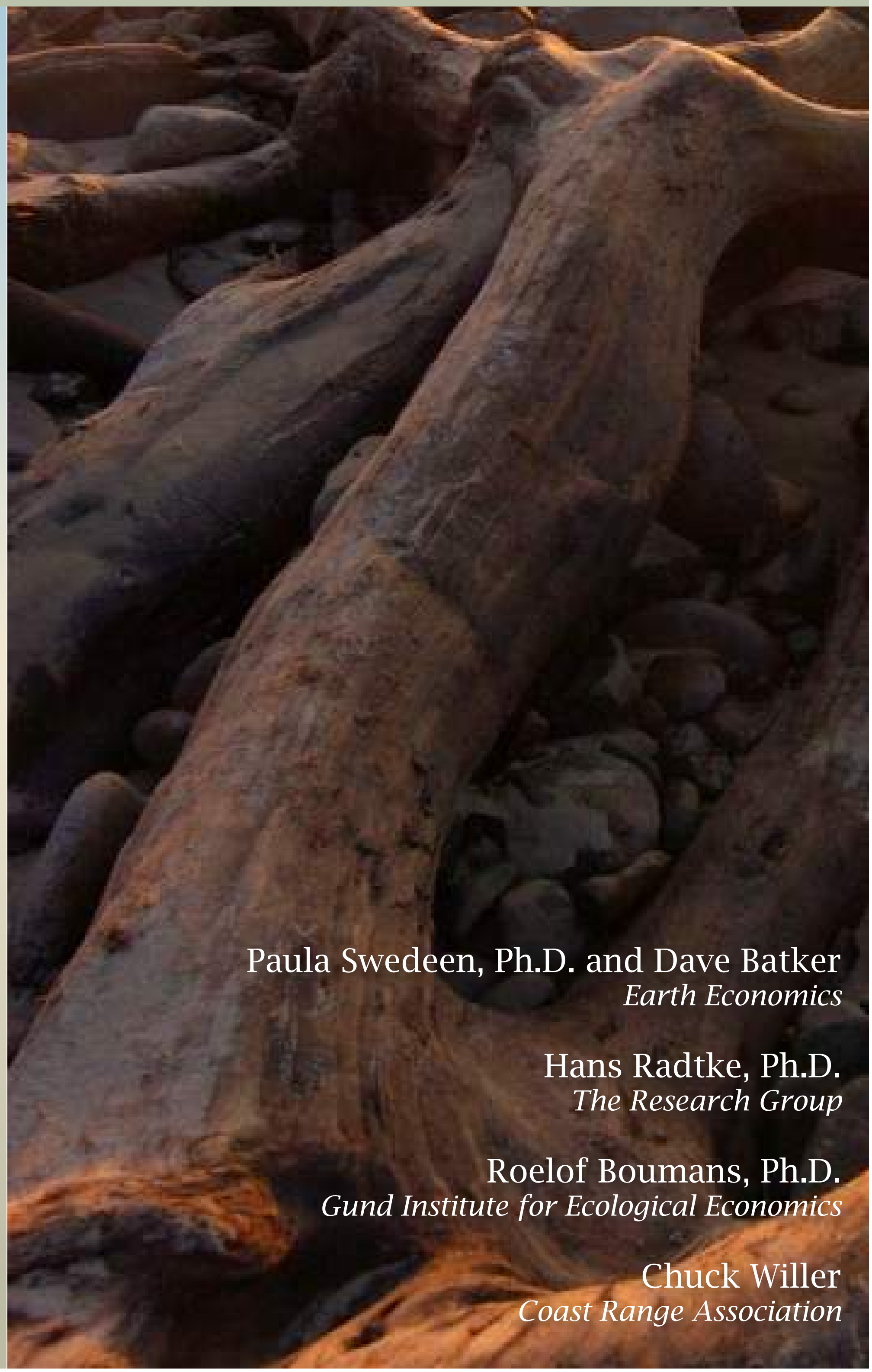
An Ecological Economics Approach to

Understanding Oregon's Coastal Economy and Environment



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Photos featured in this report by Ben Nieves.

Executive Summary

Oregon is blessed with one of the most beautiful, diverse, and productive marine coastlines in the country. It stretches some 360 miles from the mouth of the Columbia River at the Oregon-Washington state line to the Oregon-California state line, and is marked by dramatic sea stacks, sandy beaches and towering sand dunes. These features draw tourists from around the world, as well as retirees, artists and others who come to make the coastal region their home. Marine waters off the coast are abundant in fish and invertebrates that support commercial and recreational fishing industries, and provide habitat to marine mammals and birds that draw wildlife watching enthusiasts, kayakers and scuba divers.

Two major recent reports on the state of U.S. oceans (Pew Oceans Commission 2003, The U.S. Commission on Ocean Policy 2004) provided a summary of evidence of the decline of the health of marine ecosystems in U.S. waters. Dwindling catches of various groundfish species and the on-going concerns with salmon, plus an overall awareness of the fragility and richness of Oregon's marine resources have prompted discussion among citizens and state government about establishing a series of marine reserves in Oregon's territorial waters. That discussion also includes concern for coastal communities and the economic impact that further restrictions on fishing could have on their economies. Oregon's coastal economy is greatly influenced by what happens in marine waters. The health of the entire coastal and marine environment is a matter of economic and cultural importance to coastal residents and the people of Oregon.

There have been no studies to date that address the broad economic relationship between Oregon's estuary and marine ecosystems and the economic health of Oregon's coastal communities. This paper reports on the first phase of an economic analysis linking marine and marine influenced ecological conditions to the general coastal economy by exploring those ecosystem services that connect economy and ecology. We present the general concept of ecosystem services and discuss qualitatively their contribution to the coastal economy of Oregon. Specifically, we provide the background ecological economics framework in which the role of ecosystem services is assessed in its support of the coastal economy. This includes describing the relationship between the long-term sustainable management of coastal resources (natural capital) and the resilience of the Oregon coastal economy. The paper incorporates concrete data, examples, and discussions of coastal Oregon conditions including the coastal economy and marine environment, and past and current fisheries. The report lays the foundation for a further and more in-depth analysis which will explore a thorough ecosystem service valuation for the Oregon coast.

Economic Character of Coastal Oregon

The report provides in-depth statistics on the demographic and economic make up of Coastal counties. These include Clatsop, Tillamook, Lincoln, Coos, and Curry counties and coastal portions of Lane and Douglas counties. Demographically, important points to note pertain to the rate of growth and age structure of the population, and changes in employment over the past 30 years. Coastal Oregon has grown at a slower rate than the rest of Oregon and the U.S. as a whole since 1970 – 9 percent versus 20 percent for Oregon and 13 percent for the U.S. This growth has mostly occurred as a result of in-migration of both working age adults and retirees, though the retiree population has grown more than other age cohorts, suggesting that people of retirement age are choosing to live in coastal Oregon. Population growth due to births within the coastal region has actually declined. The slower rate of growth, age structure and in-migration pattern has a large bearing on the character of the economy.

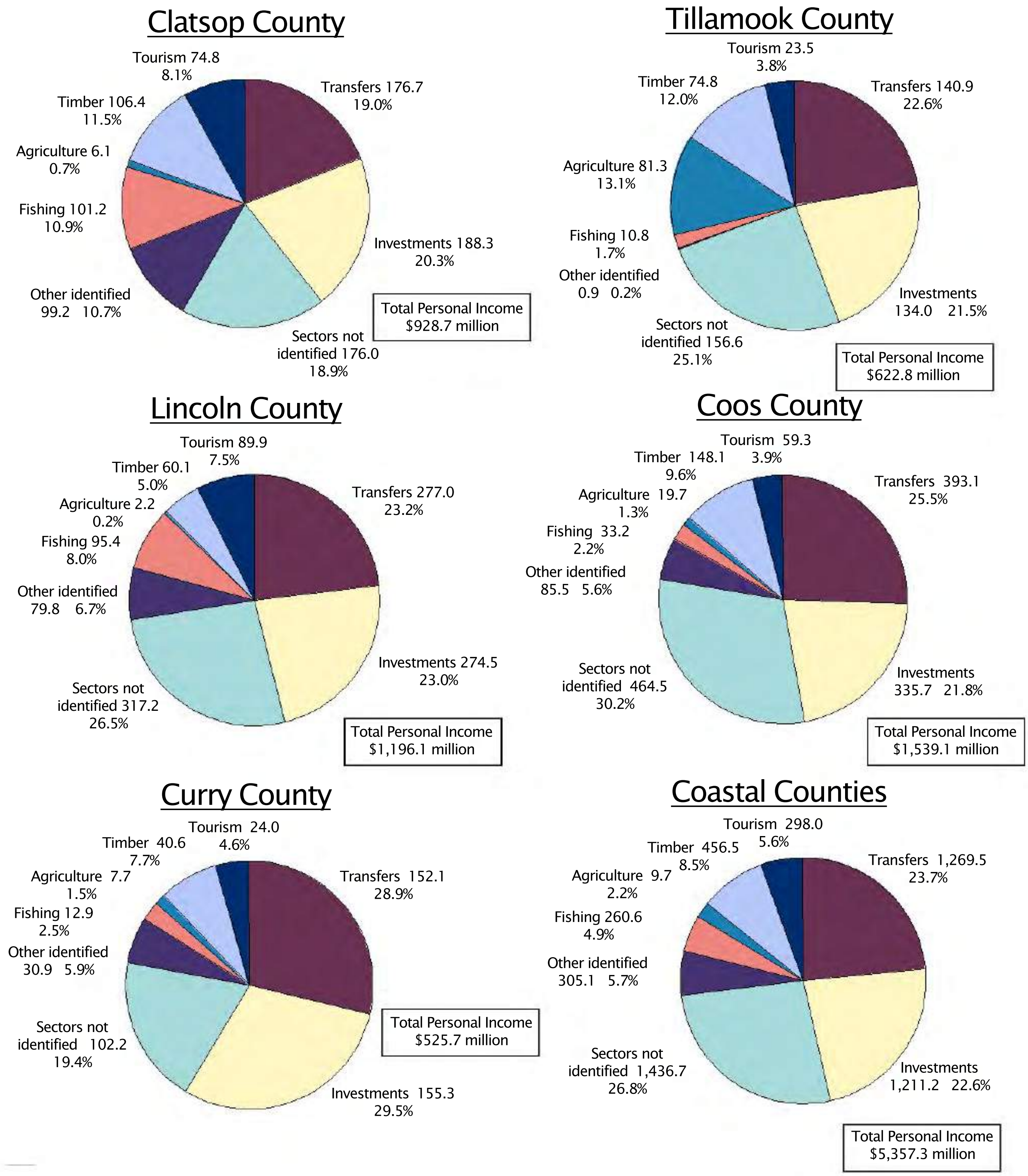
On the employment front, Coastal Oregon has undergone a shift: Historically, natural resource extraction and natural resource-based manufacturing provided the most jobs to the service sector and currently light manufacturing provides the bulk of employment-based income. Decline in natural-resource-based jobs has occurred mostly since 1990. Another major change is that the proportion of total personal income that comes from investment and transfer payments (Social Security, pensions, and Medicare and Medicaid) has grown relative to employment-based income. The growth of the proportion of retirement-age population coupled with national trends in the increase in non-employment based income accounts for these trends. Again, these changes towards a service and retirement based economy has many implications for how the Coastal area can think about employment, growth, natural-resource-based jobs, and the whole question of how the economy and the environment are related.

We used the results of an input-output based model to examine how much each sector of the economy contributes to the personal income of Coastal Oregon residents. This analysis sets up the broader discussion of how coastal and marine ecosystems affect and are affected by economic activity, and in turn how human well-being is affected by ecological systems and the services they provide for people.

The results of the input-output model (see full report for details) for each of the coastal counties and the Coast as a whole are summarized in Figure ES1. Coast-wide, transfer and investment income and a collection of small businesses and industry not associated with natural resource extraction make up nearly 75 percent of the total contribution to personal income. Non-aquaculture commercial fishing contributes 3.5 percent of total personal income. Some individual counties, however, have a higher dependency on fishing for personal income with Clatsop and Lincoln counties at between 8 and 9 percent.

The coastal economy is not, however, heavily dependent on natural resource extraction, either directly, or through processing of raw materials such as fish and timber. Instead, we argue in

Figure ES1. Share of total personal income sources for identified sectors by Coastal County in 2003



Notes: 1.Total personal income expressed in millions of dollars.

2. Graphs for coastal Lane and Douglas counties are not displayed, but analysis results are included in the coastal counties summation graph.

Source: The Research Group (2006).

this paper that the economy is much more dependent on aesthetic beauty and intactness of the natural environment for nature-based tourism and high quality of life that draws both retirees and entrepreneurs.

Ecosystems as Natural Capital

The marine ecosystem off of Oregon's coast provides significant support and benefits to Oregon's coastal communities. The marine environment can be described as the defining element of coastal natural capital. It is an engine for economic and social well-being for Oregon's coastal communities. Viewing the marine environment as "natural capital" sets the framework for assessing how that environment contributes to human well-being, and establishes that the marine environment is not just an amenity or an expendable aspect of Oregonians' lives. A healthy marine ecosystem provides an irreplaceable foundation for fisheries, recreation, and tourism industries, as well as less recognized services such as waste processing, hydrological cycling, storm protection, and nutrient cycling – all of which contribute to the habitability of a place, the region, and the planet as a whole. In short, healthy marine ecosystems are the natural capital base from which many vital goods and services flow. While human-built capital such as water treatment plants and storm walls degrade over time and must be replaced, natural capital provides goods and service in perpetuity if it is not overused or destroyed by human activity.

Ecosystem Services and the Coastal Economy

Ecosystem services are the things that ecological systems, such as oceans, estuaries, wetlands, and forests provide to support human life and social and economic well-being. Ecosystem services fall into four broad categories (Figure ES2):

1. Provisioning services are those that directly provide the materials for subsistence and economic activity, including food, building materials, fiber for clothing and other implements, medicines, and fuel. Ocean ecosystems produce fish, crustaceans, and other organisms that humans have relied on for food for much of their evolutionary history. Forests, as another familiar example, provide trees for building materials and other plants used for medicinal purposes.

2. Regulating services are those that create and maintain conditions favorable to human life and economic activity. Climate stability, cycling water from oceans to land, keeping disease agents in check, and breaking down waste products are all examples of regulating services.

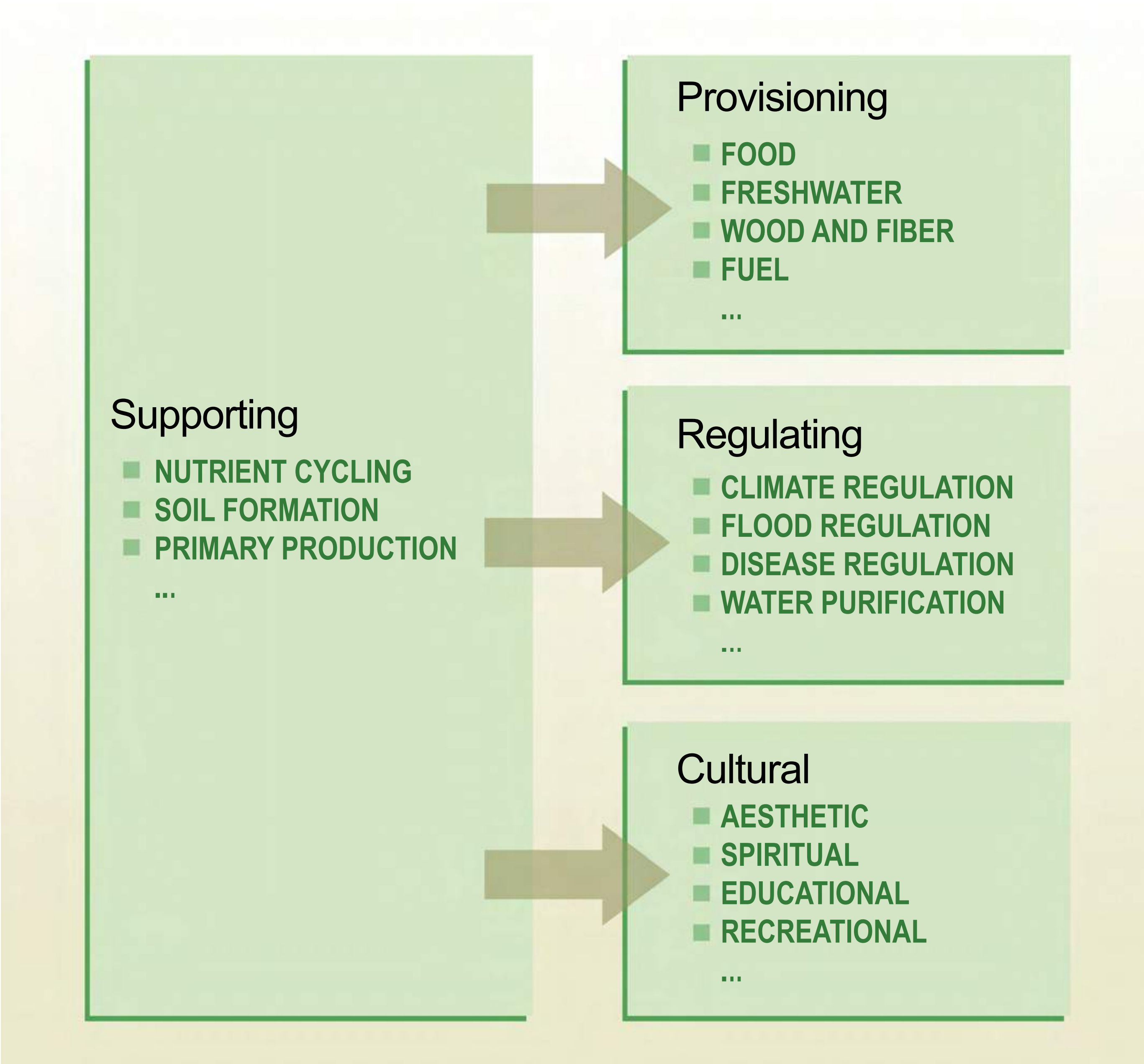
3. Supporting services are the basis of ecosystem function. These include primary productivity – or the fixing of CO2 by plants to produce food that forms the basis of the vast majority of all food webs on the planet, and nutrient cycling.

4. Cultural services include all of the ways people interact with nature in socially meaningful traditions, such as spiritual significance, enjoying natural places for recreation, and learning about the planet through science and education. This basic scheme (see Figure ES2) was developed in the Millennium Ecosystem Assessment (UNEP 2005). Other authors place ecosystems in 23 finer-scale categories (e.g., De Groot et al. 2002).

We define 17 ecosystem services that occur in Oregon's coastal environment, describe which habitat types provide which ecosystem services, and describe how each of them relates to economic and social activity. Ecosystem services are defined in Table ES1 and ten services are related to ecosystem types in Table ES2.

The large amount of retiree income as a proportion of total income in the coastal counties indicates high quality of life is a large draw to the Oregon Coast. There are convincing analyses from other parts of the country, which have had large natural resource-based industries in the past, showing high environmental quality is a key factor in drawing entrepreneurs to start up small businesses (Power 1996, Power and Barrett 2001).

Figure ES2. Ecosystem Services



Source: Millennium Ecosystem Assessment, 2005

Although specific economic valuation survey data are not available, it is fairly safe to conclude that Oregon's beautiful coastline, accessible beaches, relatively high air and water quality, watchable marine and coastal bird and mammal life, and recreational hunting and fishing opportunities are a big draw to retirees and prospective business owners. Therefore, maintaining ecosystem services that support high natural aesthetic and recreational opportunities, in addition to the health and safety of coastal residents, should be the primary policy objective in support of today's coastal economy and quality of life. Biodiversity and all of the supporting services – primary productivity, nutrient cycling, habitat provision plus regulating services such as shoreline stabilization, water quality and waste treatment and storm protection – are essential to maintaining these important values.

This policy conclusion is not to say, however, that the fishing sector should be dismissed in consideration of the coastal economy. Quite the contrary: Although some fishing income has declined since 1990, a well-managed and vibrant fishery based on recovered and healthy marine ecosystems could once again be a substantial part of the coastal economy. The transition to ecosystem-based marine management and the recovery of coastal fish stocks to levels that are both abundant and resilient could become the foundation for a profitable coastal marine fishing fleet. Fishing practices would be guided by the need to maintain a highly productive ecosystem. In this way, efforts made to restore marine ecosystems and their full biological diversity would pay off for years to come, by supporting commercial and recreational fishing that is truly sustainable and is once again a larger and vibrant part of Oregon's coastal economy.

A full assessment of the economic value of ecosystem services provided by coastal and marine ecosystems, especially in the context of evaluating proposals for establishing marine protected areas, can help further elucidate our preliminary conclusions and quantify the ecological contributions to the economy. Such analysis will constitute phase two of this study.

Table ES1. Marine and Coastal Ecosystem Services

Ecosystem Service	Definition	Examples
Biodiversity	The number and types of species and the ecosystems they comprise. Measured at gene, species, population, ecosystem and regional levels. Biodiversity provides resilience to ecosystems and the opportunity for the provision of most other ecosystem services.	Intact fish populations occur within more intact native species and ecosystem assemblages than those populations which are in decline.
Provisioning		
Food	Biomass for human consumption, provided by web of marine organisms and a functioning marine ecosystem (see biodiversity definition above).	Fish, seaweed
Materials	Biological materials used for medicines, fuel, and building.	Conical mollusk shells used for anti-cancer drugs, oil, lime
Regulating Services		
Shoreline stabilization	Keeping shorelines in a state of equilibrium with ocean waters, especially in the face of rising sea levels.	Rocky shores, seagrass beds, wetlands, and estuaries trap sediments and sand that allow land accretion which can balance or exceed subsidence or erosion.
Storm protection	Mitigation or attenuation of the effects of wind, waves, and flood waters on coastal land and communities.	Estuaries and coastal wetlands absorb wave energy and flood waters from ocean storms, thus reducing damage to coastal property.
Water flow regulation	Retention and storage of fresh water.	Estuaries and coastal wetlands store fresh water and keep salt water from intruding upon fresh water supplies.
Human disease control	Undisturbed ecosystems keep organisms in check which can cause disease in humans.	Coastal waters with proper nutrient, oxygen, and pH levels prevent algal blooms that produce toxins which are poisonous to humans via shellfish consumption from affected areas.
Waste processing	Detoxification or absorption of natural or human-made contaminants.	Wetlands take out excess nitrogen and biologically breakdown contaminating bacteria from human waste, thus preventing release to marine waters.
Carbon sequestration	The capture and long-term storage of carbon is part of the global carbon cycle. Oceans play a crucial part in role climate stabilization.	Oceans absorb carbon both chemically and biologically. Surface absorption occurs over short time frames (1 year); deep water mixing allows long-term storage and more surface absorption; phytoplankton fix carbon through photosynthesis.
Supporting		
Nutrient regulation and cycling	Transfer of nutrients from one place to another; transformation of critical nutrients from unusable to usable forms.	Estuaries are zones where mixing of nutrients from fresh water and saltwater systems occur, making them very productive; anadramous organisms transport marine nutrients to upland habitats where they are used by terrestrial organisms (salmon and grizzly bears) and enhance primary productivity of terrestrial plants.

