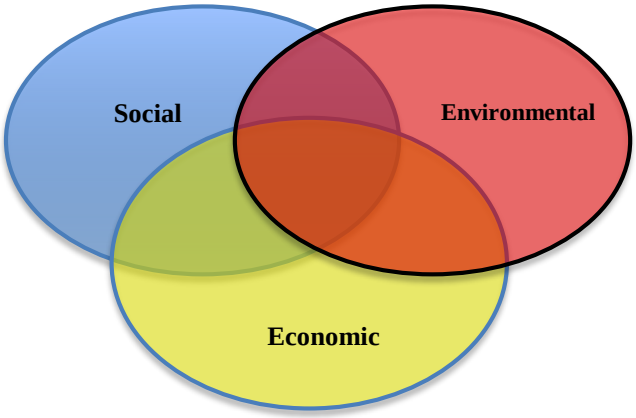

Figure 1: Three spheres of sustainability.

Figure 1. Depicts the *three spheres of sustainability* illustrating how they overlap. The three areas where only two of the spheres overlap provide only partial sustainability. For example, socio-economic sustainability considers both economic conditions and social welfare but at the expense of the environment. An example would be where people prosper and are able to continue cultural practices but where such practices cause environmental damage such as pollution or degradation of grazing areas.

Alternatively, where economic and environmental sustainability overlap, extraction or harvest of resources will be done responsibly and lead to economic prosperity, but at the expense of cultural traditions. Sustainability is possible and inclusive of all concepts where all three are balanced.

It is often necessary to have substantial government engagement to allocate and/or protect many non-renewable resources. While governments are concerned with environmental sustainability, they must also consider the economy and wellbeing of society. Governments therefore set rules and regulations to meet political and cultural objectives in addition to economic goals.

4.3 The Fishing Industry in the Circumpolar North

Fisheries in the North are important to local economies for food security and economic development and the world as a supply of affordable protein. All countries in the circumpolar North have fishing industries ranging from large commercial to subsistence operations.

Learning Activity 1

Conduct an Internet search on the definition of the word "sustainability." Discuss how the definitions are inclusive or exclusive of the three spheres of sustainability. Think of examples that fit within each of the spheres and where the spheres overlap.

Fisheries economics is concerned with defining an economically sustainable catch meaning that capture will not impede fish stocks from reproducing thereby ensuring fisheries' survival. Economic theory attempts to maximize the value of current and future harvests based on catch value, costs and the technology used. Management models are based on

biological factors including the size of the fish stock or population and reproduction rates. When all factors are considered the result should be sustainability of the marine environment, economic prosperity and long-term survival of communities dependent on the fishing industry.

With a rapidly growing global population demand for fish has steadily increased and this trend is expected to continue. A 2009 study by the Food and Agriculture Organization provides the following assessment of world demand.

> *Fish and fishery products are highly traded, with more than 37 percent (live weight equivalent) of total production entering international trade as various food and feed products. World exports of fish and fishery products reached US $85.9 billion in 2006. In real terms (adjusted for inflation), exports of fish and fishery products increased by 32.1 percent in the period 2000 – 2006. Exports of fish for human consumption have increased by 57 percent since 1996. Available data for 2007 indicate further strong growth to reach about US $92 billion. Although some weakening in demand was registered in late 2007 and early 2008, as turmoil from the financial sector started to affect consumer confidence in major markets, the long-term trend for the trade in fish is positive, with a rising share of both developed and developing country production arriving in international markets. (FAO, 2009: p 8)*

While demand is increasing, supply of world fish stocks is diminishing. A 2006 study published in *Science* by a team of ecologists and economists suggested that at current harvest rates increasing pollution to marine environments and other environmental factors will cause most of the world's fisheries to collapse by 2048. Twenty-nine percent of fisheries had already collapsed by 2003 (Worm et al., 2006).