Table ES1. Marine and Coastal Ecosystem Services (cont'd)

Ecosystem Service	Definition	Examples
Habitat	Providing for the life history needs of plants and animals.	Estuaries provide nursery habitat (relatively more protected places where fish and other sea animals hatch then mature to a life stage where they can handle harsher environments).
Primary productivity	Fixing of carbon by plants; provides basis of all terrestrial and most marine food chains.	Phytoplankton plays a crucial role as the basis of marine food webs and in the global carbon cycle.
Cultural		
Spiritual and Heritage	The role which ecosystems and their components play in the spiritual beliefs of people. This is especially important for indigenous cultures. These values do not lend themselves well to economic quantification. Heritage values refer to the role that intact ecosystems play in forming the cultural identity of people and the long-term value people place on being able to pass on traditions to their children.	Salmon play a key role in spiritual and cultural life of Native American tribes. Families that have made a living from commercial and recreational fishing in Coastal Oregon value being able to pass on their way of life to their children.
Scientific and Educational	Ecosystems are the subject of much scientific study for both basic knowledge and for understanding the contribution of functioning ecosystems to human well-being.	Research institutions focused on marine habitats contribute economically and socially significant knowledge to society.
Tourism	The explicit role that intact land and seascapes play in attracting people to areas for vacationing.	Visits to coastal state parks to view unobstructed views of the ocean, walk on the beach, and to see marine life.
Aesthetic	The role natural beauty plays in attracting people to live, work and recreate in an area.	Home values with ocean views are higher than homes without.
Recreation	The contribution of ecosystem features, such as biological diversity and clean water play in attracting people to engage in recreational activities.	Clean water and marine animals attract kayakers and scuba divers.

Table ES2. Marine and Coastal Ecosystem Types and the Services They Provide

	Beaches	Headlands and Rocky Islets	Estuaries and Marshes	Intertidal	Kelp	Rock Reefs	Eelgrass	Inner Shelf	Outer Shelves Edges Slopes
Biodiversity	X	X	X	X	X	X	X	X	X
Provisioning Services									
Food	X		X	X	X	X	X	X	X
Fiber, Fuel			X		X		X	X	X
Medicines			X		X			X	
Regulating Services									
Shoreline stabilization/erosion control	X	X	X			X	X		
Storm protection	X	X	X	X	X	X	X		
Water flow regulation and storage			X						
Human disease control	X		X	X		X	X		
Waste processing	X		X				X		
Carbon sequestration			X	X		X	X	X	X
Supporting Services									
Nutrient cycling	X		X	X	X	X		X	X
Habitat	X	X	X	X	X	X	X	X	X
Primary productivity		X	X		X		X	X	X
Cultural									
Spiritual	X	X	X	X	X	X	X	X	X
Scientific and educational	X	X	X	X	X	X	X	X	X
Tourism/recreation	X	X	X	X	X	X			
Aesthetic	X	X	X	X					

Introduction

Oregon is blessed with one of the most beautiful, diverse, and productive marine coastlines in the country. It stretches some 360 miles from the mouth of the Columbia River at the Oregon-Washington state line to the Oregon-California state line, and is marked by dramatic sea stacks, sandy beaches and towering sand dunes. These features draw tourists from around the world, as well as retirees, artists and others that come to make the coastal region their home. Marine waters off the coast are abundant in fish and invertebrates that support commercial and recreational fishing industries, and provide habitat to marine mammals and birds that draw wildlife watching enthusiasts, kayakers and scuba divers. Industrialization and urbanization, while not absent, are far less dominant than east coast marine shorelines, and less than in many parts of Washington State and California, allowing the natural character to remain an asset to the state.

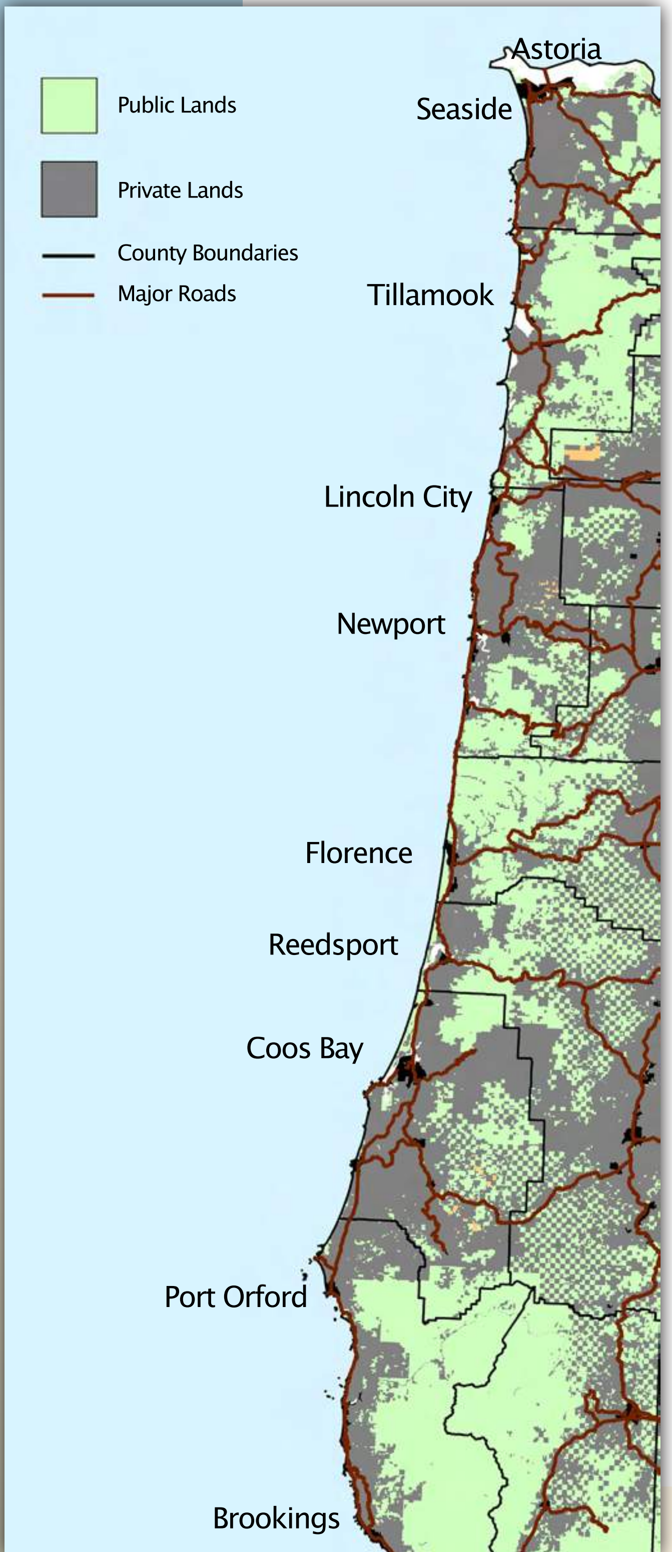
Photo by Ben Nieves

Two major recent reports on the state of U.S. Oceans (Pew Ocean Commission, 2003; The U.S. Commission on Ocean Policy, 2004) provided a summary of evidence of the decline of the health of marine ecosystems in U.S. waters. Dwindling catches of various groundfish species and the on-going concerns with salmon, plus an overall awareness of the fragility and richness of Oregon's marine resources have prompted discussion among citizens and state government of establishing a series of marine reserves in Oregon's territorial waters. That discussion also includes a concern for coastal communities of the economic impact that further restrictions on fishing could have on their economies. Oregon's coastal economy is greatly influenced by what happens in marine waters. The health of the entire coastal and marine environment is a matter of economic and cultural importance to coastal residents and the people of Oregon.

The studies by the Pew Ocean Commission and the U.S. Ocean Policy Committee provide a valuable context for understanding our coastal marine environment. Several Oregon-based studies have provided much needed insight into the role that marine related economic sectors play in the coastal economy. However, there are no studies to date that address the broad economic relationship between Oregon's estuary and marine ecosystems and the economic health of Oregon's coastal communities. This paper reports on the first phase of an economic analysis linking marine and marine influenced ecological conditions to the general coastal economy by exploring those ecosystem services that connect economy and ecology. We present the general concept of ecosystem services and discuss qualitatively their contribution to the coastal economy of Oregon. Specifically, we provide the background ecological economics framework in which the role of ecosystem services is assessed in their support of the coastal economy. This includes describing the relationship between the long-term sustainable management of coastal resources (natural capital) and the resilience of the Oregon coastal economy. The paper incorporates concrete data, examples, and discussions of coastal Oregon conditions including the coastal economy and marine environment, and past and current fisheries. The report lays the foundation for a further and more in-depth analysis which will explore a thorough ecosystem service valuation for the Oregon coast.

The demographic and economic characteristics of the coast are described first, including an in-depth picture of how various sectors of the coastal economy contribute to personal income. We then use concepts from ecological economics in order to describe the general relationship between the environment and the economy. This includes a description of coastal ecosystems and the services they provide to support human well-being and economic activity. Finally we describe how ecosystem services can be valued from an economic perspective to give a more quantitative picture of their contributions to Oregon's coastal economy. Actual quantification of the monetary value of ecosystem services will be conducted in future work.

Demographic and Economic Description of Oregon Coast



The Oregon Coast has a particular geography that has heavily influenced its social and economic development. Bordered by the Pacific Ocean and the Coast Range mountains, coastal residents have had comparatively less space to establish their homes and economic activities than people in the Willamette Valley. However, in the past the ocean, estuaries, and forests have also provided abundant natural resources that, combined with a mild climate, have made coastal Oregon a desirable place to live for thousands of years. In modern times, the coastal economy on the landward side has been shaped by the opportunities and limitations offered through its land tenure of large private timber companies or the state and federal governments. As an outcome of land ownership and geography, most industrial, commercial, and residential development has occurred on a relatively narrow strip of land between the forest and the sea.

U.S. Highway 101 is the major transportation corridor connecting coastal towns along the coast's north - south axis. Eight major state highways link the coast to the larger cities of the Willamette Valley and the I-5 corridor. Thus, the coastal economy is not a closed system: residents buy and sell goods to areas outside the coast, and acquire major services from cities like Portland, Eugene and Roseburg. While the geography of the coast makes it an Oregon region whose economy is uniquely influenced by the ocean, it is linked economically and socially to the larger Pacific Northwest region.

Map 1. Oregon's coastal region. (at left)

Demographic

This section provides a brief description of current demographic and economic characteristics of coastal Oregon. It is derived from the 2006 Oregon Coastal Zone Management study conducted by the Research Group. Coastal Oregon, by which we mean the seven coastal counties (Clatsop, Tillamook, Lincoln, coastal Lane, coastal Douglas, Coos, and Curry Counties), was home to about 200,000 out of a total of 3.5 million Oregonians as of 2000, 6 percent of the state's population. The coastal population has grown by 35 percent since 1970, but that rate of growth slowed between 1990 and 2000 to 9 percent for the decade. By way of comparison, the population of Oregon as a whole grew by 64 percent between 1970 and 2000, with a growth rate of 20 percent between 1990 and 2000. The largest part of this growth has by far been due to in-migration rather than natural growth, with natural growth reaching negative rates between 1990 and 2000 (Tables 1 and 2 and Figure 1). Because of this, and because the coast seems to be drawing a large retiree community (see below), the overall composition of the population is distributed in older age classes.

Population density is relatively low in coastal counties at 27.6 people per square mile versus 35.6 in the state as a whole and 357 people per square mile in metropolitan Portland. Given coastal geography, however, county-wide population density may be misleading since most people live near the ocean along Highway 101 due to the land inward being mountainous or off limits to settlement due to ownership.

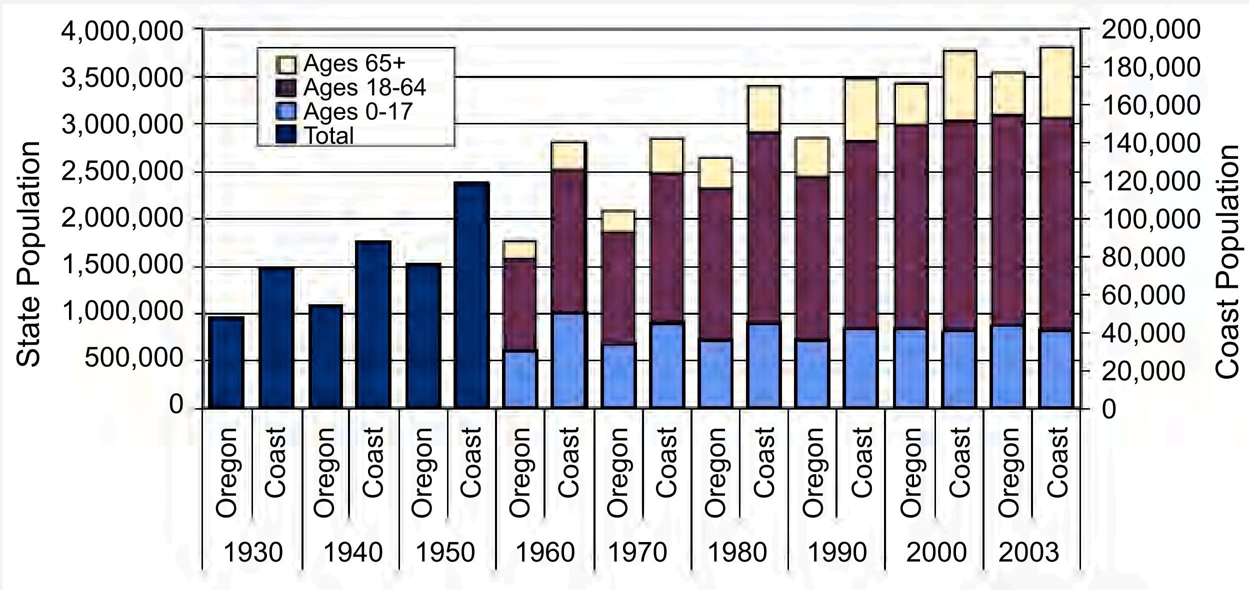
The Oregon Coast has higher levels of staffed hospital beds per capita than the State when you use county boundaries to define proximity. The doctor count, however, is proportionally much lower than the State. Hospitals and health clinics along the Oregon Coast provide trauma and basic health services while specialized medical services are located in the major population centers of the State. Many coastal residents likely spend health care dollars outside of the coastal counties.

Table 1. Population Percent Change During 1970 to 2000 for U.S., Oregon, and Coastal Counties

					Percent Change		
	1970	1980	1990	2000	1970-2000	1980-2000	1990-2000
Clatsop	28,473	32,489	33,301	35,630	25%	10%	7%
Tillamook	18,034	21,164	21,570	24,262	35%	15%	12%
Lincoln	25,755	35,264	38,889	44,479	73%	26%	14%
Coastal Lane	2,246	4,411	5,162	7,340	227%	66%	42%
Coastal Douglas	4,039	4,084	4,796	4,870	8%	12%	9%
Coos	56,515	64,047	60,273	62,779	11%	-2%	4%
Curry	13,006	16,992	19,327	21,137	63%	21%	9%
Coast	148,068	179,351	183,318	199,997	35%	12%	9%
Oregon	2,091,533	2,633,105	2,842,321	3,421,399	61%	30%	20%
U.S.	203,211,926	226,545,805	248,709,873	281,421,906	38%	24%	13%

Notes: 1. Cities of Florence and Reedsport represent coastal Lane and coastal Douglas counties, respectively.
Source: U.S. Census Bureau and Portland State University Population Research Center (PSU).

Figure 1. Population by Age Cohort in Oregon and Coastal Counties in 1930 to 2003



Notes:

1. Coast includes Clatsop, Tillamook, Lincoln, Coos, and Curry counties.
2. Several age years in cohorts for early decennial years are estimated using ratios from more recent decennial years.

Source: U.S. Census Bureau

Table 2. Coast and Oregon Population Change by Components During Years 1940 to 2000

	Years	Population	Total Change	Net Migration	Natural Increase
Coast	1940	88,276			
	1950	119,003	30,727	19,915	10,812
	1960	139,908	20,905	-700	21,605
	1970	141,783	1,875	-9,193	11,068
	1980	169,956	28,173	20,916	7,257
	1990	173,360	3,404	-1,913	5,317
	2000	188,287	14,927	16,929	2,002
Oregon	1940	1,090,000			
	1950	1,521,341	431,341	293,478	137,863
	1960	1,768,687	247,346	18,501	228,845
	1970	2,091,385	322,698	160,346	162,352
	1980	2,633,156	541,771	395,157	145,614
	1990	2,842,321	209,165	35,766	173,399
	2000	3,421,399	579,078	421,452	157,626

Notes:

1. Net migration equals in-migrants minus out-migrants.
2. Natural increase equals births minus deaths.
3. Coast does not include coastal Lane and coastal Douglas counties.

Source: U.S. Census Bureau and Portland State University Population Research Center

This is significant given the age structure of the population.

The crime rate for coastal counties is less than that for the State. The trend over the last decade shows decreasing overall reported crimes for both the Coast and the State.

Employment shifts in coastal Oregon between 1970 and 2000 reflect larger trends seen in both Oregon and the nation as a whole. They are very relevant for thinking about the relationship between environmental quality, the services that the environment provides, and how these relate to how people are now employed as opposed to patterns of the past. Traditional natural resource-based industries (timber, agriculture, fishing, and mining) plus the closely related industries of construction and manufacturing[1] comprised 42 percent of jobs in coastal counties in 1970. By 2000, these "transformative" sectors (Beyers,1991) accounted for 22.3 percent of employment (The Research Group, 2006, p. II.10). In another breakdown of employment data, it appears that this loss of jobs in the transformative sector was driven by a loss of manufacturing jobs. In 1980, forestry, fishing, and agricultural jobs accounted for 6.7 percent of employment. In 2000, these sectors still accounted for 6.0 percent of total employment. Manufacturing jobs, however, declined from 20.8 percent to 8.3 percent of total employment between 1980 and 2000. By way of comparison, in Oregon as a whole, forestry, fishing, and agricultural jobs declined from 4.6 to 3.1 percent of jobs between 1980 and 2000 while manufacturing jobs declined from 19.5 to 14.4 percent over the same time period (Table 3). The national trends in loss of manufacturing jobs hit coastal Oregon counties harder than the state as a whole (The Research Group, 2006, p. II.11)

We might note that the overwhelming percentage of manufacturing job loss was from lumber mills as mills consolidated inland during the 1980s and 1990s or those that remained became more automated. At the same time in Oregon, there has been no loss of lumber production. Fish processing jobs also must have suffered from some degree of automation or consolidation. Note 1 below signals both points.

In contrast, the proportion of jobs known as consumer services (for example, arts, entertainment, recreation, accommodations, and restaurants) grew by 206 percent, from 6.3 to 18.9 percent of total employment between 1970 and 2000 (The Research Group, 2006, p. II.10). This sector grew by a similar amount for Oregon as a whole over the same time period. These contrasting trends between manufacturing jobs and tourism and amenity-related jobs are significant and are discussed later in the report.

It is also interesting to note that population growth trends in the coastal counties are slowing down relative to the state as a whole, and relative to the fastest growing counties in the state, which are projected to more than double by 2040. In contrast, coastal counties are projected to grow by between 3 (Curry) and 22 percent (Lincoln)[2]. Relatively slower population growth would make it easier to maintain a higher environmental quality and quality of life associated with less congestion. However, slow population growth could make maintaining a robust economy difficult unless a more "steady-state", locally self-sufficient approach is taken to economic development (see discussion of ecological economic principles below).

1 Construction and manufacturing in timber dependent counties in the Pacific Northwest are closely tied to natural resource activities, especially forest products processing (Power and Barrett, 2001). Coastal fishing activities also fed canning and processing plants in coastal counties (The Research Group, 2006).

2 See http://www.oregon.gov/DAS/OEA/docs/demographic/pop_components.xls.

Table 3. Coast and Oregon Occupation and Selective Industry Trends in 1980 to 2000

	1980		1990		2000	
	Coast	Oregon	Coast	Oregon	Coast	Oregon
Management, professional, and related occupations	24.0%	26.7%	25.5%	29.4%	27.5%	33.1%
Service occupations	19.3%	15.1%	19.6%	15.3%	20.3%	15.3%
Sales and office occupations	22.5%	27.8%	25.2%	27.8%	24.8%	26.1%
Farming, fishing, and forestry occupations	3.1%	1.7%	2.7%	1.7%	3.6%	1.7%
Construction, extraction, and maintenance occupations	11.1%	10.4%	9.9%	9.1%	10.5%	9.1%
Production, transportation, and material moving occupations	20.0%	18.4%	17.1%	16.8%	13.3%	14.7%
Total	**86,721**	**1,138,425**	**70,220**	**1,319,960**	**79,884**	**1,627,769**
Selected industries						
Agriculture, forestry, fishing, and hunting	6.7%	4.6%	7.4%	5.1%	6.0%	3.1%
Manufacturing	20.8%	19.5%	15.0%	17.7%	8.3%	14.4%
Selected worker classes						
Government workers (local, state, or federal)	17.6%	17.3%	17.3%	15.1%	16.6%	14.4%
Self-employed workers	13.6%	9.1%	13.1%	9.3%	12.4%	8.9%

	% Change 1980-1990		% Change 1980-2000		% Change 1990-2000	
	Coast	Oregon	Coast	Oregon	Coast	Oregon
Management, professional, and related occupations	11.9%	27.8%	37.4%	77.5%	22.8%	38.8%
Service occupations	6.5%	17.5%	25.5%	45.1%	17.9%	23.4%
Sales and office occupations	17.7%	16.0%	31.5%	34.5%	11.6%	15.9%
Farming, fishing, and forestry occupations	-6.7%	15.2%	40.3%	46.2%	50.4%	26.9%
Construction, extraction, and maintenance occupations	-6.2%	1.7%	12.9%	25.3%	20.4%	23.1%
Production, transportation, and material moving occupations	9.9%	5.1%	20.0%	13.9%	11.2%	8.1%
Total	**5.2%**	**15.9%**	**19.7%**	**43.0%**	**13.8%**	**23.3%**
Selected industries						
Agriculture, forestry, fishing, and hunting	16.9%	27.6%	7.8%	-3.5%	-7.8%	-24.4%
Manufacturing	23.9%	5.0%	-52.2%	5.6%	-37.1%	0.5%
Selected worker classes						
Government workers (local, state, or federal)	3.6%	1.3%	13.4%	18.9%	9.4%	17.4%
Self-employed workers	0.9%	18.8%	8.6%	40.2%	7.6%	18.0%

Notes:

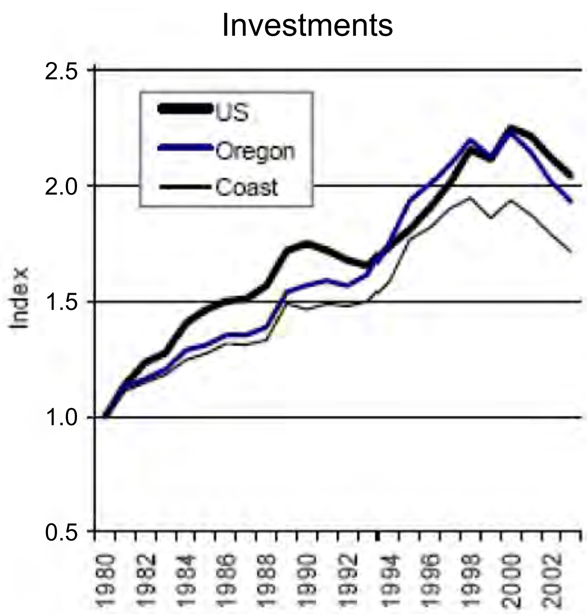
1. Totals include employed population 16 years and over.
2. The 1980 and 1990 occupation categories were translated to 2000 titles using the U.S. Census Bureau's "1990-2000 Census Tabulation Crosswalk Template: Occupation, Level 1."

Source: U.S. Census Bureau

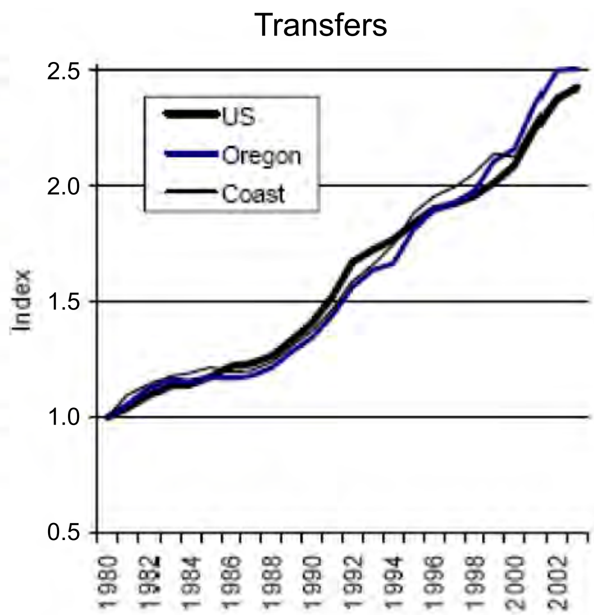
A different way of looking at economic activity other than where people work (employment) is to look at where their personal income comes from. In today's economy it is not unusual for personal income to be the result of retirement savings, rents, dividends, social security payments, Medicare payments, and from other non-wage sources. A revealing income trend over time, particularly on the Oregon coast, is the dramatic increase in investment and transfer payments as a percent of total household and individual personal income. This is partially because as total personal income has increased, the share of total personal income that is earned (i.e., employee compensation and proprietor income) has remained about the same (Figure 2). This means that a sizable portion of coastal spending is not tied to salaries and wages from local businesses or industries. It is also interesting to note that total personal income in the coastal counties has increased over time in real dollars. As can be seen in Figure 4, non-wage income has been growing as a part of total personal income since the early 1970s.

The increase in non-employment income plus a shift to service-sector jobs runs parallel to the historic decline in lumber related manufacturing jobs. This represents a broad shift in the structure of the US economy that has also played out in coastal Oregon, as can be seen by the employment statistics here, and by the personal income analysis presented below.

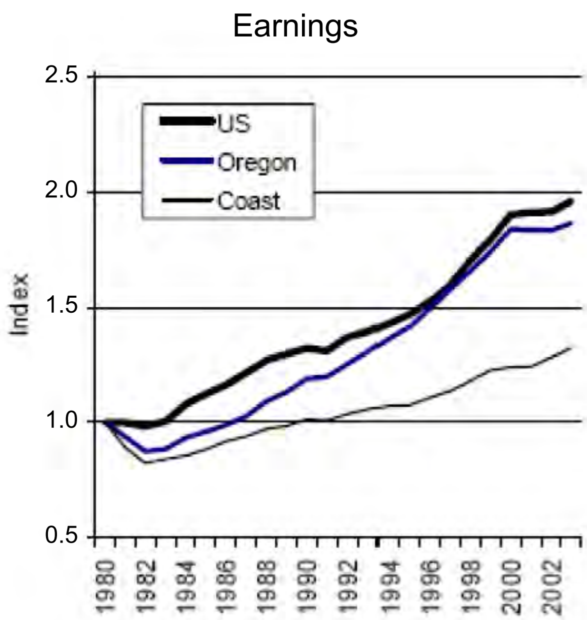
Figure 2.



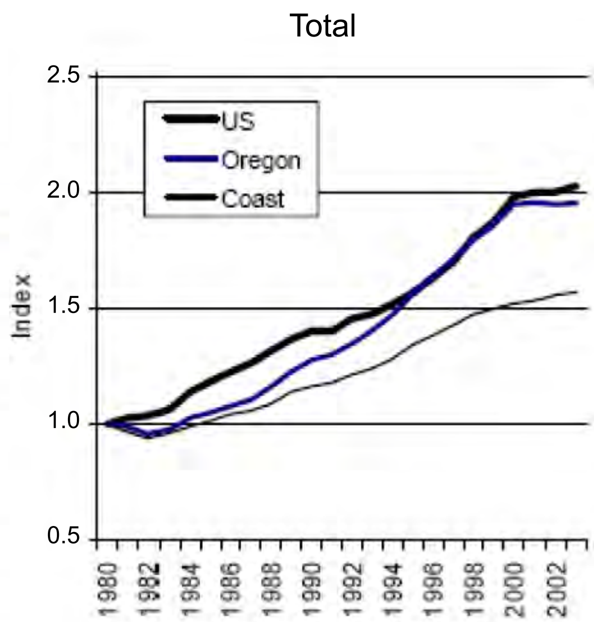
Notes: Investments include dividends, interests, and rent.



Notes: Transfers are payments to persons for which no current services are performed, and include such disbursements as retirement, disability insurance, unemployment insurance, veterans benefits, and student loans.



Notes: Earnings are wages, salaries, and proprietor income by place of residence.



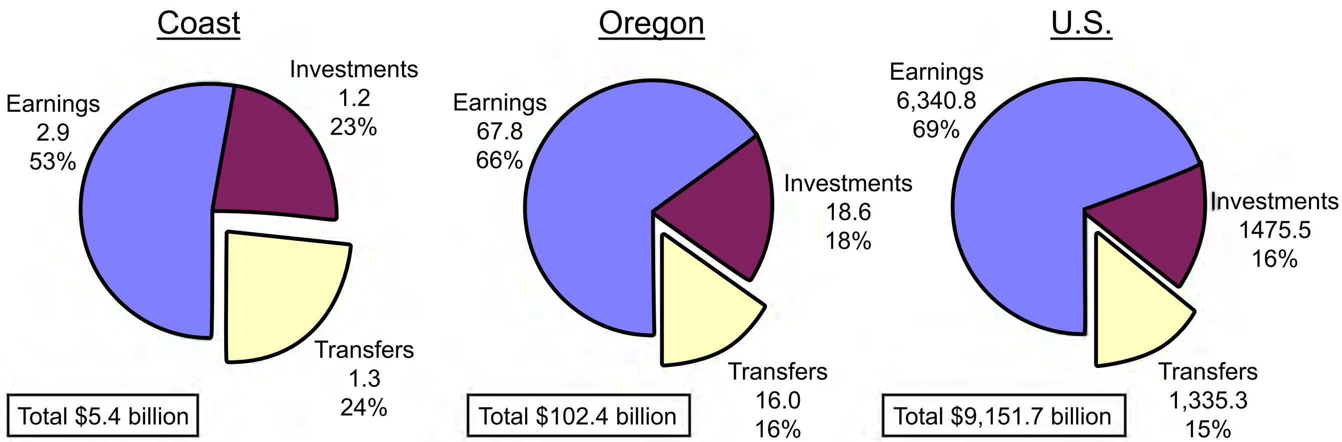
Notes: Total personal income is the sum of investments, transfers, and earnings.

Notes:

1. Personal income adjusted to Year 2003 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Oregon Coast includes Clatsop, Tillamook, Lincoln, Coos, and Curry counties.

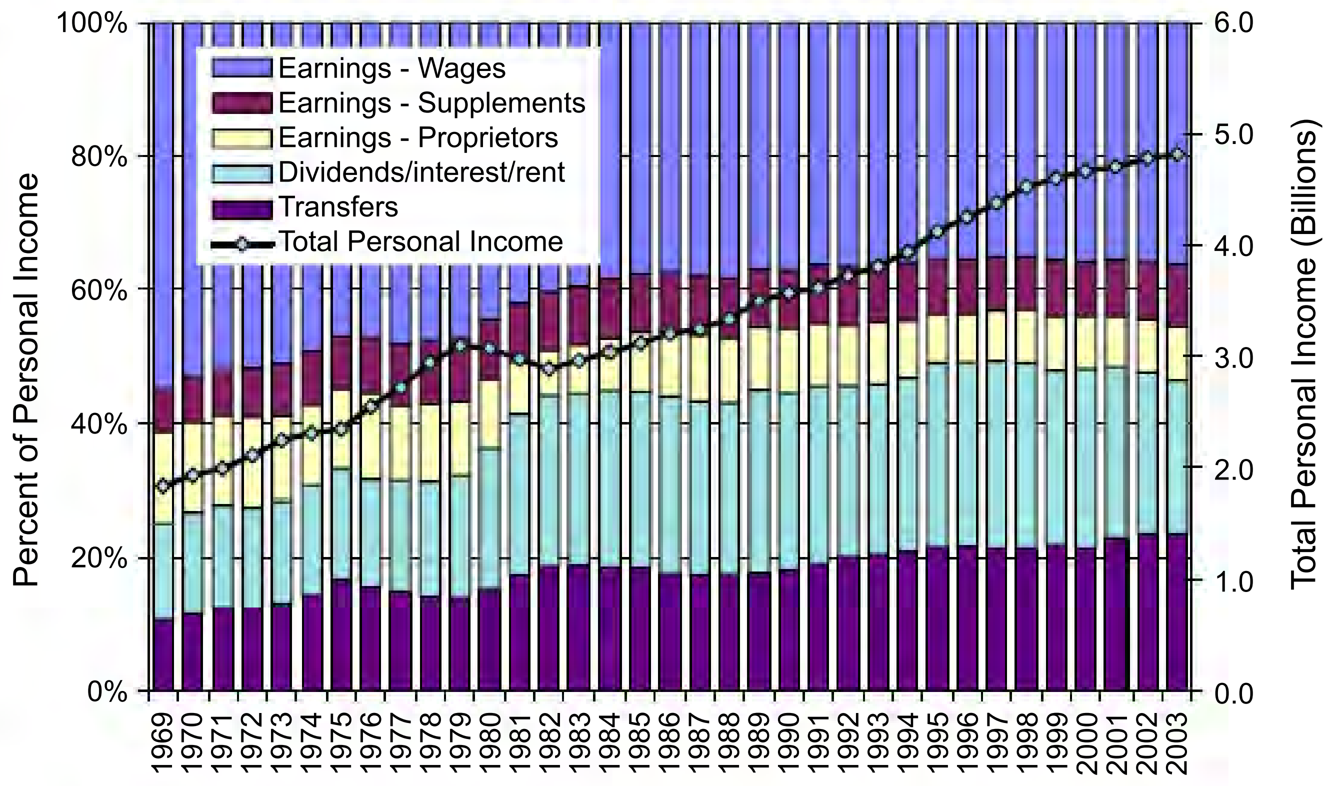
Source: U.S. Bureau of Economic Analysis

Figure 3. Sources of Personal Income to the Coast, Oregon, and U.S. in 2003



Notes: 1. Coast includes Clatsop, Tillamook, Lincoln, coastal portions of Lane and Douglas, Coos, and Curry counties.
Source: U.S. Bureau of Economic Analysis and Study.

Figure 4. Totals and Shares in Sources of Total Personal Income for the Oregon Coast in 1969 to 2003



Notes:

1. Total personal income in billions adjusted to Year 2003 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
2. Includes Clatsop, Tillamook, Lincoln, Coos, and Curry counties.
3. Components of earnings by place of residence estimated using components of earnings by place of work.

Source: U.S. Bureau of Economic Analysis

Per capita income is an indicator most tracked for showing economic well-being. It is the total of income from all sources—wages, interest earnings, dividends, business profits, and transfer payments like welfare, unemployment compensation, and retirement—divided by the total population. The per capita net earnings in the coastal counties are well below per capita net earnings at the State or national level. However, the gap has been decreasing in recent years (Figure 5).

The personal income component for wages, largely comprised of the amount the average worker earns, is less along the Coast than in Oregon[1]. Measured in real 2000 dollars, the average Coast worker earned about $24,112; the average Oregon worker earned $32,776.

A significant factor in the comparison of wages has been the rapid growth of employment in lower wage service sector jobs. However, personal income is highly correlated with education level. Coastal counties have fewer people with college or graduate degrees than the rest of the state, thus educational attainment may also be part of the explanation for why personal income levels are lower on the coast than statewide (see above).

In addition, coastal Oregon does not have large cities. Wages per worker are correlated with city size (Power and Barrett, 2001). Thus, average wages statewide are going to be affected significantly by Portland and other cities that are larger than coastal towns and pull average wages up. When cost of living is factored into a comparison of wages by city size, the difference in "buying power" diminishes almost to zero (Power and Barrett, 2001, p. 112). A greater fraction of the population is earning wages now than in previous years. In other words, today there are more workers per capita than ten years ago. This increase in workers per capita has helped offset the decline in wages per worker relative to household well-being.

Income inequality statistics can be misleading when averages are used as indicators. A few households in very high income brackets can mask the effects of many households in lower income brackets. The income brackets by county are shown in Table 4. All coastal counties have far fewer households in the highest income brackets than the State. Coos and Curry counties have the highest proportion of households in the lowest income bracket.

Another indicator which shows that coastal counties are skewed towards lower household incomes than the State is the proportion of people living below poverty level. The proportion in coastal counties is 13.6 percent, compared to the State's 11.6 percent in 2000. A comprehensive accounting of Oregon's poverty data, causes, and assistance programs can be found in Oregon Housing and Community Services (2004).

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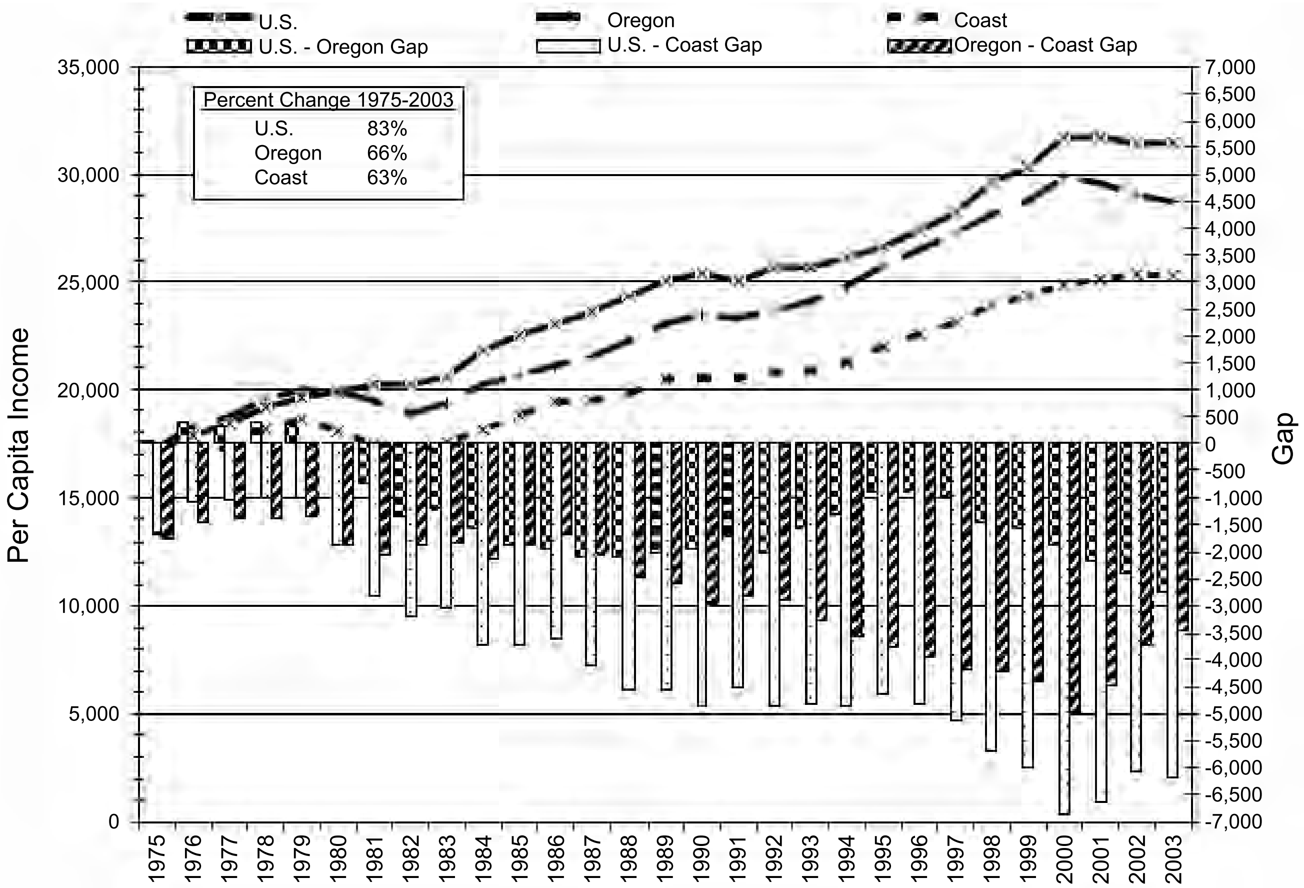
1 Real wages are the average wages for all workers adjusted for inflation. The data for this calculation are drawn from payroll tax data collected by the Oregon Employment Department. The average wage is the sum of all wages for all covered workers divided by the average number of workers each year. Wages are adjusted for inflation by dividing the actual average wage for each year by the change in the cost of living as measured by the GNP implicit price deflator calculated by the U.S. Bureau of Economic Analysis. Neither the self-employed, agriculture, nor the fishing work force are specifically included in payroll income.

The net earnings component of total personal income includes more than just wages and salaries. It also includes proprietor earnings. Wages and salaries typically are three quarters of net earnings, proprietor earnings are one fifth, and the balance is employer contribution to pensions. The share of net earnings that are proprietor earnings are generally higher at the Coast because there are more business units per employee than in the State.

Figure 5. Coastal Counties Income Maintenance in 1978 to 2003



Notes:

1. Per capita income is average annual per capita personal income. This includes household income from all sources (net earnings, investments, and transfers) divided by population.
2. Dollars adjusted to 2003 using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis
3. Coastal counties are Clatsop, Tillamook, Lincoln, Coos, and Curry.

Source: U.S. Bureau of Economic Analysis; data adapted by The Researh Group (2006)

Table 4. Household Income Distribution by County in 1999

Median Household			Income				Income Distribution			
Area Name	Household Income	Households	Less than $15,000	$15,000 to $74,999	$75,000 or more	$100,000 or more	Less than $15,000	$15,000 to $74,999	$75,000 or more	$100,000 or more
Clatsop	$36,301	14,741	2,709	9,959	2,073	946	18.4%	67.6%	14.1%	6.4%
Tillamook	$34,260	10,214	1,914	7,157	1,143	548	18.7%	70.1%	11.2%	5.4%
Lincoln	$32,769	19,352	3,675	13,285	2,392	1,071	19.0%	68.6%	12.4%	5.5%
Coos	$31,542	26,181	5,929	17,459	2,793	1,251	22.6%	66.7%	10.7%	4.8%
Curry	$30,117	9,554	2,198	6,438	918	456	23.0%	67.4%	9.6%	4.9%
Coast	$32,893	80,042	3,833	12,438	2,129	968	20.5%	67.8%	11.6%	5.3%
Oregon	$40,916	1,335,109	201,824	870,422	262,863	133,375	15.1%	65.2%	19.7%	10.0%

Source: U.S. Census Bureau

Lagging wages contribute to the problem of affordable housing along much of the Coast. Many coastal residents are unable to secure affordable housing adequate to their needs as the demand for coastal second homes makes homes and rentals too expensive for many people to afford. This lack of affordable housing in turn makes it more difficult for employers to attract and retain workers in occupations such as trade and service workers. This is especially true for businesses oriented towards the tourism industry. Figure 6 shows housing stock as a proportion of total that are second homes. Plus, the constrained land/geography of the coast along with increased construction costs complicates the provision of affordable housing. Figure 6 indicates that a sizeable percentage of coastal homes, particularly in the north half of the coast, are owned by non-residents. High cost per square foot non-residential construction competes with full time residents' need for new housing construction.

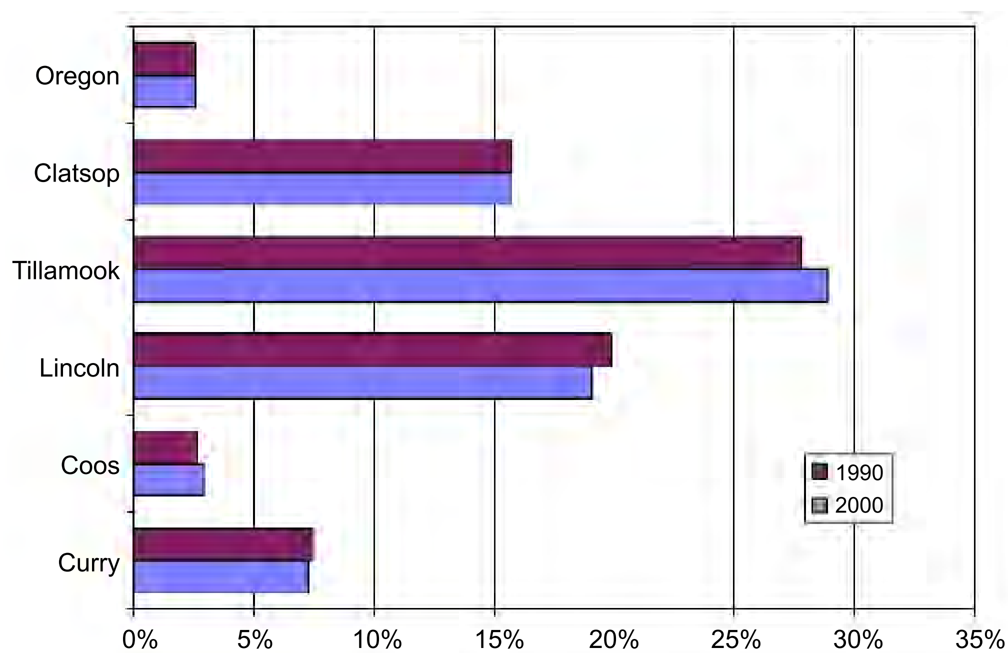
Understanding the Coastal Economy: Jobs, Economic Sectors and Income

Introduction

The following is a summary of an economic base analysis for five coastal counties and the coastal portions of Lane and Douglas Counties.

Economic base analysis was used by The Research Group (2006) to describe the coastal economy. The theory behind economic base analysis, also known as export base sector analysis, is that some parts of local and regional economy (called sectors) produce goods and certain services which are "exported" to other areas in exchange for cash. On the coast, these sectors traditionally have

Figure 6. Second Homes as a Percent of Total Housing Units for Oregon and Coastal Counties in 1990 and 2000



been the timber industry (saw timber production), commercial fishing, agriculture (dairy), and lumber manufacturing. Cash generated by these sectors in the form of business profits and pay to employees is then used to fuel other economic activities, support services (lawyers, family doctors, real estate agents), and retail stores.

The idea behind base sector theory has been that if exporting sectors shrink, the rest of the economy will suffer. In western states, including both the Pacific Northwest and the Mountain West, base sector theory is often interpreted to mean that natural resource sectors are the only ones driving economic vitality and, as these sectors shrink in significance, the entire regional economy suffers. Analyses of these regions though have shown that the linkage between natural resource-based "exports" and the overall health of regional economies does not often hold and that many other factors are at play (e.g., Power 1996; ECONorthwest, 1999; Power and Barrett, 2001). These new economic interpretations of the modern western economy include the notion that other sectors, such as business services and financial services, in addition to natural resources, generate local primary income. Additionally, economic vitality is often maintained in rural areas through the inflow of new people who are drawn to areas with high amenity values, including high environmental quality.

The idea that some sectors of regional economies generate income from outside the region and are therefore responsible for other local economic activity still is a valid approach to regional economic analysis. Such is the theory behind the data that is summarized here. The results set the stage for our complimentary analysis exploring the economic context of natural resource industries and the role that ecosystem services play in the overall economic welfare of the coastal region.