Why do humans continue to engage in unsustainable behavior given that economic models are geared toward sustainability? The problem is that economic models assume that fisheries have well-defined property rights whereby people are rational in their catch and will leave sufficient breeding stock to ensure sustainable harvests. This is not the case. *Property rights* and tenure are difficult to assign to fish stocks thereby resulting in **market failure**.

Fish can be defined as **common pool** resources that have *two characteristics*: *non-exclusivity* and *rivalry or consumptiveness*. Fish stocks are non-exclusive. It is difficult to define ownership until the resource has been captured and it is almost impossible to prevent capture. Fish move and are found in international waters where there is no national jurisdiction so all nations are able to capture the resource.

The second characteristic is **subtractability** whereby consumption of part of the resource reduces the total amount available. Increasing catch amounts reduces total current stocks available and possibly future available stocks depending on population and recovery rates.

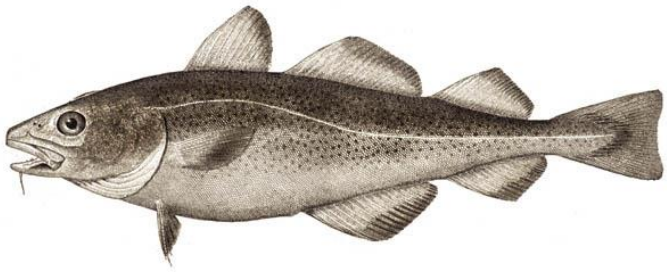

Figure 2: Atlantic cod once the lifeblood of Newfoundland.

Common pool resource characteristics are important for two reasons. In international waters beyond national jurisdictions the resource is treated as **open access** where all nations have the right to fish. There is a strong incentive to overfish due to the lack of *exclusive rights* and the inability of nations to set quotas or enforce regulations. The result is a decline in the total population resulting in eventual collapse because fish are *subtractable* or *consumptive*. Many once teeming fisheries, such as the Grand Banks of Newfoundland cod fishery, are now depleted due to total collapse of the population. Capture rates were greater than birth rates resulting in unsustainable fisheries.

Government intervention is required to ensure fisheries are not overharvested. While there are a number of methods to promote sustainability, none result in economically optimal solutions and such methods can be enforced only in waters in which countries have jurisdiction. Governments are able to enforce national regulations that affect supply and demand. Governments have the option to levy taxes to influence consumption because demand for commodities is dependent on price. Higher taxes shift consumption to lesser-priced goods causing a drop in demand.

A number of options are available to control amounts harvested (e.g. supply). Governments can develop quotas defining catch amounts, and limit season lengths and fishing in known spawning areas. Regulations can also apply to harvesting technology regarding vessel size and catch methods (e.g. nets, long lines, dredging).

The development of aquaculture (e.g. fish farming) is an economic development that takes pressure off natural fisheries. *Substitution* from wild to farm-raised species ensures wild species are not overfished. The difference between wild and domestic is the ability to define property rights. There is no incentive to overfish the stock and populations can be managed sustainably because farmed fish are contained.

4.4 Northern Boreal Forests

The **taiga** or **boreal forest** is the world's largest terrestrial biome and constitutes an important northern renewable resource. The expansive coniferous forest is common to Canada, Norway, Sweden, Finland, Russia and the United States. Greenland and Iceland are the only circumpolar countries that do not have this resource.

This unique ecosystem provides numerous environmental goods and services, such as one of the world's largest carbon sinks. In addition to non-timber forest products known as Non-Timbre Forest Products (NTFPs), it also provides a range of social, economic and cultural resources. Forests have long provided wood for shelter and cooking as well as wood products for subsistence.

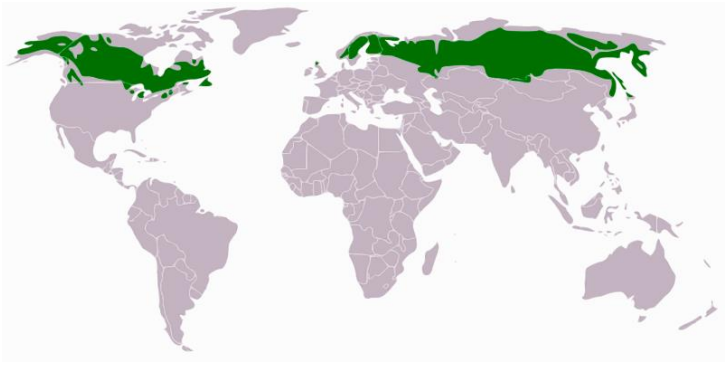

Figure 3: The Taiga or Boreal Forests of the World.