For this analysis, The Research Group adopted seven sectors that are thought to represent means of generating income by exporting products to outside the region, or by drawing people from outside the region for services provided within the region. These sectors are: commercial fishing,

Photo by Ben Nieves

timber, agriculture, tourism, "other identified export based industries," "other earned income," and "non-earned income." All other business activity is assumed to be dependent on these "export" sectors (The Research Group, 2006, p.III.2). The "other identified export based industries" sector includes four sub-sectors: water transportation and marine cargo; paper and paperboard mills; ship building, steel fabrication, and other construction; and other identifiable components such as government, research, communication, special education, and military. The "other earned income" sector contains several unique businesses found on the Oregon Coast which cannot be identified due to data confidentiality and/or data specification issues. Other earned income is a residual calculation after accounting for the other five earnings sectors multiplier effects. The non-earned income sector is composed of transfer payments and investment earnings. The economic base model was developed to generate estimates of the seven basic sectors' direct, indirect, and induced income at the county level. Wages and profits are the ***direct impacts***; purchases made with wages and profits are ***indirect impacts***. As workers and owners in non-export sectors receive wages, salaries, and profits from these expenditures, they spend money for a variety of goods and services in the general economy. The resulting consumer sector income amounts are the ***induced impacts***. The sum of these impacts is the *total personal income impact*.

The model was derived from an economic input-output methodology. The economic analysis used Year 2003 county-level personal income released by the federal Bureau of Economic Analysis (BEA).

Detailed Economic Sector Descriptions and Trends

The adopted sectors were chosen because they had high export qualities, i.e. brought "outside" money into the Coast. The major points for making the economic contribution calculation are as follows: (For a more detailed description of the model, see The Research Group, 2006).

The seven sectors are:
1. Commercial fishing
2. Agriculture
3. Timber
4. Tourism
5. Other export based industries
6. Other earned income
7. Non-earned income

The other export industry sector consists of these components:
- Paper and paperboard mills
- Water transportation and marine cargo handling
- Boat and ship building, steel fabrication, and other heavy construction
- Other identifiable industries (state and federal government, research facilities, communication, special education, and military)

Other earned income is a residual calculation after accounting for the other five earnings sectors' multiplier effects. The non-earned sector includes transfer payments (Social Security, etc.) and investment (dividend, interest, and rent) income.

• Each of the seven sectors, with the exception of non-earned income, involves the exchange of locally produced goods or services for income from sources outside of the regional or local economies. Again, this is what is meant by “export base sectors.” Transfer payments and investment incomes are the geographic movement of income that are not directly attributable to goods or services provided. The transfer income components of social security and Medicaid represent a socially sponsored redistribution of income based on cultural values that the elderly, the infirmed, and the sick deserve to live in dignity.

• An input/output model called IMPLAN was used to derive personal income response coefficients. Input/Output models are a means of keeping track of how inputs to industries, exchanges between industries, and final demand by consumers affects a variety of variables in the economy. One of the variables that can be studied is total personal income. Personal income response coefficients represent the amount of local personal income directly and indirectly generated from an increase in sales. The coefficients were applied to production measurements for the five earnings sectors. The non-earned income sector was calculated to have a 1:1 multiplier effect in order to account for total personal income.

• Total personal income for each county, provided by the U.S. Bureau of Economic Analysis, is the standard to which each sector’s contribution is compared.

• The Oregon coastal area includes coastal portions of Lane and Douglas counties. For Lane and Douglas counties, which include important coastal cities as well as inland areas, basic sector production in the coastal portions of the two counties is expanded using multipliers from Lincoln and Coos counties, respectively. These multipliers should more closely apportion income in the coastal areas, rather than the whole Lane and Douglas multipliers.

The impacts estimated in this study are effects on total personal income: the amount that is retained as household income (salaries, wages, and proprietary income). It is important to keep in mind that the “equivalent job” figures described for each economic sector represents the number of jobs assumed to be supported by the sector’s total income divided by an average wage or salary for the coast (we use $27,500) and also those jobs generated by the indirect and induced effects of the export sector. For example, when a sector’s personal income impact is said to be the equivalent of 16,600 jobs, as in the timber sector described below, this includes non-timber jobs that result from money flowing from direct timber-related activities. This is what is known as the “multiplier effect.” It is also important to remember that some sectors, like fishing and tourism, have many part-time jobs. Thus, an equivalent job represents a full-time position, but in reality that “full time equivalent” may be split among two or more part-time positions.

Results

The amount of personal income generated by each sector is summarized in Figure 7, which shows total personal income by each of five of the seven counties, and for all seven coastal counties as a whole. Trends in each sector are then described.

Commercial Fishing Sector

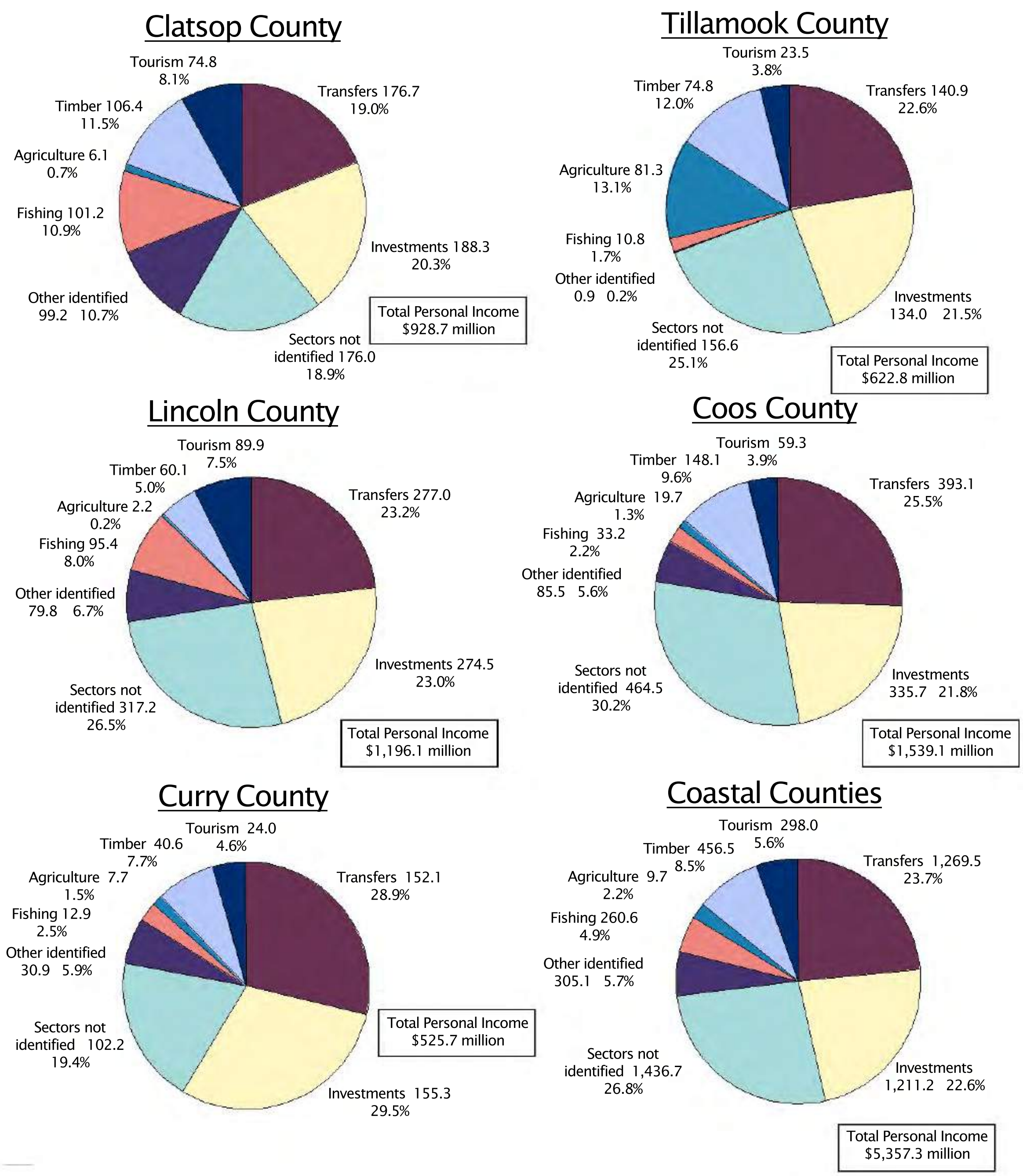
The commercial fishing industry, not including aquaculture and the distant water fleet, account for 3.6 percent of total personal income in the Coastal region. Total personal income in 2003 of $194 million translates into 7,054 full-time equivalent jobs at an average coastal wage of $27,500. Aquaculture and the distant water fleet bring in an additional $66 million, or the equivalent of 2,400 jobs. The addition of the distant water fleet and aquaculture bring total fish-related income to 4.9% of total personal income in the coastal economy. For the fishing industry, this probably means that there are more part-time jobs, some of which would pay more and others pay less than the average full-time equivalent wage.

Three current developments are affecting the potential contribution this industry can make to the coastal economy. First, increasing global supplies of all fish products have decreased the real per pound ex-vessel price for salmon, shrimp, and crab during the years 1991 through 2003. Second is the crisis facing the salmon industry, and third, and more recently, the restriction or closure of the groundfish industry. Because of unfavorable ocean conditions, inland freshwater habitat decline, and multiple demands for the harvest rights of the salmon resource, the availability of salmon for commercial ocean harvesting has declined steadily along the Oregon and Washington Coast. Although there has been an increase in salmon prices (prices for other species have continued to decline), the closure of the salmon fishery due to the Klamath River water crisis and low returns are of special concern to the Oregon salmon industry. Some stocks may be experiencing a modest population recovery, however the management restrictions to protect Klamath River stocks may not allow "access" to the more abundant species. Currently 24 Northwest Salmon and trout stocks are listed as threatened or endangered under the federal Endangered Species Act (ESA). Decreased abundance and resilancy, in addition to ESA listings in California, have resulted in a reduced ocean troll harvest to just a fraction of historic levels.

Photo by Ben Nieves

It must also be mentioned that the absolute abundance of coastal salmon stocks experienced a 100 year decline during the 20th century. At the same time, the inability of hatcheries to provide a long-term alternative to natural salmon production became clear under El Nino driven down-turns in ocean productivity. Habitat decline, hatchery failure, and over-harvest all account for a distressed

Figure 7. Share of Total Personal Income Sources for Identified Sectors by Coastal County in 2003



Notes: 1.Total personal income expressed in millions of dollars.

2. Graphs for coastal Lane and Douglas counties are not displayed, but analysis results are included in the coastal counties summation graph.

Source: The Research Group (2006).

Table 5. Sources of Personal Income for Identified Sectors in 2003

	U.S.		Oregon		Clatsop		Tillamook		Lincoln		Coastal Lane		Coastal Douglas		Coos		Curry		Coastwide	
	Income	%	Income	%	Income	%	Income	%	Income	%	Income	%	Income	%	Income	%	Income	%	Income	%
Total Personal Income	9,151,694.0	100%	102,418.8	100%	928.7	100.0%	622.8	100.0%	1.196.1	100.0%	398.5	100.0%	154.1	100.0%	1,539.1	100.0%	525.7	100.0%	5,355.9	100.0%
Net Earnings	6,340,842.0	69%	67,825.2	66%	563.6	60.7%	348.0	55.9%	644.6	53.9%	214.7	53.9%	75.4	52.5%	810.3	52.6%	218.3	41.5%	2875.9	53.7%
Commercial fishing					89.2	9.6%	6.1	1.0%	54.8	4.6%	1.1	0.3%	2.5	1.7%	28.0	1.8%	12.2	2.3%	194.0	3.6%
Distant water and fish meal					12.0	1.3%	1.2	0.2%	39.7	3.3%	1.5	0.4%	1.9	1.3%	2.1	0.1%	0.7	0.1%	59.1	1.4%
Aquaculture					0.0	0.0%	3.5	0.6%	0.8	0.1%	0.0	0.0%	0.1	0.1%	3.1	0.2%	0.0	0.0%	7.6	0.1%
Agriculture					6.1	0.7%	91.3	13.1%	2.2	0.2%	1.6	0.4%	1.0	0.7%	10.7	1.3%	7.7	1.6%	110.7	2.2%
Timber					106.4	11.5%	74.8	12.0%	60.1	5.0%	13.7	3.4%	12.8	8.8%	148.1	9.6%	40.0	7.7%	456.5	8.5%
Tourism					74.8	8.1%	23.5	3.8%	89.9	7.5%	19.2	4.8%	7.2	5.0%	59.3	3.9%	24.0	4.6%	298.0	5.6%
Other indentified industries																				
Paper and paperboard mills					41.3	4.4%	0.0	0.0%	60.3	5.0%	0.0	0.0%	0.0	0.0%	25.3	1.6%	0.0	0.0%	126.9	2.4%
Water transportation and marine cargo					7.4	0.0%	0.0	0.0%	0.7	0.1%	0.0	0.0%	0.0	0.0%	50.9	3.3%	0.6	0.1%	59.6	1.1%
Ship building, steel fabric., other heavy constr.					43.7	4.7%	0.0	0.0%	0.8	0.1%	0.0	0.0%	5.3	3.5%	8.0	0.5%	0.1	0.0%	57.9	1.1%
Other identifiable (govt., research, comm., special ed., military)					6.9	0.7%	0.9	0.2%	17.9	1.5%	1.2	0.3%	2.3	1.6%	13	0.1%	30.2	5.8%	60.7	1.2%
Subtotal identified industries					387.7	41.7%	191.4	30.7%	327.4	27.4%	38.4	9.6%	38.1	22.8%	345.8	22.5%	116.1	22.1%	1,439.9	26.9%
Other not identified					176.0	18.9%	156.8	25.1%	317.2	26.5%	176.3	44.2%	48.3	29.8%	464.5	30.2%	102.2	19.4%	1,436.0	26.8%
Investments	1,475,529.0	16%	18,634.0	18%	188.3	20.3%	134.0	21.5%	274.5	23.0%	91.5	23.0%	31.0	21.8%	335.7	21.8%	155.3	29.5%	1,210.9	22.6%
Transfers	1,335,323.0	15%	15,959.6	16%	176.7	19.0%	140.9	22.6%	277.0	23.2%	92.3	23.2%	37.1	25.5%	393.1	25.5%	152.1	28.9%	1,269.2	23.7%
Total Employment	127,795,027		1,580,725		15,096		6,030		16,509						22,289		8,461			
Unemployment Rate	6.0		8.1		7.0		6.0		8.0						8.7		7.2			
Per Capita Personal Income	31,472		28,734		25,801		25,210		26,872		25,057		23,504		24,380		24,228			
Population	290,788,976		3,564,330		35,993		24,705		44,846		15,902		6,174		63,130		21,697		212,447	

1. Personal income in millions of 2003 dollars
2. Personal income generated by identified sectors includes direct as well as indirect and induced income. The economic sectors dependent upon the identified sectors, such as retail, and service businesses are included in the identified sectors. This means the "multiplier effect" is included.
3. Investment and transfer personal income is only direct income, although research shows that the multiplier effect is approximately one for both of these sections.
4. Population is from U.S. Bureau of Economic Analysis estimates.
5. Total employment includes covered payroll.
6. For coastal Lane and Douglas counties, the ratio of coastal county to county per capita personal income from census information in 2000 was applied to county per capita personal income from U.S. Bureau of Economic Analysis information in 2003 to determine coastal county per capita personal income in 2003. Coastal county total personal income in 2003 was based on population estimates developed using Census 2000 zip code data adjusted using the PSO rate of growth between 2000 and 2003 for the cities of Florence and Reedsport. The shares of earnings, investments, and transfers from adjacent counties are used as a proxy.

Source: The Research Group (2005). U.S. Bureau of Economic Analysis, Bureau of Labor Statistics, Census Bureau, and Portland State University Population Research Center (PSU).

commercial salmon fishery on the coast.

Because of reduced salmon harvests, Oregon coastal areas have experienced an annual personal income loss from averages of about $110 million per year (1976-1990 average) to less than $10 million in the early 2000's. This is a reduction of about 90 percent in average fishing related personal income derived from salmon for coastal counties in 2000. Small ports along the coast have historically relied upon the salmon trolling industry to generate local income and to support vital services such as local marinas and have used the local fishing industry to justify dredging operations by the U.S. Army Corps of Engineers.

Several species of rockfish have experienced sharp population declines in recent years. This prompted the states and NOAA-Fisheries to drastically curtail groundfish harvest in order to rebuild stocks. Harvest of groundfish in some ports along the West Coast has been reduced by over 50 percent. This has a large impact on remaining commercial fishing activity.

Agriculture

Agriculture in the coastal economies is part of the lifestyle for many coastal residents and adds diversity to the local economy. It also helps provide a buffer to the sometimes cyclical nature of the forest, fishing, and recreational industries. The mild coastal climate is ideal for vegetable, berry and nursery crops. Livestock production for meat and dairy are important sources of income for Tillamook, and to a lesser degree Coos and Curry counties. Tillamook County is the primary producer of milk in the State, and much of it is used in cheese manufacturing. The agricultural industry has remained consistently strong in Tillamook County, and is continuing to change and diversify. The Tillamook Creamery has purchased the Bandon Cheese factory operations and has expanded its dairy operation to eastern Oregon (Pacific Northwest Cheese Project 2005).

The value of agricultural production in Oregon in 2003 was $3.5 billion. Of this, Tillamook County produced $90.3 million in sales (2.6 percent of the state). The coastal share of Oregon's agriculture income was $120 million in 2003. Most of this $81 million was in Tillamook County and was generated by the dairy and dairy processing sectors of the industry. There are no expectations that climate and ecological considerations will allow this industry to expand further. There are nursery stock business opportunities that have not yet been capitalized by coastal businesses.

Timber

The trend in timber harvests since 1970 for the coastal counties has been a gradual decrease in harvests from about 1.8 billion board feet (bbf) in the 1970's to about 1bbf in 2003. All coastal counties, especially Coos County, have experienced cyclical harvests, depending on national demand patterns for fiber and the local availability of timber. However, the harvest volumes in these areas have generally declined since the 1980's. Much of these counties' timberlands are in private ownership, except Tillamook, where over two thirds of the timberlands are in federal or state ownership. Stumpage prices have increased as final product prices have increased, therefore transportation costs have become a smaller part of final manufacturing costs [automation, not haul costs, have concentrated mill capacity]. Mills are willing to expand their timbershed boundaries. This has resulted in a dramatic reduction in processing capability on the Coast. Most timber in Oregon is now shipped to the major processing centers of Roseburg, Eugene, Albany, or the

Portland area.

The timber grown, harvested and processed in Oregon's seven coastal counties produced an estimated $457 million in total personal income; this is equivalent to about 16,600 annual jobs, again at an average salary for the coast, and assuming full-time employment. Some jobs are part time, and some jobs – like tree planting, pay substantially less than the average. It is also important to remember that these "jobs" include the indirect and induced economic activity that is not direct employment in the timber industry. However, the largest portion of this income and annual jobs is generated by logging and harvesting.

Tourism

Tourism is experiencing a steady growth in coastal economies. The growth of tourism has served to diversify coastal counties' economic bases, but this industry is characterized by low wage rates and seasonal demand for jobs. These characteristics do not assist in ameliorating seasonality effects from the other natural resource based industries.

Wages and salaries in travel related industries totaled $363.8 million for the coastal counties in 2003. In terms of full time equivalent jobs (at $27,500 per year salary), this is equivalent to 13,200 annual jobs in the tourist industry. After correcting for sales to in-area residents, the total estimated personal income generated by the tourist-oriented industries is $298 million (or about 10,800 jobs).

The results for this sector require some caveats. Proprietorships make up a large portion of businesses in the tourism sector. The IRS has recently analyzed the size of systematic underreporting for all income tax sources. Non-farm proprietorships have an underreporting rate of 57 percent (IRS, 2006), indicating that a substantial amount of income to this class of businesses does not get recorded in accounts that feed into input/output tables. If these national figures apply on average to the Oregon coastal economy, then it is very possible that the tourism industry makes a larger contribution to the coastal economy than The Research Group was able to capture in its models. This result would shrink the "other non-identified" sector as those businesses became identified as part of the tourism sector. This should be an area of future research as it has important implications for the structure of the economy and an understanding of the importance of environmental amenities in supporting the economy.

Other Identified and Unidentified Export Based Industry

The "other identified" sector accounted for $305 million or 5.7 percent of total personal income. This translates into an equivalent of 11,094 jobs. Included in this category again are paper and paperboard manufacturing plants, marine cargo and water transportation, ship-building, steel fabrication, heavy construction, government research, special education, and military, among others.

The residual, not identified category accounted for $1.43 billion of total personal income to the coastal counties, or 26.8 percent on average (the indirect and induced effects of investment income and transfer payments are included in this calculation). This translates into an equivalent of 52,280 average full time job equivalents. For some coastal areas, many small manufacturing and service companies export their product. Such industries as plastic wedge manufacturers, plastic water tank manufacturers, computer hardware and software developers, writers, and artists sell products outside the coastal area and bring income back to regional economies for spending. Such small industries are important when summed together. However, they are too dispersed to be identified in this study (The Research Group 2006).

Other observations about businesses represented in this sector deserve mention.

• Paper and Paperboard Mills. More than 60 percent of processed paper is from recycling supplies and the share is expected to grow. The locational advantage of the Coast is for offering a waste sink, or a place for dumping pollutants into the ocean or coastal river) and not for offering wood fiber. This has implications for maintenance of other ecosystem services important to the coastal economy.

• Waterborne Commerce. There should be no expectations for a turn-around in industry needing Oregon Coast waterborne commerce facilities. For example, the recent interest for liquefied natural gas facilities in Astoria may be transient. The forecast is for the nation to only need three or four new facilities and a couple of those are replacement for inadequate existing locations. Energy prices in the northwest are a disincentive for producing electricity using natural gas.

Transfer Income

There has been a dramatic increase in transfer payments as a percent of total personal income. This is partially a function of the increase in retirees collecting Social Security payments. Transfer payments and returns from investments range from 39 to 58 percent of the total personal income in coastal counties. This compares to about 35 percent in Oregon and about 31 percent for the U.S.

The growth of non-earned or previous generational income, particularly from retirement, represents a major source of purchasing power in rural areas. The in-migration of retirees to Pacific Northwest coastal areas has helped increase investment income and transfer payments from nine to 28 percent higher share in Oregon coastal counties than for the U.S. These higher percentages may be viewed as the "immigrant retiree effect." Figure 8 shows the contribution of this effect.

Summary

Tracing personal income sources in the coastal areas shows that natural resource based industries such as commercial fishing, agriculture, and timber continue to be important contributors to coastal communities. The contributions from these industries to each of the counties' economy for the year 2003 were shown in Figure 7 and described in Table 5 above. Fishing (including oyster culture) makes up as much as 11 percent of the total personal income of coastal residents in such areas as Clatsop County. Agriculture makes up as much as 13 percent in Tillamook County. The timber industry contributes five to 12 percent of personal income in the seven counties on the Coast. Coos County has pulp and paper mills (pulp and paper is Other Export Based Industries), marine transportation sectors, and sizable ship building sectors. These identified sectors contribute up to 11 percent to these counties. All of these industries function as a result of extraction and alteration of natural ecosystems.

Tourism is also a significant contributor to coastal areas, contributing as much as eight percent of total personal income in Clatsop and Lincoln counties, according to our analysis, and given the likely underreporting of income in this sector, may actually contribute more. This industry can be said to be dependent on natural resources, but it is more dependent on intact natural landscapes, clean beaches and access to those beaches, and abundant fish and wildlife to watch. This different type of dependency becomes important when we talk about environmental quality and "ecosystem services" in the next section.

Since the 1980's, personal income generated by the timber and fishing industries has declined for various reasons. Some of these reasons are decreasing availability of natural resource for harvests, automation and industrial consolidation within the lumber sector of the wood products industry, new social demands to use natural resources for recreation and habitat preservation (what we call investments in natural capital, see discussion below), and in the case of fish products, decreasing real prices. The changing demographic of coastal areas has also led to a shift in income and employment opportunities. As the population of coastal counties has continued to age in the last 20 years due mainly to in-migration of retirees, income from transfer payments has risen, and the percent of total personal income that is earned in the current generation (i.e., employee compensation and proprietor income) has fallen. The relative importance of natural resource based industries as a source of income has declined as other industries have increased.

Other industries had a higher impact on personal income than any one natural resource-based industry. The fact that small businesses and manufacturers make up almost 32 percent of total personal income indicates that the coastal area provides a suitable environment that attracts industry, entrepreneurs, and artists. This is an important trend that adds to the diversification and stability of the coastal economy.

As was discussed and illustrated in the demographic section above, transfer payments as a percent

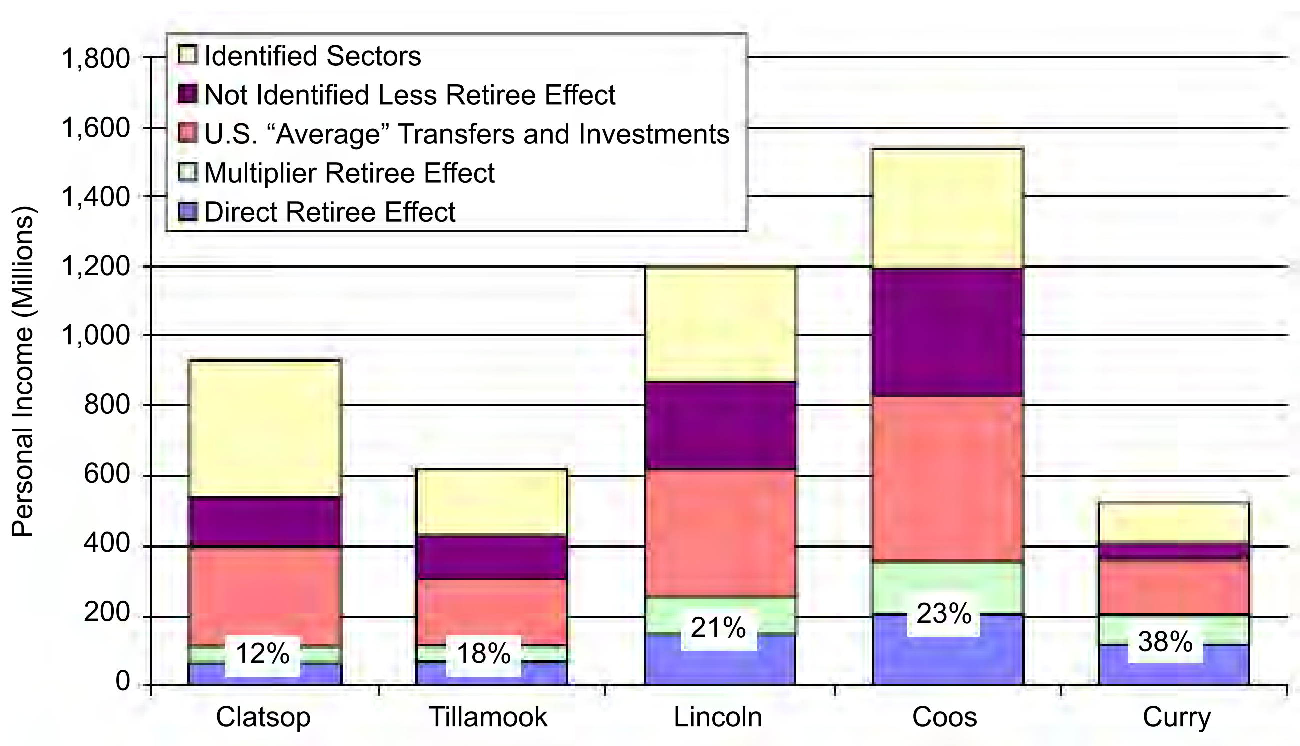
Photo by Ben Nieves

of total household and individual personal income are relatively larger than the rest of Oregon and have increased over time (see Figures 3 and 4 above). This is partially a function of the increase in retirees collecting Social Security payments in these areas. While total personal income has increased, the share of total personal income that is earned (i.e., employee compensation and proprietor income) has remained about the same (see Figure 4 above). This trend suggests a substantially different set of public policy implications for the coastal region than if natural resource extraction still dominated the economy. We say this because the quality of life and environment are large factors that attract people to the coast—these people bring transfer payment income with them. We discuss this further below.

Retirement income in coastal counties is related to income earned earlier by residents. It is either income of residents electing to stay during their retirement years or it is income that is transferred to the coastal areas by retiree aged people moving to the Coast. The in-migration of retirees has helped increase coastal counties' total personal income. It is difficult to identify the income amount using traditional data sources. It can be assumed that it is mostly from the non-earned BEA categories of transfer payments and investments, but households comprised of non-retirement aged people also have some income from these sources.

The growth of non-earned income, particularly from retirement programs, represents a major and increasing source of purchasing power in many coastal areas. Coastal areas that capture an increasing share of the retirement related income, which accompanies a net in-migration of retirees, can stimulate employment and incomes by increasing local spending. It may be that these year-round residents foster economic and employment stability.

Figure 8. Retiree Effect Economic Contributions in 2003



Notes:

1. Retiree effect assumes half of purchases for selected personal need items are made out-of-area.
2. The shown share of total personal income includes direct and multiplier retirement effect.
3. Retiree effect is an index and does not represent total economic contribution from retirement age residents' spending.

Source: Study.

An Ecological Economics Approach to the Oregon Coastal Economy

Introduction

Once, there seemed to be no limit to the forests, fish and land of Oregon. Only a lack of people, nets and boats held back increasing fish production. Today, we are no longer short of human produced nets and boats, we are short of fish, a natural economic good produced by healthy marine and freshwater ecosystems. The previous discussion of decline in the coastal fishery illustrates this point.

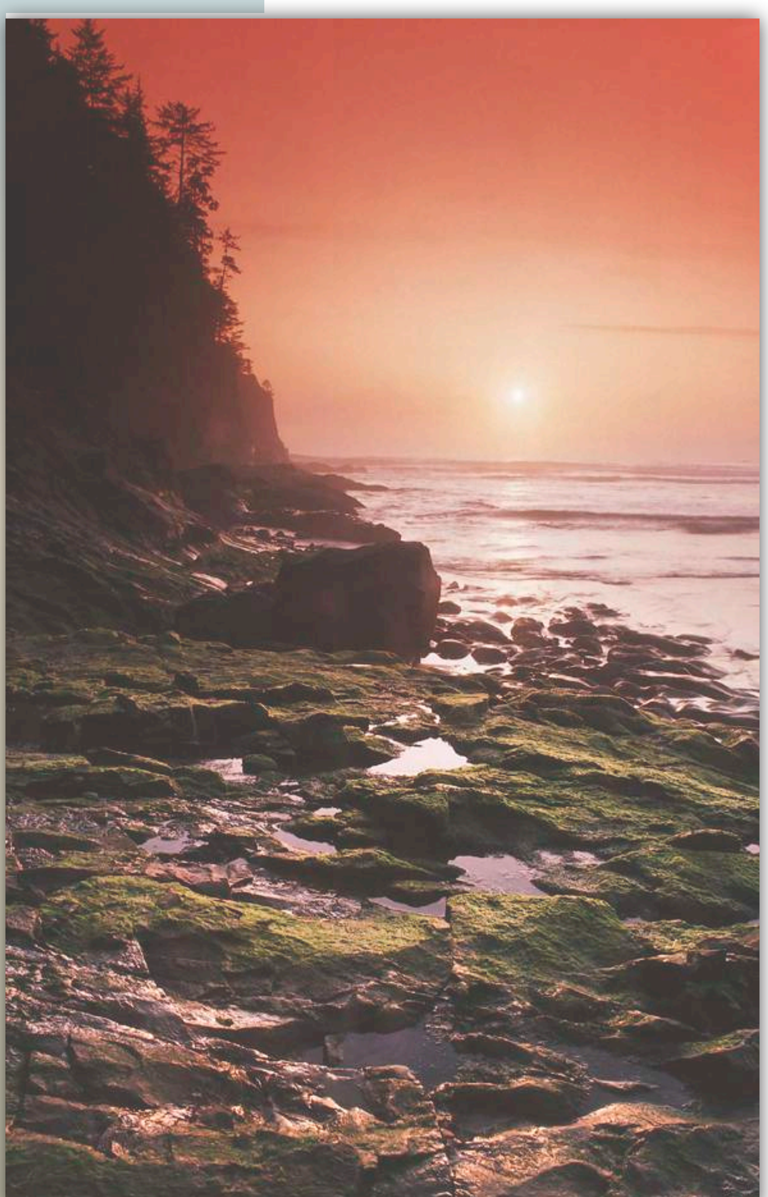


Photo by Ben Nieves

Ecological economics examines the relationship between ecosystems, the economy, and human well-being. It is arguably one of the fastest growing areas within the field of economics. Gaining a better understanding of the vital economic contribution of ecosystems to our economy is crucial for several reasons. First, coastal ecosystems are tremendously productive and contribute a large number of economic values to the coastal economy. Second, although the coastal forests, rivers, and marine ecosystems have been impressively bountiful, they all have limits to the bounty they can produce. Appreciating the limits to natural systems and figuring out the proper economic relationship of people to those limits is what ecological economists mean by the word **scale**. Ecological economic scale is simply being sensitive to the proper relationship and ratio between how much we use or take from a system relative to how much wear and tear the system can absorb. Third, all economies in general, and the coastal economy in particular, have a complex system of ownerships, markets, productive organizations, and governments that determine who is to receive the benefits of the economy and who is to pay the costs of production.

Traditionally, when economists look at the overall organization of an economy they then ask many questions about efficiency. However, for many decades, economists did not ask questions about the costs and benefits of degrading the environment (natural capital) in the course of production. The lack of a public accounting for damages that result during production and disposal of the waste products of consumption often results in an unfair sharing of economic costs and a lack of efficiency in allocating resources. It also may result in a condition where productive activities exceed the ability of ecosystems to support economic production or properly absorb its waste products. When ecological limits are exceeded over time, an eventual social hardship may occur through the collapse of a related resource such as a fishery. Only then do decision-makers and economic actors become fully aware of the natural limits that the environment imposes.

Finally, only with a broad spectrum of information about the ecosystem processes, health, benefits and economic values of Oregon's coast can we make good decisions about how to invest in and maintain the coastal region's natural capital to the benefit of present and future generations.

Scale and the Coastal Marine Environment

Scale is a crucial idea when thinking about the interaction between the economy and the environment. Scale simply refers to the size of the economy relative to the ecosystem in which it resides. The people of Oregon have long recognized that there are physical "scale" limits to coastal resources. Fish and shellfish catch limits, regulation of pollutants, coastal zone regulations, and invasive species control are all examples of ways that citizens and decision-makers have tried to limit damage to the productive capacity of coastal ecosystems. Even management goals such as maximum sustainable yield clearly identify that we must limit how much we extract from marine ecosystems if their productivity is to be maintained. If we exceed the physical limits of our coastal systems, they begin to collapse at great cost. These costs may take the form of increased direct economic costs, loss of jobs, decreased health and safety, and loss of aesthetic beauty or quality of life.

For much of the 20th century, economists did not adequately consider how the natural world contributed to economic activity. Production relationships were described only in terms of human delivered inputs of machines (capital) and labor. Sometimes land was included as an abstract concept representing space rather than a fundamental natural input such as soil, water, energy, and natural raw materials. This oversight is partly due to the fact that for almost all of human history, economic activity was small in scale relative to the planet's total capacity to produce plant energy, essential materials, and absorb our waste products—what some call an "empty world" perspective (Goodland, Daly, and El Serafy, 1992). Economists simply did not consider the environment a limiting factor, and what entered the economic process from the environment was seen as "free" and thus not valuable.

As the industrial revolution progressed, fossil fuels made possible a massive expansion of economic activity and the human population grew from less than one billion to over 6 billion in 100 years. It took biologists and other natural scientists time to measure the contemporary impact of human activity on the planet, and a little longer still for them to get the message out to economists that growth in economic activity was having significant ecological impacts that could in turn affect how the economy functions and humanity's basic quality of life.

Starting in the 1960's "natural resources" started to be taken into account in economic equations, and analyses centered around "optimal" rates of depletion and pollution. This perspective was still too limited however, in that it does not take into account the dynamic and complex nature of ecological systems and the idea that some aspects of what natural systems do and produce cannot be replaced by human ingenuity. In recent years though, many economists are coming to understand that taking nature, not just natural resources, into account is fundamentally important to understanding the dynamic relationship between human economies and the natural world. Given that we now live in a "full world" with economic activity having a large size and impact in relation to the capacity of the earth to handle our demands and wastes, "ecological" economics is coming into its own. The following figures help illustrate.

In an empty world view, forests could be cleared because there were always more over the horizon. Wetlands could be drained for farmland because there were plenty of them, or because people did not understand how important they were to their well-being. Likewise, rivers could be controlled to reduce floods and make navigation for commerce more feasible because science had not been able to tell us that by changing how rivers function, vital wetland-building processes would be stopped. Fish could be fished without end because the oceans are superabundant and anything and everything could be dumped in the ocean because its depths were unfathomable. However, from a full-world perspective, the idea of limits is more easily understood. Here, the economy is large, and space for ecosystems to function to provide both inputs to the economy and to absorb waste products is small and under strain. Indeed, we now know this is true of our oceans and atmosphere, and many other aspects of the environment.

The recent acceptance of climate change as a human-caused problem is a perfect illustration of full-world ecological economics. Climate scientists have a high level of certainty that burning fossil fuels and clearing land, especially forests, has reduced the ability of the biosphere and atmosphere to absorb carbon dioxide, a waste product of human economic activity (and a natural part of the planet's life cycle at the right scale) (IPCC, 2007). The potential consequences of climate change to the economy could be massive. One recent estimate put it at 20 percent of GDP (Stern, 2006). This seems large until one realizes that this number includes catastrophic loss of coastal areas and massive increase of human death due to disease, drought, and severe storms. Such outcomes would appear unacceptable to most people, and putting the cost at 20 percent of GDP appears like a gross underestimate.

Climate change will also have regional impacts in coastal Oregon that are scale issues. For instance, sea-level rise can affect the amount of beach and coastline available for recreation and living space. Warming ocean temperatures are predicted to negatively impact fish that require cold water, especially salmon, thus further reducing the size of the resource base available for harvest. Loss of living space, recreational opportunities, and traditionally available natural resources all constitute a shrinking of opportunities for economic activity and other activities that support human well-being and is a clear example of how human economic activities cause us to bump up against ecological scale.

Figure 9. Empty World Perspective, based on Goodland, Daly, and El Serafy, 1992.

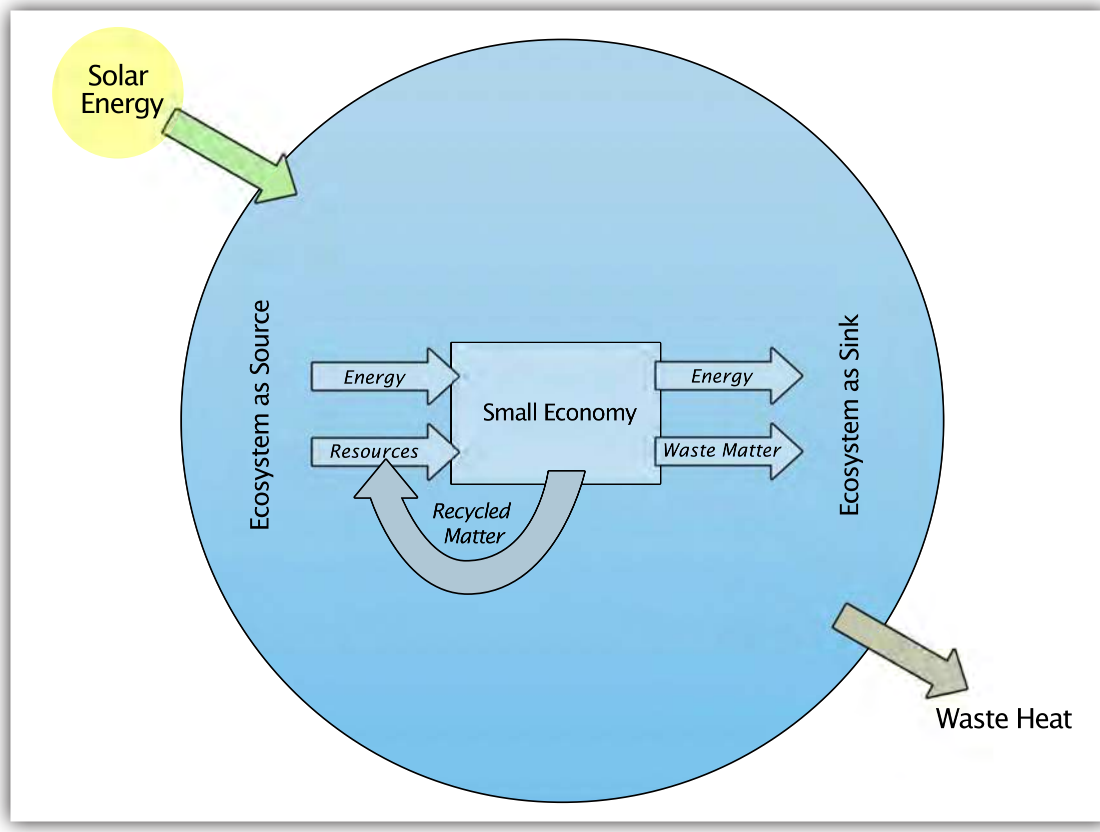
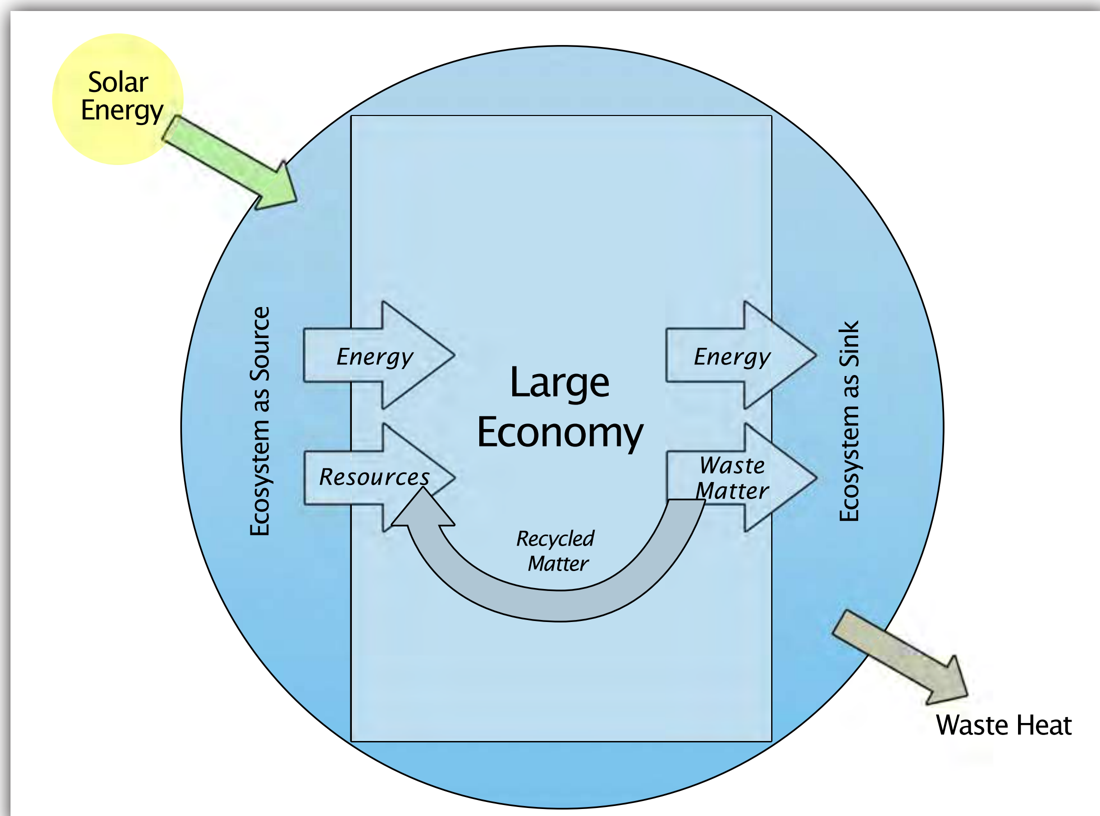


Figure 10. Full World Perspective, based on Goodland, Daly, and El Serafy, 1992.



Most significantly, when Northwest ecosystems are healthy, they are tremendously productive and provide many opportunities for people to make a living and enjoy a high quality of life. But when they decline, we lose far more than a single good or service. When fisheries collapse, a signal is given that many things beyond the species in question have changed. Overfishing has caused very large changes in the trophic (food web) structure of coastal ecosystems (Jackson et al., 2001). When top predators are removed, species that were kept in check by these predators become more abundant, which can in turn change the populations of smaller species and/or the vegetation eaten by animals that are in the middle of the food chain. Loss of kelp forests due to removal of sea otters (who eat urchins who in turn eat kelp) provides a regional example. As is described below, kelp forests play very important roles in delivering ecosystems important to people. Loss of oysters in Chesapeake Bay is another example. Oysters filter water very efficiently. As their populations declined, water quality became a serious issue in that part of the country. Oysters are thought to play similar roles in estuaries of the Northwest. The point is that eventually, if enough parts go missing or stop working properly, the overall health of coastal and marine ecosystems will decline and an increasing number of measurable impacts to the health and the quality of life along the coast will appear.

In addition to taking size of the economy in relation to its supporting ecosystems into account, ecological economists offer another helpful interpretive tool – the idea of natural capital. Looking at the environment as an important input to economic activity, as important as the machines and people who produce things, helps re-frame the discussion of ecological restoration, conservation, and environmental protection from one of trade-offs with economic well-being to one of vital support function.

Traditionally, economists have focused their research and theories on production of manufactured capital. Manufactured capital is the machines, tools, factories, and anything else that people make to produce other things. Steel presses, mining equipment, tractors, and computers are all concrete examples of manufactured or "built" capital. When economists talk about productive investment in the economy, they are referring to the amount of money or economic output that is spent on building up more manufactured capital so that more things can be produced. Economists have also focused on labor as an input, or factor of production. This is a very abstract concept though, and not really a focus on the real human beings that produce labor or the conditions under which people function well to be productive members of an economy. Sometimes, economists have also included land in descriptions of how economies work, but in a very simplified and abstract way to represent space, not the actual thing that land is—a collection of ecological systems with their own life processes. Figure 11 depicts this traditional perspective.

Ecological economists take a much broader view of what goes into making a fully functional economy. To start with, they move from an abstract and simplified view to one that recognizes that real economies are comprised of arrangements of people, things people make, the social organizations used to arrange people and things in productive ways, and very importantly, how the parts and processes of the natural world are used both as input and waste sink to what people make and how they make it. Once the shift occurs of looking at concrete real things and processes in the world, it becomes possible to divide productive things into four groups or what economists call types of capital.