Woody species common to the boreal forest include birch, poplar, larch, tamarack, and softwoods such as pine, fir and spruce. These species are important to the forest industry and are used to produce commodities (e.g. pulp and paper products), building materials (e.g. dimensional lumber, plywood and veneer) and specialty products (e.g. house logs, wood for furniture). In earlier times, in Canada for example, forests provided great wealth for timber barons who exploited such forests for the shipping industry. On the Canadian east coast in the 1700s, vast areas of forest were clear-cut for valuable white pine used for ship's masts.

The boreal forest has provided important renewable resources for communities since the beginning of human habitation. In addition to forest products for building and heating, forests produce medicinal plants (e.g. aspirin is derived from the birch tree), to non-timber forest products (e.g. mushrooms, other edibles). Many characteristics of forests are also culturally and spiritually important to Indigenous communities.

Forest management has long been concerned with managing forests and trees. Forests produce not only commercial and subsistence values, but environmental services such as air and water purification, species habitat, forage, recreation experiences and non-market values arising from aesthetics. The age-old economic question of how to maximize the value of the forest has evolved from looking only at commercial value to including other values and services. The characteristics of the classic forest economics model will be examined to explain how it has been modified to include environmental values as society evolves and is responding to challenges brought about by climate change and changing social values.

Forest economics has long studied one key question: *what is the optimal harvest age*? Three key elements, (e.g. the **production function**, forest management costs and forest product prices), must be examined to answer this question. Integral to the economic decision is the *forest ecosystem*, which influences *forest growth rate* and tree size in terms of height and total volume. Different sized trees are used for different products and sold at different prices depending on the value of the goods produced. Changes to the ecosystem or environment in which trees grow affect the *final value*. For example, if an ecosystem is polluted due to poor management practices, forest productivity will decrease and reduce the economic value of that forest. Also, trees below a minimum size will not produce great value and conversely, trees allowed to grow too long (by economic standards) will decrease in value as trees begin to reach maturity, die and fall.

The second component to determining the highest value of a forest resource and optimal harvest age is the *resource cost* or *investment*. Costs can be incurred throughout the life of a tree beginning with planting, fertilizing and thinning, as well as protection from fire, insects and disease. In addition to management costs, there are harvest costs that vary based on

access and costs to transport trees to market. If costs are higher than revenues, profit will be negative.

Finally, it is important to consider markets at time of harvest. Forest sector prices in the first decade of the 21st century have been depressed. While this means timber and forest products are likely to be less expensive for the final user, communities relying on timber have experienced significant hardships as mills and processing facilities have closed causing people to lose their jobs.

Economic models help guide forest managers to determine optimal harvests while considering community well-being and environmental services. Environmental sustainability can be built into decision-making processes because economic models used for forest management are based on tree biology and functioning ecosystems.

Learning Activity 2

Fisheries are experiencing a significant collapse. Is this true for forest resources? What are the key differences between fish and trees as a resource?

Forest management has become environmentally considerate as more is learned about the non-commercial value of ecosystems for water and air purification and carbon sequestration, and competing demands on forests caused by increases in land and resource scarcity.

In many cases a forested area produces a myriad of commercial and non-commercial resources. Several disputes have ensued where land with high timber values also holds significant social, cultural and environmental value, particularly in unique areas. In such cases government intervention is often necessary. Rather than only considering financial values of commercial species, which are often higher in purely monetary terms than social and cultural values, it is necessary to consider community stability and cultural or social value tradeoffs. Economists refer to such tradeoffs as **opportunity costs.**

The *Canadian Boreal Forest Agreement* that pertains to 72 million hectares of forestland in Canada is an example of an approach that resolved a conflict between two historically and diametrically opposed groups. This landmark agreement brought together 21 commercial forest companies and 9 environmental organizations to work toward sustainable forest management covering all aspects of sustainability: economic, environmental and social (Canadian Boreal Forest Agreement, 2010).