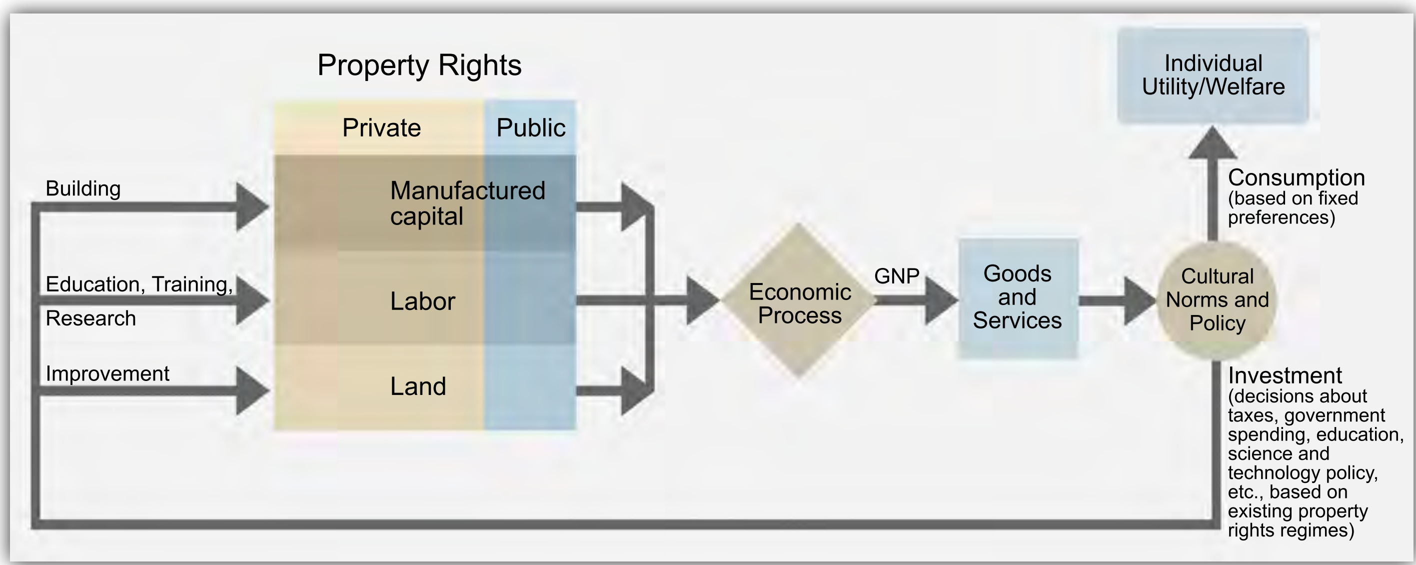
Four Capitals

Economic health and a high quality of life require four capitals:

1. **Natural Capital:** the earth's stock of organic and inorganic materials and energies, both renewable and nonrenewable, as well as the planetary inventory of living biological systems (ecosystems) that when taken as one whole system, provides the total biophysical context for the human economy. The inputs of natural resources, energy, and ecosystem function to human economic processes of production. Nature by itself produces many things that are useful and necessary to human well-being.
2. **Human Capital:** acquired knowledge through education, self-esteem, interpersonal skills such as communication, listening and cooperation as well as creating individual motivation to be productive and socially responsible. It is well recognized that education and training are essential to economic growth and innovation.
3. **Social Capital:** the inventory of organizations, institutions, laws, informal social networks, and relationships of trust that make up or provide for the productive organization of the economy. Without a functioning society in which people respect each other and have some concern for the well-being of others, most economic activity would be impossible.
4. **Built Capital:** the productive infrastructure of technologies, machines, tools and transport that humans design, build and use for productive purposes. Coupled with our learned skills and capabilities, our built techno-infrastructure is what directly allows raw materials to be turned into intermediate products and eventually finished products for use.

Traditionally, much economic analysis has focused on built capital and the outputs of built capital stocks—that is what most of our economic measures are geared to view. However, without the trust, laws, social customs, associations and networks that make up social capital, built capital

Figure 11. Conventional Model of the Economy that Excludes Natural Capital



cannot function or be sustained. One Nobel Prize winner in economics, Herbert Simon, observed in 1998 that "it might surprise an observer of a modern economy to note that most of the activities of members of organizations, perhaps eighty percent as a rough guess, are not [involved in] market transactions at all, but decision-making and communication activities that involve extensive problem solving."[1]

Nature and natural capital allows both good social relations through access to spiritually and culturally relevant places, through providing a secure life through access to clean water, air, and food, and as critical input to economic production. Neoclassical economics often characterizes natural capital as something that can be substituted by human-built alternatives. Ecological economists point out that while in limited circumstances, some natural materials can be switched, like plastics for metal or plant material, that the economy as a whole cannot function without natural inputs of energy that are all ultimately driven by ecological processes which turn sunlight into usable forms of energy (Daly and Farley 2004). Additionally, natural capital and built capital are usually complements of each other rather than substitutes. Fishing boats are human built capital. Fish are natural capital. Fishing boats are useless without fish. These four capitals are woven together to build an economy.

The presence of a balance of all four capitals is also important to people's sense of well-being. Recent analysis demonstrates a high level of correlation at the national level between human, built, and natural capital, and especially the presence of adequate natural capital, and subjective well-being (Vemuri and Costanza, 2006).

What is important to remember in the context of this study is that both economic capital and natural capital are associated with people's sense of their own well-being. It can be easy to forget when focusing on economic factors that the purpose of an economy is to support human well-being, rather than the functioning of the economy being an end in itself (Daly and Cobb, 1994). Therefore, when the ecological health of the Oregon Coast is considered in relation to its economic health, it should be kept in mind that the purpose for being concerned about ecosystem health is the effect of natural capital decline on human welfare in coastal counties. This paper is focused on the contribution of natural capital to the economy of coastal Oregon in the context of human well-being. Figure 12 illustrates this fuller picture of an economy with all four capitals taken into account.

Distribution

Distribution is an important concept in economics and refers to how the benefits of what society produces get distributed among its members. When markets function without any intervention whatsoever, benefits tend to get concentrated among a small number of people who control productive resources. The Great Depression was a very large example of what happens when markets are allowed to run their course: many people became poor in a short period of time and there was no social safety net to help them nor were there any mechanisms to prevent markets from collapsing. As a result of this calamity, new policies were put into place that were designed to

1 Herbert Simon, ***Can there be a science of complex system?*** in Unifying Themes in Complex Systems: Proceeding from the International Conference on Complex Systems. Edited by Yaneer Bar-Yam. 2000 Perseus Books, Cambridge, MA

protect people from the worst ravages of poverty. In other words, intentional decisions were made through the tax code, creation of social security and Medicaid, and unemployment insurance, to provide a more fair distribution of economic benefits than had previously been the case.

Distribution is very important in ecological economics because of the issue of scale. While most economists recognize that unequal distribution is an outcome of how market economies function, the standard answer beyond limited social safety net programs, is to push for increased growth with the idea that as the economic pie gets larger, there will be more of it to share and more people will be better off (Daly, 1996). However, in a "full world" economy in which we are approaching the limits of the size of the material economy relative to what the biosphere can handle, continued unbalanced physical growth generally causes more harm than good[2]. Thus, if society is to not be plagued with further inequality in incomes and all the problems that creates, ecological economists recommend distribution policies that are not based on one dimensional economic growth.

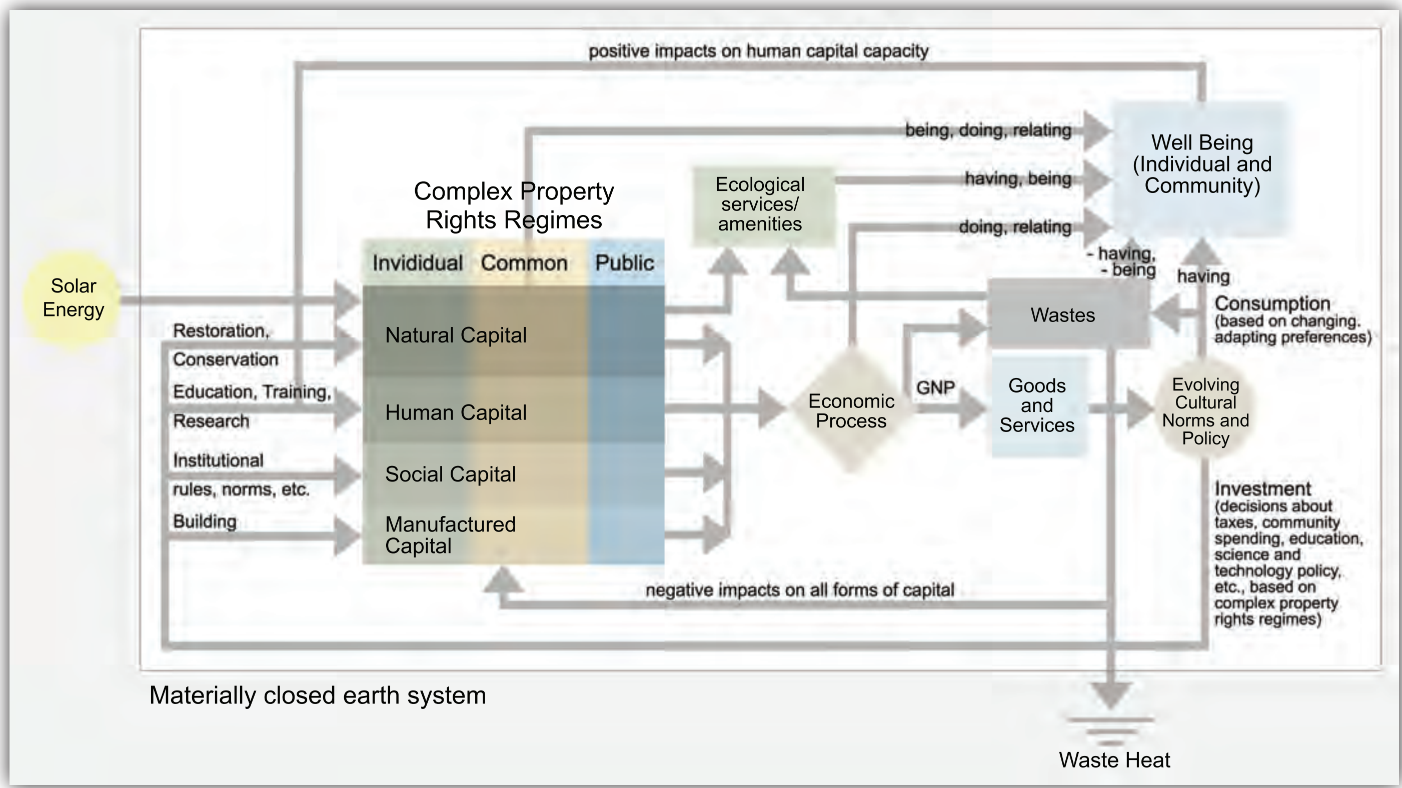
The second way in which distribution is important in ecological economics is that nature distributes its bounty unevenly. That is why most of the world's population and most of its economic output occurs in coastal areas. Access to areas that are good for building ports, like estuaries and bays, access to fish, fresh water from rivers flowing into the seas, access to forests that are near coasts, access to beautiful landscapes for residents, and as a source of tourism income, and in many parts of the world, access to moderate climates, have all attracted people to live in coastal areas. Globally, poverty rates are far higher in landlocked areas than in coastal areas (Sachs, 2005). When human institutions interact with naturally uneven distributions of natural resources, they can either exacerbate the unevenness, making it harder for some proportion of the population to gain access to important resources, or they can help make sure that everyone has access at least to basic necessities to lead a dignified life.

Distribution issues are apparent in Oregon's coastal economy. With a recreational license, anyone can collect shellfish or fish within regulatory areas and catch limits. However, access to some commercial fisheries requires substantial financial capital and thus not everyone has access. The way in which catch limits are set can affect distribution as could the institution of individual quotas if that were a mechanism that regulators chose to use. All the public has access to Oregon beaches, for example. However, had Oregon allowed privatization of beach access, the distribution of access to the natural services of recreation and views (see below) would be much different. Everyone who did not or could not purchase beach front property would be excluded. The open access to beaches draws more tourists than perhaps would otherwise be the case and thus broadens the opportunity for small businesses to provide services to those tourists. With privatized beaches, landowners could charge rent or access fees, restricting the number of people who can recreate. While this may produce some income from high income customers, there would likely be fewer businesses that could get into the market and thus support the local economy.

Landownership is a distribution issue. About 80 percent of coastal-related private forest land is

2 There is also growing empirical evidence demonstrating that even as total economic output has grown both in the U.S. and worldwide, the vast majority of those benefits are flowing to people who are already in the top income brackets while a decreasing share of total income and assets is held by people who are already poor (see e.g., Stiglitz, 2004). Thus, growth has not been a solution to eliminating poverty.

Figure 12. Ecological Economic Model of the Economy



owned by large companies with headquarters outside of Oregon, much less the coastal region. Thus, the profits that are derived by harvesting coastal forests "leak" out of the area to other regional economies. All the while, important decisions about how to manage coastal forestlands are generally made outside the region. A different distribution of forest ownership would likely have a different effect on how the goods and services produced by local forests benefit people living in the coastal area. Poverty rates in coastal Oregon tend to be higher than in other parts of the state (see above). Within an ecological economics framework, one would start thinking about how to address poverty with explicit redistribution policies that relied on existing natural capacity rather than growth of throughput of resources. A relevant example would be if communities within coastal counties decided to purchase forest lands from large private landowners who were based outside the region and then managed those forests for multiple goods and services that benefited people within the region to a greater extent.

Efficient Allocation of Resources

Allocation is a critical part of any economy. Allocation means how resources get divided up among potentially competing uses. Markets are the main mechanism by which these decisions get made through the way people decide to spend their money. Ideally, a good market gives accurate and complete price signals which in turn determine how raw materials are allocated to produce goods and services. Most allocating issues are settled according to what people need and want and what producers are willing to make for how much people are willing to pay. Prices carry all this information between producers and consumers.

When supply and demand operates with full information, there is theoretically a point at which no one can be made better or worse off by a different allocation of resources among competing demands. This is called optimal efficiency (technically, Pareto optimal efficiency after the economist who derived the theory). In reality, this kind of condition is met under very rare and restricted conditions. A major problem in reaching actual efficiency occurs when there is a lack of information on true cost. This occurs because some resources are used up in production and sometimes ecosystems that are damaged provide other economically valuable services besides providing harvestable commodities and neither of these things are accounted for in the price of a product sold in the market. For example, over several decades the ground fishery allowed the harvest of all age classes of female fish across all areas of habitat. Due to ignorance of the life history of certain ground fish, highly fertile females, required for the future productivity of the fishery, were allowed to be over-harvested. The price of ground fish in the market did not reflect the loss of irreplaceable egg-laying females and the damage to the whole food web of which these fish are a part.

Another resource mis-allocation outcome can occur when production scarcities emerge that people are not aware of until it is too late to correct. For example, if salmon are selling for less than full cost of catching them, if fishers do not have to pay the full cost of catching fish though subsidies like cheap fuel, or if people measuring their abundance were not able to get an accurate picture of how the population was doing, too many salmon would be consumed in the market and more people would be induced to fish for more salmon than the natural population could support. For populations that take a long time to recover, such as the long-living ground fish species, it may be too late when people discover that there are not enough fish left to sustain past harvest levels. Fishery collapse is not uncommon and can happen suddenly without giving people time to prepare for alternative livelihoods. Thus, in the case of coastal fisheries, marine resources were often misallocated through subsidies and the overcapitalization of fishing fleets.

Producing too much pollution because there is no price to pay for its disposal is another misallocation of resources. Too many resources go to making things that make us sick or destabilize the climate. Such a situation results in people having to spend too much money dealing with health issues or fixing the problems of climate change when their money could have been spent on things they would otherwise prefer.

Ecological economics recognizes that many of nature's services do not lend themselves to either full information (due to their complexity) or to being part of a market system because of their characteristics (see discussion of valuation below). Thus, only attempting to fix markets to reflect better prices will not solve the entire problem of misallocation of nature's services. Ecological scale plays a role here, too. It is very likely that the best way to solve environmental problems is to set ecologically appropriate limits outside of the market system, then let the market system adjust based on these limits. This is exactly the idea behind Governor Kulongoski's goal of developing a limited system of marine reserves in Oregon's territorial waters.

An example is how the U.S. government set limits on sulfur oxide emissions from power plants to levels that cleaned the air and reduced negative health effects. This was an externally established scale. Then, permits were auctioned off to power plants that in sum lead to lower and lower pollution levels. Plants that could not meet their pollution targets bought permits from other plants that could more efficiently modernize or otherwise reduce their pollution levels. The overall program achieved reduced pollution levels in a manner that was less expensive than if each plant had to act individually to cut sulfur dioxide levels. Thus, a market mechanism operated well after government set a scale limit on behalf of public well-being. While this approach does not work for every ecological issue, it is an example of how setting scale external to the market, then letting the market function, is an appropriate policy tool.

Photo by Ben Nieves

Some aspects of natural capital cannot be subject to market-based allocation systems, even of the type just described. For example, all oxygen is produced by plankton or plants. Marine and terrestrial ecosystems are the only substantial producers of atmospheric oxygen. Oxygen is produced in abundance and distributed equitably for all people to breath. It would be folly to attempt to replace the natural system of oxygen production with oxygen factories. Not only would it be impossible to produce the quantity of oxygen needed, humans could never build a better distribution and allocation system than the atmosphere. Free air flowing with natural weather systems provides everyone with their fair share of oxygen and does so quite efficiently. In this case, the ability of the planet to produce and distribute oxygen needs to be protected by institutions that act on behalf of the public. There needs to be a "macro" allocation of resources devoted to protecting the amount and configuration of natural capital that produces oxygen. The same can be said of much of the critical natural capital that allows human life to exist.

Private Wealth and Public Wealth

Some ecological goods, such as salmon and Dungeness crab can be captured and distributed privately through the market. Many ecosystem services, by their nature, cannot be privatized and are thus "non-market" goods or services, such as clean water, breathable air, or flood control services. It is now understood that public ecosystem services are highly important and make up our common well-being or "common wealth." Institutions of governance are required to protect and manage common resources, and to ensure the equitable access to their benefits for this generation and future generations. Ecological economics is very much about the proper governance of common wealth.

For wise governance policies to be adopted it is very important, particularly in a region such as the Oregon coast, to clearly understand the relationship between natural ecosystem services and economic well being:

1. The coastal ecological common wealth provides vast and essential benefits to people.
2. Ultimately, all private wealth depends upon the common wealth of nature.
3. If fundamental biophysical systems decline the economy will eventually decline and human well-being will suffer.

A few examples include these areas:
1. Ozone layer protection from deadly ultraviolet light.
2. Oxygen and primary food production from photosynthesis.
3. Climate functions within a sphere of habitability.
4. Non-toxic environment.
5. Protection from devastating weather and storms.

The remainder of this report describes in more detail how natural capital relates to Oregon's coastal economy.

Natural Capital and Ecosystem Services of Oregon's Coastal and Marine Environment

Ecosystems as Natural Capital

The marine ecosystem off of Oregon's coast provides significant support and benefits to Oregon's coastal communities. The marine environment can be described as the defining element of coastal natural capital. It is an engine for economic and social well-being for Oregon's coastal communities. Viewing the marine environment as "natural capital" sets the framework for assessing how that environment contributes to human well-being, and establishes that the marine environment is not just an amenity or an expendable aspect of Oregonians' lives. A healthy marine ecosystem (or systems, see below) provides an irreplaceable foundation for fisheries, recreation, and tourism industries, as well as less recognized services such as waste processing, hydrological cycling, storm protection, and nutrient cycling – all of which contribute to the habitability of a place, the region, and the planet as a whole. In short, healthy marine ecosystems are the natural capital base from which many vital goods and services flow.

Differences Between Natural and Human Capital

An important feature of natural capital, in contrast to human-built capital, is that it is self-maintaining. Ecological systems, when not degraded, provide a flow of goods and services that support and benefit people at no cost. Built capital, such as water treatment plants and aquaculture farms, cost substantial amounts of money to build and require constant maintenance to keep up with wear and tear. Human capital eventually needs to be torn down and replaced while ecological systems maintain themselves for very long periods of time and do not rely on human intervention.

For instance, a sea wall built to protect areas inland from storm waves and erosion costs money up front to build. The community or individual who owns it must pay periodic maintenance costs to ensure the wall keeps doing its job. When the wall wears out in 30 or 40 years, the whole thing must be torn down and replaced. In addition, the wall probably affects the dynamics of the coastline, making other landowners or communities up shore or down shore more vulnerable to the impact of currents and waves. In contrast, relying on ecological features for storm protection, including building in areas that are naturally protected from storms, costs far less money. Keeping coastal wetlands, rock reefs, and kelp beds all intact, and not building right on top of bluffs, uses natural capital to enhance a community's long-term safety with no physical capital maintenance costs. An added advantage of thinking this way is that all the other services provided by the intact shoreline and ecological systems that provide storm protection are also available. It is also important to understand that while sometimes humans can engineer a substitute for a few of the functions of natural capital, there are many critical types of natural capital for which we cannot engineer substitutes, such as primary productivity or water.

How Marine Ecosystems Function as Natural Capital

Coastal and marine ecosystems are comprised of structures and functions. These structures and functions are what produce goods and services that people rely on. Structure is built from interactions between species with each other and with the abiotic environment. Plants and animals themselves build structure, in addition to that provided by non-biological matter like rock. It includes things like food webs; physical habitat space such as rock reefs, kelp forests, and eel grass beds; and physical processes such as nutrient-rich up-wellings. Functions include primary productivity like phytoplankton fixing carbon dioxide (CO_2) through photosynthesis to form the base of the marine food chain, predator-prey interactions, and bacterial breakdown of dead animal matter on the seafloor. For example, salmon do not exist in isolation. They rely on a number of habitats such as coastal estuaries and eel grass beds, favorable ocean conditions, adequate prey species, and clean water to survive to become of commercial or subsistence value. In short, salmon exist as part of a food web and as a result of the interactions of several structural elements of the ocean, nearshore, estuarine, and fresh water environments. If some of these pieces are lost or cease to function, salmon, as an ecosystem good, becomes scarce or unavailable.

When natural capital is depleted or damaged, economic activities and other aspects of human well-being that depend on it are adversely impacted. For example, toxic algal blooms in estuaries or off the coast kill commercially important sea life such as Dungeness crab. These toxic conditions also make eating seafood from affected areas dangerous, and make swimming ill-advised. Thus, people living or traveling to coastal areas lose economic opportunities for fishing, their health can be negatively impacted if they eat poisoned seafood, and they lose the option of recreating in affected waters, which is a direct well-being issue, in addition to a loss of revenue for businesses serving tourists.

Over-fishing is another clear example of the impacts of the loss of natural capital. When fish stocks collapse suddenly, or fisheries must close for a period due to low or declining populations, commercial fisher people are put out of work and the businesses which provide them with equipment and those who process fish suffer losses. The fact that the share of personal income from fishing has declined in coastal Oregon serves as an important illustration of this concept.

Ecosystems, like forests, oceans, grasslands, and rivers, are our natural capital stock. The things that flow from or are done by functioning ecosystems, like production of clean air that is the right composition to be breathable by humans, or clean water for drinking, or the processing of wastes, are what we call ecosystem services. Ecosystem services support human life, well-being, and economic activity. The next section describes in detail the kinds of ecosystem services that flow from marine and coastal ecosystems of Oregon's coast and territorial waters.

Coastal and Marine Ecosystem Types and the Services They Provide

We have identified six major landform/marine form divisions with nine coastal and marine ecosystem types that occur along Coastal Oregon. We describe each type followed by a description of the ecosystem services that they provide.

Major Land and Marine Forms and their Ecosystems

Oregon's coast contains a great diversity of natural areas including sandy dunes and beaches interspersed with rocky headlands and islets[3] , bays and estuaries, rocky intertidal zones, the shallower marine waters of the continental shelf and the outer shelf. All of these habitats interact and influence each other, making it important to understand the whole coastal-marine area as a complex ecosystem. A brief description of each habitat type follows. A more detailed discussion of the coastal marine ecosystem and its functions and services follows later in the document.

Coastal Beaches and Dunes: Coastal beaches and dunes cover approximately 52,000 acres in Oregon (Chappell et al. 2001). Beaches and dunes are an important interface between marine and land systems. Beaches especially are also a place where many people access coastal environments for recreation. These elements of the coastal landscape are influenced by longshore drift and wave action. Many marine intertidal invertebrates live in the sandy substrates of beaches, providing food for shore birds. Seaweeds, crabs, and jellyfish, among other organisms wash up on beaches providing food for scavengers, thus making them locales of nutrient interchange between land and sea.

Sand dunes are formed by the combination of wave deposition of sand and strong off-shore winds. Large stretches of Oregon's coast, or 139 miles are covered in dunes (McConnaughey and McConnaughey, 1985). Dune formation is naturally a very dynamic process and dune formations can be ephemeral. However, introduction of European beach grass to speed the stabilization process has actually led to a truncation of the natural dynamics and to an impoverishment of some native plant and animal communities. Most of the dramatic dune structures in Oregon formed

3 This report describes the relationship marine and coastal aquatic habitats and the economies of coastal Oregon counties. While terrestrial ecosystems play a role in the economies of these counties, the focus of here is on the contribution of marine ecosystems to human economic well-being so as to better inform marine management policies. Given that we are not discussing terrestrial management policies, except as they relate to pollution effects on marine habitats, we do not describe terrestrial habitats.

after the 1930's as a result of colonization by European beach grass. Other European invasive species such as Scotch Broom have also altered native dune communities. Dune formations serve the purpose of protecting inland areas from the force of waves during strong Pacific storms. Dunes also provide habitat to several bird and mammal species (Buchanan et al., 2001).

Headlands and Rocky Islands: The Oregon coast is also characterized by dramatic headlands and small rocky islands. These formations cover slightly more than 9,000 acres (Chappell et al. 2001). They are usually covered with at least a thin layer of soil, and therefore support grasses, evergreen shrubs and trees. The tops and sides of these formations serve as nesting habitat for seabird colonies. Rocky benches along the bottom of headland cliffs serve as haul-out sites for marine mammals such as harbor seals, and higher boulder piles above the splash zone serve as nesting sites for black oyster catchers (Buchanan et al., 2001). Headlands and rocky islands provide some of the most picturesque scenery along the coast and therefore provide an important aesthetic component to the landscape. High aesthetic appeal plays a large role in drawing tourists and artists to the Oregon Coast.

Bays and Estuaries: Bays and estuaries are formed where rivers meet the sea. There are 22 principal bays and estuaries in Oregon plus numerous small estuaries, covering nearly 173,000 acres (Chappell et al., 2001). Map 2 shows the distribution of major estuaries along the Oregon Coast. Bays and estuaries hold diverse habitats within them, including salt marshes, eel grass beds, open water, mud flats and river deltas. These are highly productive ecosystems and provide essential nursery habitat for commercial and recreational fish species. For example, all salmon species caught in Oregon waters spend some portion of their lifecycles in Oregon's estuaries, and over 50 species of fish are found in estuaries during some part of the year where they find food and cover from predators until they are ready to go out into the open water. Smaller fish, which serve as prey for salmon and depend on healthy populations of zooplankton also find habitat in Oregon's estuaries. Estuaries serve as a crucial nutrient mixing zone, which is in part what makes them so productive. A very important function of estuaries which is not yet well appreciated is the ability of salt marshes to sequester carbon on an on-going basis (Boumans et al., unpublished data). These areas also serve as favorite habitat for humans, with many port, restaurant, hotel, and industrial facilities cited along their edges which is why estuaries have suffered large declines in species diversity and abundance and deteriorated water quality nationwide and worldwide (EPA, 2007; UNEP, 2006). Estuaries play a prominent role in many of the ecosystem services that are described in the next section.

Nearshore Habitat: Nearshore habitat extends between the high tide line and sixty-six feet (20 meters in depth). Near shore habitats include the intertidal zone and sub-tidal shallow water habitat. There are approximately 223,000 acres of non-estuary intertidal coastline habitat (Chappell et al., 2001). Substrates in the intertidal zone can be rock, gravel, cobble, or sand. Some kelp species, brown rockweed, red algae, surfgrass, and a large variety of invertebrate organisms are supported in rocky intertidal habitat (Chappell et al. 2001). Given its accessibility, the rocky intertidal zone is one of the best studied marine ecosystems in the world. Rock reefs also occur within the intertidal and sub-tidal zones. These structures provide nursery habitat to several rockfish species, in addition to habitat for encrusting corals, sponges, marine mammals, and seabirds (Weeks and Merems, 2004). Larger kelp species are found in submerged habitats with rocky substrate. Sandy bottom intertidal and sub-tidal areas do not support plants because lack of plant anchoring substrate prevents establishment in areas exposed to wave energy. They do however support diverse communities of benthic invertebrates that have adapted means of dealing with the disruptions of waves and tides.

Kelp forests occur in the lowest part of the intertidal zone, but mostly extending into the nearshore waters below the intertidal zone. These forests can extend over 100 feet from the sea floor to the surface and provide habitat to an array of invertebrate species such as sponges, worms, bryozoans, small arthropods, sea stars, and sea cucumbers, among others. They also provide nursery habitat to numerous fish species which are attracted to the cover and ample food supplies. Sea urchins, which are voracious herbivores, can wipe out kelp forests if they are not kept in check by predators. Kelp forests serve to moderate wave action on shorelines and beaches, and are harvested by people for food and other derivatives.

Territorial Sea: Oregon's 3 mile territorial waters, which are measured from the mean lower low water (below the ordinary low tide line) cover approximately 1,000 square miles (640,000 acres)[4]. Habitats in these waters include the inner edge of the marine shelf and open water, in addition to already described submerged nearshore lands, kelp forests, and rock reefs, are the inner edge of the marine shelf and open water. Some proportion of commercial and a larger proportion of recreational fishing activity originating in Oregon occurs in the territorial waters.

Marine Shelf: Marine inner and outer shelf habitat occurs between 66 and 667 feet (20 and 200 meters) and extends from within the three mile territorial waters up to 40 miles off of the coast. There are several bank features in this zone off the Oregon coast, in contrast to Washington's shelf, which is dissected with several deep canyons. We discuss shelf habitat even though it extends well beyond the territorial waters because its ecology influences ecosystems in the territorial waters (PISCO 2002). Plant life in this zone consists of phytoplankton species, which forms the base of the marine food chain. Upwellings are more influenced by wind patterns than currents, in contrast to California. Upwellings in this zone are extremely productive and thus provide food for fish and other sea life that use waters closer to shore. In addition, when wind patterns, currents and upwellings in the marine shelf area are disturbed, changes in nearshore habitat occur. For example, changes in summer winds are apparently the source of changes in upwelling patterns that led to the appearance of a dead zone along central Oregon's coast in 2002, 2004, and 2006 (PISCO 2006). Several commercially important species are fished in shelf habitat, including shrimp, flatfish, Pacific hake, and albacore.

Ecosystem Services Provided by Oregon's Coastal and Marine Ecosystems

Ecosystem services fall into four broad categories (Fig 16). Provisioning services are those that directly provide the materials for subsistence and economic activity, including food, building materials, fiber for clothing and other implements, medicines, and fuel. Ocean ecosystems produce fish, crustaceans, and other organisms that humans have relied on for food for much of their evolutionary history. Forests, as another familiar example, provide trees for building materials and other plants used for medicinal purposes. Regulating services are those that create and maintain conditions favorable to human life and economic activity. Climate stability, cycling water from oceans to land, keeping disease agents in check, and breaking down waste products are all examples of regulating services. Supporting services are the basis of ecosystem

4 To get a sense of area, 1,000 square miles is approximately the size of Lincoln County or the Siuslaw National Forest.

function. These include primary productivity – or the fixing of CO_2 by plants to produce food that forms the basis of the vast majority of all food webs on the planet, and nutrient cycling. Cultural services include all the ways that people interact with nature in socially meaningful ways, such as spiritual significance, enjoying natural places for recreation, and learning about the planet through science and education. This basic scheme (see Fig. 1) was developed in the Millennium Ecosystem Assessment (UNEP, 2005). Other authors place ecosystems in 23 finer-scale categories (e.g., De Groot, et al., 2002).

We describe 17 ecological services and their relationship to 9 ecosystem types in the coastal and marine environment. In Tables 6 and 7, we define and summarize ecosystem services provided by coastal and marine ecosystems and which ecosystem types provide what services.

Photo by Ben Nieves

Biodiversity

Biological diversity is defined as the number and types of species and the ecosystems they comprise. It is measured at gene, population, species, ecosystem and regional levels (Magurran 1988). Marine and coastal systems interact with each other and their functioning is tied to the biological diversity of the entire marine environment. For all ecosystems, biodiversity is both a precondition of the flow of ecosystem services, and an ecosystem service in itself (UNEP 2005, Vol. 1, Chapter 11). It is a precondition because ecosystems with their full native complement of species tend to be more resilient to change in environmental conditions or external shocks, and they tend to be more productive. Biodiversity is also an ecosystem service in itself because novel products have been derived from genetic and chemical properties of species, because it provides a secure food base (multiple sources of food with different seasonal availability), and because people ascribe value to it simply for its existence.

Oregon's coastal and marine biological diversity is highly rich and irreplaceable. There are approximately 3,000 species of invertebrates, 500 fish species, 26 mammals, and 155 species of birds that make their homes in Oregon's coastal ecosystems (Lubchenco, in Green Fire Productions, 2005).

Sea floor microorganisms, which are not well catalogued, likely number in the several thousands. Marine biodiversity in general is less well-described and understood than land-based biodiversity, although recent organized efforts such as the Census of Marine Life are making strides to increase the number of species described on a global basis (see www.coml.org). Regionally, the Partnership for Interdisciplinary Studies in Coastal Oceans (PISCO) is working to improve knowledge of coastal nearshore ecosystems, including improving knowledge of community composition and structure, ecosystem function, and the influence of a changing ocean environment on biodiversity

Photo by Ben Nieves

and ecosystem function in the Pacific west coast. (http://www.piscoweb.org)

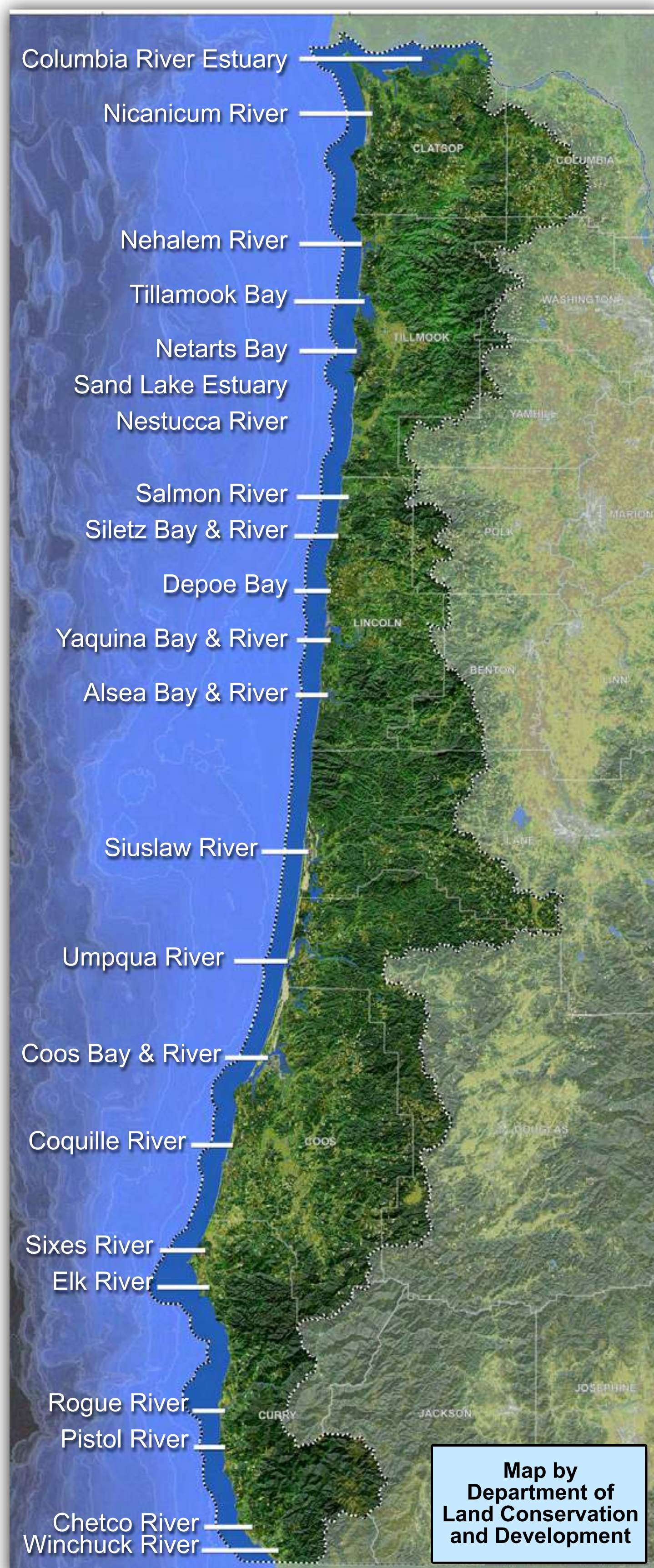
A recent meta-analysis of marine data and studies examining the effects of biodiversity on ecosystem services found strong evidence that loss of biodiversity leads to fisheries collapse, lower potential for stock and system recovery, loss of system stability, and lower water quality.

The relationship is one of an exponential loss of ecosystem services with declining diversity (Worm et al., 2006). In contrast, Worm et al. also found that restoration of biodiversity, including through the establishment of marine reserves protected from fishing pressures, leads to a fourfold increase in system productivity and a 21 percent decrease in variability (i.e., an increase in stability). This study provides the best evidence to date of the direct relationship between biological diversity and ecosystem services in the marine environment.

At a global scale, the loss of biodiversity through fishing and habitat damage has been substantial in marine and coastal ecosystems and has large implications for maintenance of ecosystem services (UNEP, 2006). Over-fishing has affected Oregon's marine fish stocks and there is every reason to believe that documented localized extirpation is placing coastal marine biodiversity at risk. In September 2002, over 10,000 square miles of waters were closed to ground fish fishing off the coast of California, Oregon, and Washington. Seven out of twelve species of rockfish for which the National Marine Fisheries Service has adequate data have been fished to below 25 percent of their un-fished abundance.

Food and materials

One of the most important functions of marine ecosystems is the provision of food. Globally, fish and seafood provide the primary source of protein for one billion people and fishing and fish industries provide direct employment to some 38 million people (UNEP, 2006). It is also important to note that most of the fisheries catch comes from within coastal areas, putting a great deal of pressure on a small portion of the total marine environment. Other important materials, including petroleum, lime, wood, and medicinal products come from coastal and marine ecosystems. In Oregon, fishing is an important activity, both in terms of food production and as a source of livelihood. In 2003, fishermen landed 225 million pounds of fish worth $82 million (The Research Group, 2006). Salmon, tuna, ground fish (such as cod, flounder, halibut, rockfish species, soles, flounders, and Pacific whiting), Dungeness crab, pink shrimp, and sardines comprise the most important commercial species. Some of the commercial fish and seafood caught in Oregon's waters are shipped to other states and overseas. Oyster aquaculture is also practiced in Oregon's estuaries and bays, bringing in additional income to coastal



Map 2. The major estuaries of the Oregon coast

residents. Successful oyster farms require intact systems which provide food and clean water to cultured shellfish.

Kelp can be harvested for medicinal and food purposes, and is done so regularly on a commercial basis in California. However, this does not appear to be a major activity off the Oregon coast. While oil and gas resources occur in Oregon's coastal waters, exploration is banned.

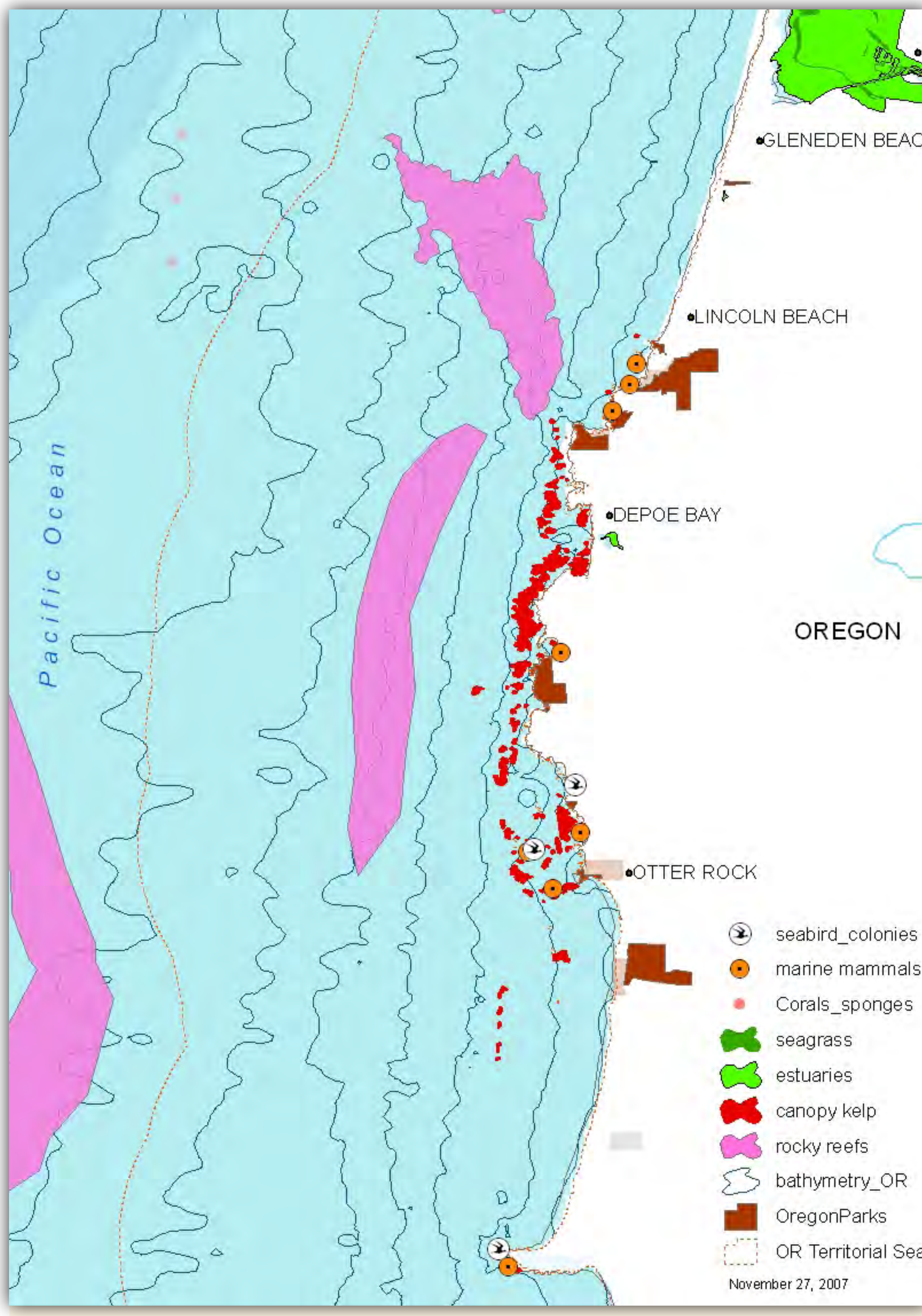
As is seen in Table 7, many ecosystem types in the coastal and marine environment are involved in provisioning services. Estuaries and bays, mudflats, rock reefs, kelp beds, seagrass beds, and continental shelf waters are all part of the marine food web, and some food species rely on multiple ecosystems for their life history needs.

Shoreline stabilization

Estuaries and bays, rocky islets, headlands, intertidal areas, rock reefs, seagrass and kelp beds all buffer against wave energy. Shorelines are built and maintained naturally with interactions of the physical aspects of these structures, wave energy, tides, and sediment deposition. The biota in mudflats and nearshore soft bottom sediments also play a key role in maintaining the structure of sediments and preventing erosion (Weslawski et al. 2004). When these features are removed or significantly altered, dramatic changes and loss of shorelines can occur. Coastal wetlands and natural processes of land accretion are also very important for maintaining the line between land and sea, especially in the face of rising sea levels. Loss or sudden change in shoreline can result in private property damage,

Photo by Ben Nieves

public infrastructure damage, loss of wildlife habitat, and in extreme cases, loss of life. Coastal erosion is a natural process along Oregon's coast. However, changes in the habitat types listed above plus shoreline development have created multiple hazard areas. Thus, retention of ecosystem features that stabilize the shoreline help reduce cost of engineered stabilization efforts and retain space for recreation and aesthetic enjoyment of the coast.



Map 3. Marine ecological features, Siletz Bay to Yaquina Head, Oregon Map by Oceana. Data provided by NOAA, Oregon Department of Fish and Wildlife and the Oregon Coastal Atlas.

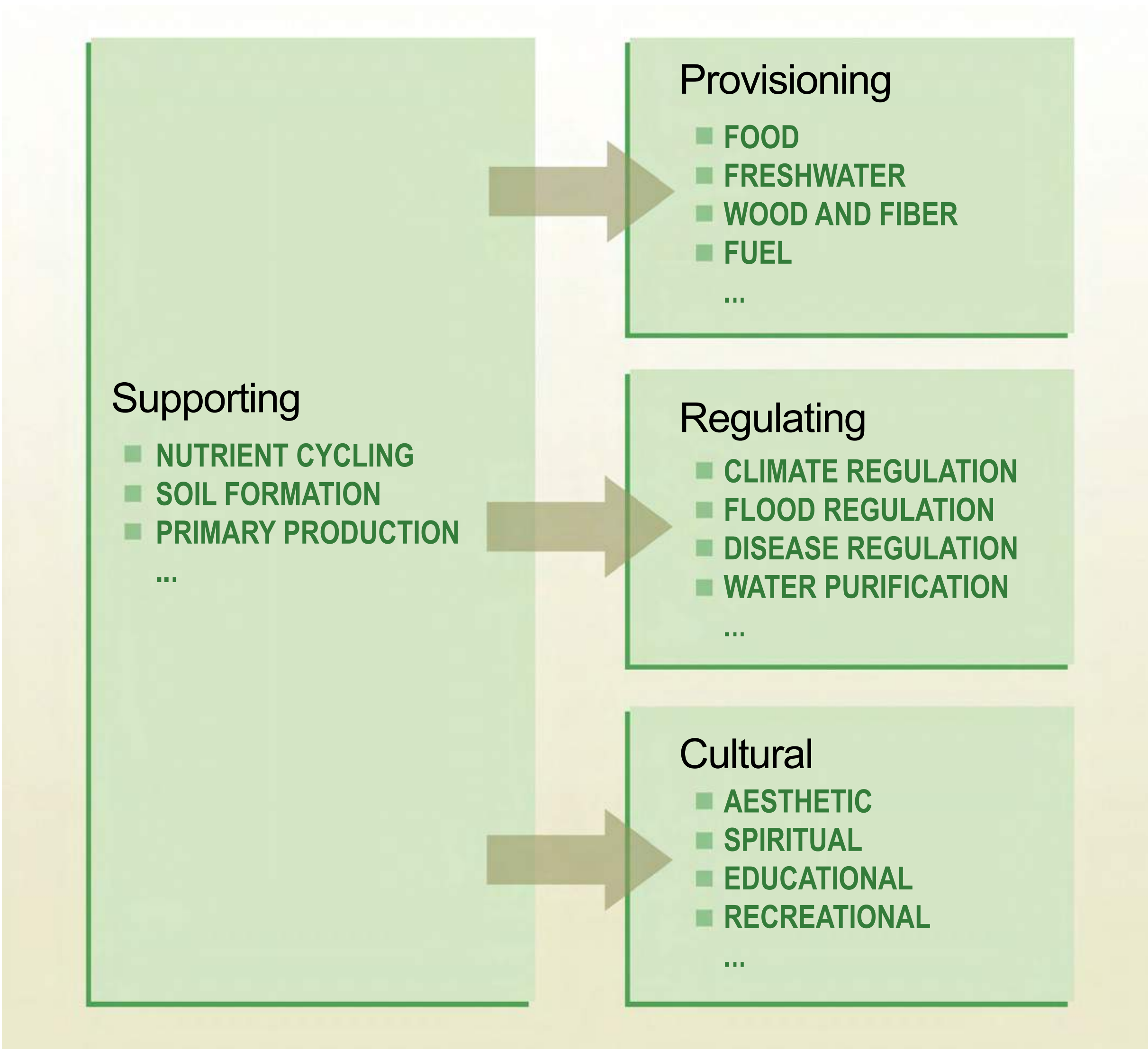
Storm protection

Estuaries and bays, coastal wetlands, headlands, intertidal mudflats, seagrass beds, rock reefs, and kelp forests provide storm protection. The same wave energy absorption capacity of these areas that stabilizes shorelines also dampens the energy of intense waves that come from storm events. Estuaries, bays, and wetlands are particularly important for absorbing flood waters (Costanza et al., in review; UNEP 2005).