Although forests are not typically managed as open access or common resources, significant threats to forested ecosystems may affect sustainability. Climate change is affecting ecosystem functions resulting in changing forest fire regimes, increased incidence of insects and disease and a change in the growing season. While some of these changes bring about positive economic effects, many require significant adaptation in human behavior and management.

Figure 2: Volunteers near Roshal (Shatursky district of Moscow region).

For example, wildfire, although a natural and necessary ecosystem function, is increasing in intensity and frequency resulting in greater damage to timber and human resources situated in and near forests. Fire behavior requires ever increasing scarce resources to be allocated to protect such areas. Consider damage done to forests near Moscow in the summer of 2010.

Conclusion

This module examined different renewable resources throughout the circumpolar North and how their harvest and use affects northern economies. We have shown the extent of the importance of northern resources to the global economy and have tried to assess the meaning of sustainability as far as the development of these resources are concerned.

Discussion Questions

1. Discuss the relative importance of fisheries resources to three circumpolar countries. Conduct research to determine the relative size of the fishery, the contribution to GDP (Gross Domestic Product) and management differences in each country.
2. Evaluate the state of the world's fisheries.
    a. Discuss factors required to prevent the world from total fisheries collapse by 2048.
    b. Choose a species of fish and provide a brief research report on its economic role to a fishery dependent community. For example, illustrate the historical and current role of cod in Newfoundland, Canada.
3. Demonstrate how timber management differs across circumpolar countries.
    a. Discuss how differences in property rights lead to differences in forestland management.
    b. Articulate challenges society faces in making tradeoffs among commercial and non-commercial uses of forest resources.

Study Questions

1. Articulate reasons renewable resources in the circumpolar North are increasingly becoming globally important.
2. Analyze conditions required in the circumpolar North to achieve sustainable production while meeting demands of the global economy.
3. Summarize the economic and political challenges that characterize the fishing industry in the circumpolar world.
4. Examine economic factors important to achieving sustainable boreal forests.

Glossary of Terms

Boreal Forest: The circumpolar, subarctic forest, also known as taiga, including deciduous trees but dominated by conifers. At the northern boundary is tundra and to the south temperate, broad-leaved, deciduous forest, steppe or semi-desert. This forest is common to six circumpolar countries excluding Iceland and Greenland.

Common Property: Access to property or resources available to a defined group or commons.

Effective Supply: That supply or quantity available for use given existing technology. While total supply may be greater than the effective supply, it is unavailable for use due to its inaccessibility.

Open Access: Non-exclusive access to property or resources open for use by anyone.

Opportunity Cost: The cost of the most highly valued alternative surrendered or given up.

Production Function: Economic term used to describe the change in total production as a result of one input where all other production inputs are held constant. The shape of the curve is a sigmoid showing an increasing growth rate and quantity, followed by a decreasing growth rate but increasing quantity, and ultimately a decreasing growth rate and a reduction in the total quantity.

Property Rights: A bundle of rights that define how a resource or asset can be used, for how long and by whom, who has the right to benefit and who is liable. Property rights are often related to types of property and access to property.

Substitutes: Goods that replace one another and can be used interchangeably. As the price of good A increases, the demand for good B will increase all other things constant.

Subtractability: The degree to which use of a resource reduces the amount available for others.

Sustainability: The ability to perpetuate indefinitely. Sustainability can refer to many things such as economic wealth, social customs and the environment.

Taiga: Russian term for the world's largest biome also known as boreal forest consisting of coniferous and deciduous trees that refer to the northernmost edge of the boreal forest located from the subarctic north in the circumpolar North.

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Supplementary Resources

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