Storm events along Oregon's coast are both part of normal weather patterns, and may become more frequent and intense with climate change. Where significant infrastructure exists and where wetlands and wave-absorbing structures in the nearshore environment have been lost, higher levels of property damage could already be occurring as a result of this diminished ecosystem service. Thus, storm protection as an ecosystem service is important to residents living close to the ocean-front or in other flood-prone areas. Given that significant infrastructure can be damaged during large storm events, tourism and recreation could be harmed as well.

Water flow regulation
Coastal fresh water wetlands form a salinity gradient with saltwater marshes and the ocean. These freshwater wetlands keep salt water from intruding on coastal freshwater supplies, both at the surface and in aquifers (UNEP, 2005, Vol. 1, Chapter 19). Alteration of hydrology through diverting water to estuaries is considered to be a major threat to coastal areas (Pringle, 2000). Hypersalinization can occur when too much fresh water is prevented from reaching estuaries, threatening not only fresh water supplies, but the several other services that estuaries provide. Agricultural and urban development and removal of riparian vegetation are the most important

Figure 16. Ecosystem Services



Source: Millennium Ecosystem Assessment, 2005 causes of loss of fresh water flow to coastal wetlands and bays.

Human disease reg- ulation and waste processing micro- organisms in sediments and mudflats of estuaries, bays, and nearshore submerged lands breakdown human and other animal wastes (Weslawski et al., 2004). They can also de-toxify petroleum products. When the ecology of these organisms is disrupted either through physical destruction of habitat, alteration of food webs, or through overload of nutrients or waste products, disease regulation and waste processing services are disrupted. Alteration of ecosystems can also create breeding sites for disease vectors where they did not exist before. People can be exposed to disease in coastal areas through direct contact with bacterial or viral agents while swimming or washing in fresh or marine water, by ingesting contaminated fish or seafood, or drinking contaminated water. Cholera outbreaks in coastal areas have recently been on the rise in the southern hemisphere for example and are associated with degradation of coastal ecosystems (UNEP, 2006). Oregon has had several incidents of shellfish and beach closures due to red tide and amnesic shellfish poisoning in recent years (Oregon Progress

Table 6. Marine and Coastal Ecosystem Services

Ecosystem Service	Definition	Examples
Biodiversity	The number and types of species and the ecosystems they comprise. Measured at gene, population, species, ecosystem and regional levels. Biodiversity provides resilience to ecosystems and the opportunity for the provision of most other ecosystem services.	Intact fish populations occur within more intact native species and ecosystem assemblages than those populations which are in decline.
Provisioning		
Food	Biomass for human consumption, provided by web of marine organisms and a functioning marine ecosystem (see biodiversity definition above).	Fish, seaweed
Materials	Biological materials used for medicines, fuel, and building.	Conical mollusk shells used for anti-cancer drugs, oil, lime
Regulating Services		
Shoreline stabilization	Keeping shorelines in a state of equilibrium with ocean waters, especially in the face of rising sea levels.	Rocky shores, seagrass beds, wetlands, and estuaries trap sediments and sand that allow land accretion which can balance or exceed subsidence or erosion
Storm protection	Mitigation or attenuation of the effects of wind, waves, and flood waters on coastal land and communities.	Estuaries and coastal wetlands absorb wave energy and flood waters from ocean storms, thus reducing damage to coastal property.
Water flow regulation	Retention and storage of fresh water.	Estuaries and coastal wetlands store fresh water and keep salt water from intruding upon fresh water supplies.
Human disease control	Undisturbed ecosystems keep organisms in check which can cause disease in humans.	Coastal waters with proper nutrient, oxygen, and pH levels prevent algal blooms that produce toxins which are poisonous to humans via shellfish consumption from affected areas.

Table 6. Marine and Coastal Ecosystem Services (cont'd)

Ecosystem Service	Definition	Examples
Carbon sequestration	The capture and long-term storage of carbon is part of the global carbon cycle. Oceans play a crucial in role climate stabilization.	Oceans absorb carbon both chemically and biologically. Surface absorption occurs over short time frames (1 year); deep water mixing allows long-term storage and more surface absorption; phytoplankton fix carbon through photosynthesis.
Supporting		
Nutrient regulation and cycling	Transfer of nutrients from one place to another; transformation of critical nutrients from unusable to usable forms.	Estuaries are zones where mixing of nutrients from fresh water and saltwater systems occur, making them very productive; anadramous organisms transport marine nutrients to upland habitats where they are used by terrestrial organisms (salmon and grizzly bears) and enhance primary productivity of terrestrial plants.
Habitat	Providing for the life history needs of plants and animals.	Estuaries provide nursery habitat (relatively more protected places where fish and other sea animals hatch then mature to a life stage where they can handle harsher environments).
Primary productivity	Fixing of carbon by plants; provides basis of all terrestrial and most marine food chains.	Phytoplankton plays a crucial role as the basis of marine food webs and in the global carbon cycle.
Cultural		
Spiritual and Heritage	The role which ecosystems and their components play in the spiritual beliefs of people. This is especially important for indigenous cultures. These values do not lend themselves well to economic quantification. Heritage values refer to the role that intact ecosystems play in forming the cultural identity of people and the long-term value people place on being able to pass on traditions to their children.	Salmon play a key role in spiritual and cultural life of Native American tribes. Families that have made a living from commercial and recreational fishing in Coastal Oregon value being able to pass on their way of life to their children.
Scientific and Educational	Ecosystems are the subject of much scientific study for both basic knowledge and for understanding the contribution of functioning ecosystems to human well-being.	Research institutions focused on marine habitats contribute economically and socially significant knowledge to society.
Tourism	The explicit role that intact land and seascapes play in attracting people to areas for vacationing.	Visits to coastal state parks to view unobstructed views of the ocean, walk on the beach, and to see marine life.
Aesthetic	The role natural beauty plays in attracting people to live, work and recreate in an area.	Home values with ocean views are higher than homes without.
Recreation	The contribution of ecosystem features, such as biological diversity and clean water play in attracting people to engage in recreational activities.	Clean water and marine animals attract kayakers and scuba divers.

Board, 2000; Woods Hole Observatory, 2006). While the algae that cause toxic blooms are native to west coast waters, and toxic blooms can occur as natural events, there are concerns, and in places direct evidence, that increasing pollution loads and climate change exacerbate the conditions that lead to toxic blooms (see Rabalais 2005 for a summary). Reduced access to beaches and fish and shellfish resources due to disease has obvious impacts to both human health and economic activity in coastal counties.

Coastal wetlands, estuarine macroalgae, and nearshore sedimentary biota play a crucial role in removing nitrogen and phosphorous from water (Garber et al.1992, Weslawski et al. 2004). Removal of these nutrients, which usually comes from agricultural run-off and leaking septic tanks, maintains offshore water conditions that are conducive to native fish and invertebrate biota. A well-

Table 7. Marine and Coastal Ecosystem Types and the Services They Provide

	Beaches	Headlands and Rocky Islets	Estuaries and Marshes	Intertidal	Kelp	Rock Reefs	Eelgrass	Inner Shelf	Outer Shelves Edges Slopes
Biodiversity	X	X	X	X	X	X	X	X	X
Provisioning Services									
Food	X		X	X	X	X	X	X	X
Fiber, Fuel			X		X		X	X	X
Medicines			X		X			X	
Regulating Services									
Shoreline stabilization/erosion control	X	X	X			X	X		
Storm protection	X	X	X	X	X	X	X		
Water flow regulation and storage			X						
Human disease control	X		X	X		X	X		
Waste processing	X		X				X		
Carbon sequestration			X	X		X	X	X	X
Supporting Services									
Nutrient cycling	X		X	X	X	X		X	X
Habitat	X	X	X	X	X	X	X	X	X
Primary productivity		X	X		X		X	X	X
Cultural									
Spiritual	X	X	X	X	X	X	X	X	X
Scientific and educational	X	X	X	X	X	X	X	X	X
Tourism/recreation	X	X	X	X	X	X			
Aesthetic	X	X	X	X					

known example of the loss of nutrient processing services of wetlands is the very large eutrophic zone in the Gulf of Mexico. Coastal Louisiana has lost more than 2,000 square miles of wetlands since the beginning of the 20th century, and agricultural production in the middle and upper parts of the Mississippi Basin has increased the amount of nutrient laden run-off that now reaches the Gulf without being trapped in wetland soils, resulting in loss of commercially and biologically important fish and shellfish species (Day et al. 2005). Water quality monitoring in Oregon indicates that nutrient overload in larger estuaries (e.g., Columbia, Coos Bay, Yaquina Bay) is an issue of significant concern (Oregon DEQ, 2005).

Carbon sequestration

Marine life, particularly phytoplankton and marine benthic organisms play a crucial role in the global carbon cycle. The functioning of the ocean food web turns dissolved bicarbonate into solid form (skeletons and exoskeletons of plants and animals), which falls to the ocean floor. Benthic organisms sequester carbon in sediments where it eventually gets incorporated into rock. This allows more CO_2 to be dissolved into ocean waters, keeping atmospheric CO_2 levels lower than they would be without life, and thus without biological processing occurring in the ocean (Peterson and Lubchenco 1997). The composition of phytoplankton diversity affects this process as some species are more palatable to marine grazers than others, thus determining the amount of uptake and pumping of carbon to the ocean floor (UNEP 2005, Vol. 1, Chapter 11). This is another important connection between biological diversity and ecosystem services.

The shelf ecosystem off of Oregon's coast performs these carbon sequestering functions. Management actions to maintain the ability of the entire food web to function properly contribute to carbon sequestration. Coastal and estuarine wetlands also sequester carbon through photosynthesis and long term storage in wetland soils. In fact, wetlands may rival or outperform temperate forests and agricultural sequestration projects under some circumstances (Boumans et al., unpublished paper).

Nutrient cycling

There are some 22 elements that are essential to the growth and maintenance of living things on earth. Some of these elements are only needed by a small number of organisms or in small amounts in specific circumstances, but the major planetary nutrient cycles of carbon, nitrogen, phosphorous, and sulfur are needed in relatively large quantities by all living things. These cycles are also the ones that have been most affected by human actions. Silicon and iron are also important elements in ocean nutrient cycles because they affect phytoplankton community composition and productivity. It is living things that facilitate the movement of nutrients between and within ecosystems, and turn them from biologically unavailable forms, from rocks or the atmosphere for instance, for some organisms into forms that can be used by others. Without functioning nutrient cycles, life on the planet would cease to exist. The marine role in the carbon cycle in terms of its significance for climate change was briefly described above. The marine environment plays a central role in all major global nutrient cycles. The movement of nutrients is also important locally and regionally for ecosystem productivity.

Nutrient cycling takes place at multiple scales in the marine environment, from bacteria and other microorganisms in sediments in estuaries, shelf, and deep sea floors all the way to the global scale of ocean current patterns. Marine organisms fix nitrogen and take up carbon, phosphorous, and sulfur from the water or from other organisms. Much of the mass of these macronutrients is deposited in sediments where it is either stored for the long term, or is taken back up to surface waters by upwellings. Phosphorous, nitrogen, and carbon cycles are interlinked in marine environments and their relationship depends on whether sediments are oxygen-rich (oxic) or oxygen-poor (anoxic). These conditions are in turn affected by organism composition and external nutrient loads.

Nutrient cycling is a supporting service because many other services depend on it. Given that ecosystem productivity would cease without it, and is impaired when these cycles become significantly altered, nutrient cycling is a fundamental precursor to ecosystem and economic productivity. However, due to this fundamental role and because they operate at multiple overlapping scales, they are difficult to value economically (Farber et al. 2006), and are thus usually

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undervalued.

Changes to benthic communities can therefore have significant impacts on nutrient cycling capacity of organisms in these communities. Changes come from invasion of non-native species, physical disruption of habitat through dredging of waterways for navigation and bottom-trawling, overloading of nutrients beyond the capacity of the system to absorb, and changes to the food web caused by trophic cascades after removing top predators (Snelgrove et al. 2004 and references therein).

Habitat
Habitat is the biophysical space, i.e., the juxtaposition of physical structure, adequate food availability, chemical and temperature regimes, and protection from predators, in which wild species meet some or all of their life needs. Refugium functions are sometimes distinguished from nursery habitat. A refugium refers to general living space for organisms while nursery habitat is specifically habitat where all the requirements for successful reproduction occur (De Groot et al. 2002). All ecosystem types in the Oregon coastal and marine environment are listed in Table 7. Habitat provides the places where biological diversity and commercially and culturally important species are maintained. All coastal and marine habitat types, especially estuary and nearshore habitats in Oregon have suffered degradation through either physical alteration, pollution, or invasive species affects (Buchanan et al. 2001, EPA, 2007). Habitat contributes significantly to other ecosystem services, namely, fisheries as food, recreation through wildlife watching, and cultural or spiritual values that are often expressed though people's willingness to pay for protection of natural areas.

Primary productivity
Primary productivity is another supporting service upon which all other ecosystem services depend. It refers to the conversion of energy from sunlight into forms that are used by the vast majority of living organism. Plants on land and in fresh and marine water perform this function, and use the sugars that are a product of photosynthesis for their own respiration. All other life forms eat plants, animals that eat plants, or the decaying matter of dead plants and animals. Human life depends directly on primary productivity through consumption of crops, wild plants, seaweeds, fish and seafood, and livestock. We used to depend directly on the current energy from food consumption to conduct the work of survival and reproduction, then with the help of draft animals and simple machines, then since the industrial age from fossil fuels. Fossil fuel is ancient stored energy from photosynthesis. Since humans started to perform work using fossil fuels, the number of people and amount of consumption has far exceeded what would have been possible just by operating on current energy flows. It has been calculated that humans appropriate over 40 percent of the planet's terrestrial primary productivity, and this share is increasing with massive ecological implications for the rest of planet's organisms and energy budget (Vitousek et al., 1986; Pimm, 2001). For ocean ecosystems, about 8 percent of total primary productivity supports human fisheries. However, when the calculation is confined to the parts of the ocean where most primary productivity and fish catches occur, the number approaches the proportion for terrestrial systems, at 25-30 percent (Pauly and Christensen 1995, Pimm, 2001). Again, if humans consume most ocean primary productivity in the form of fish and seafood, not much is left to fuel the remainder of the food web and all the ecological processes that it drives (Pimm, 2001).

Marine primary productivity comes from wetland plants, macroalgae, and sea grasses in the coastal and nearshore environment, and from phytoplankton on the continental shelf and deep sea waters. Most marine primary productivity occurs in the coastal zone out to the extent of the continental shelf. Climate change has large implications for ocean primary productivity due to changes in currents and upwellings and changes in water chemistry that may affect the ability of diatomaceous phytoplankton to form calcerous shells (Orr et al., 2005).

Aesthetic
Aesthetic value as an ecosystem service refers to the appreciation of and attraction to beautiful

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natural land and seascapes (De Groot et al. 2002). The existence of National Seashore and State and National Parks and Scenic Areas, and officially designated scenic roads and pullouts attest to the social importance of this service. There is also substantial evidence demonstrating the economic value of aesthetics through data on housing markets and survey data on re-location decisions. Oregon's attractive coastline is of major importance to the cultural and economic character of the state, and especially of coastal counties. There is also evidence substantiating the intuition that degraded landscapes are associated with economic decline and stagnation (Power 1996). This is an important topic relevant to Oregon's coastal economy and is discussed further below.

Tourism and recreation
Tourism and recreation are related to but not totally encompassed by aesthetic values. People travel to beautiful places for vacation, but they also engage in specific activities associated with the ecosystems in those places. Recreational fishing, scuba diving, surfing, kayaking, whale and bird watching, hunting, enjoying local seafood and wines, and beachcombing are all activities that would not occur without intact shorelines, fish and wildlife populations, and clean water, in addition to the aesthetic quality of the place. Storm protection and shoreline stabilization are also important ecological services associated with recreation and tourism because they help keep tourists safe and protect both private and public infrastructure needed for the tourist industry.

Tourism and recreation are significant portions of nearly all coastal economies throughout the world, which turns out to be both a blessing and a curse. Development designed to attract tourists has been a major source of degradation in coastal environments, and has led to physical habitat degradation, especially on beaches and in estuaries, and to water quality degradation (UNEP, 2006). Too much recreational fishing pressure and too many whale-watching boats can also put excessive pressure on the species that attract people in the first place. The concept of ecotourism has arisen in part to deal with these issues. It is however an incompletely implemented solution to date (UNEP, 2005; 2006). Recreation and tourism are, like aesthetics, an important part of the link between ecosystem services and Oregon's coastal economy. The State of Oregon has already invested significant public resources to support tourism through the establishment of over 230 state parks and by granting public access to all beaches. More specific aspects of the relationship between Oregon's coastal economy and ecosystem services related to tourism are discussed further below.

Other cultural services

Other aspects of the linkage between ecosystem and culture include the spiritual significance that individuals and societies place on nature, and the scientific and educational value derived from studying natural systems. The marine environment is especially important from a spiritual perspective to tribal communities living in the Pacific Northwest, as is evidenced by their cultural traditions around salmon and other marine organisms, and through their art and stories. Individuals of non-native origin also express spiritual value to nature through various means. One important aspect of attempting to ascribe economic value to spiritual significance should be noted here. The use of willingness to pay surveys (see below for definitions) for things like saving whales or spotted owls reveals that many people are unwilling to trade money or tangible goods for the loss of species or places, and rank the protection of nature above many aspects of material well-being (see e.g., Spash, 2005 for a review). Such an expression of what are termed "lexicographic preferences" by economists demonstrates that there is difficulty and sometimes cultural aversion to attempting to assign monetary value to all aspects of ecosystems and their services.

Scientific and educational importance of coastal and marine ecosystems is evidenced by the number of educational and research institutions devoted to studying the marine environment. Government, academic, and private resources are all devoted to formal study of marine ecosystems in Oregon. Such pursuits benefit people through direct knowledge gained for subsistence, safety, and commercial purposes. The study of natural systems is also an important intellectual pursuit in and of itself for helping people understand how complex systems work. Scientific and educational institutions devoted to the marine environment also provide locally significant employment, as with the Hatfield Marine Science Center in Lincoln County and the University of Oregon's research station at Winchester.

Relationship Between Ecosystem Services and the Coastal Economy

While Oregon's coastal economy can be readily characterized in terms of employment by sector and sources of personal income (see above), comprehensive data collection or detailed accounts of nature's systems (natural capital stock) and the corresponding flow of ecosystem services does not regularly occur. Thus, a detailed quantitative empirical analysis of the contribution that Oregon's natural systems make to the coastal economy has not been previously assessed. However, several important observations can be made about the relationship between the ecosystem services just described and Oregon's coastal economy. The first important reality to note is that the coastal economy is no longer driven by commercial fishing or other direct natural resources extraction activities. While commercial fishing is still very important to some communities, and remains a component of income for some residents that would be hard to replace, the shift to myriad small businesses, tourism and recreation, and retirement income poses a significant set of new economic facts which need to be taken into account in any assessment of marine and coastal ecosystem services.

Transfer payments and investment income make up over 46 percent of individual income in the seven coastal counties. Small businesses (not directly associated with natural resource extraction or heavy industry) comprise nearly another 27 percent. Looking at the proportions of these three sources of income in Figure 3 above is striking.

Tourism, while making up 8 percent of total income in Clatsop County, constitutes only 5.6 percent of income coast-wide. It is however, a growing sector of the economy. It may very well be a larger proportion of the economy than our model was able to show, given issues with underreporting of proprietor and cash-based income (i.e., waitpersons and bartenders).

It is clear that the structure of tourist-based firms is far more amenable to overstating expenses and underreporting income. Unlike logging firms, which are grounded in full-time, hourly wage

Photo by Ben Nieves

employees subject to strict worker compensation insurance reporting requirements, firms servicing coastal tourism tend toward part-time employees who receive a significant portion of their income in the form of cash tips.

Commercial fishing accounts for 9.6 percent of income in Clatsop County, but only 3.6 percent coast-wide, and the trend for employment and income is projected to decline for this industry (see Table 5 and Figure 7 above). Other natural resource-based industries are locally important as well, but also declining overall since 1990.

The large amount of retiree income as a proportion of total income source in the coastal counties indicates that high quality of life is a large draw to the Oregon Coast. There are convincing analyses from other parts of the county that have had large natural resource-based industries in the past, that high environmental quality is a key factor in drawing entrepreneurs to start up small businesses (Power 1996, Power and Barrett 2001). April 2007 survey data of Oregon voters indicate residents value a healthy ocean environment for its economic and recreational opportunities, with 80% backing specific policy proposals that designate marine areas and limit recreational and commercial activities to protect marine life and underwater habitats. The polling data also show an overwhelming majority of Oregon voters (69%) see no inherent conflict between jobs and ocean protection, believing we can protect our ocean and the fish and wildlife that live there while still protecting jobs that depend on ocean resources, like those in the fishing industry. Notably, of the 29% who see a conflict between jobs and ocean protection, 62% favor protecting the ocean over preserving jobs (25%) when asked to make a choice between the two priorities.

We think it is a fairly safe conclusion to state that Oregon's beautiful coastline, accessible beaches, relatively high air and water quality, watchable marine and coastal bird and mammal life, and recreational hunting and fishing opportunities are a big draw to retirees and would be business owners as well. Therefore, maintaining ecosystem services that support a high natural aesthetic and recreational opportunities, in addition to the health and safety of coastal residents, should be the primary policy objective in support of today's coastal economy and quality of life. Biodiversity, all the supporting services—primary productivity, nutrient cycling, habitat provision, plus regulating services such as shoreline stabilization, water and waste treatment, and storm protection—are essential to maintaining these important values.

The above policy conclusion is not to say that the fishing sector should be dismissed in consideration of the coastal economy. Quite the contrary, although fishing income has declined since 1990, a well-managed and vibrant fishery based on a recovered and healthy marine ecosystem could once again be a substantial part of the coastal economy. The transition to ecosystem-based marine management and the recovery of coastal fish stocks to abundance, could become the foundation for a profitable coastal marine fishing fleet. Fishing practices would need to be guided by the need to maintain a highly productive ecosystem. In this way, efforts made to restore marine ecosystems and their full biological diversity would pay off for years to come, by supporting commercial and recreational fishing that is truly sustainable and is once again a larger and vibrant part of Oregon's coastal economy.

What a traditional base sector analysis like the one reviewed in this report accounts for is the contribution of traditionally counted capital, including harvestable natural resources, to the economy. An ecological economic analysis would also account more quantitatively for the contribution of the remainder of natural capital by accounting for the flow of ecosystem services that comes from that capital. Conceptually, we can summarize the relationship between coastal marine and terrestrial systems and the economy as in Figures 17 and 18. It is important to note the relative size of each of the sectors within the human economy (Figure 17). Figure 18 depicts a local economy that is underpinned by the resilience of ecosystems and natural capital, both from within and from outside that local economy. Human well-being and economic activity interact, but human well-being is influenced directly by ecosystem health, in addition to indirectly through the support that intact natural capital gives to a functioning economy.

We conclude this section with a quote from The Research Group's 2006 study to sum up where the coastal economy is:

> The West's once-important natural resource industries declined dramatically in terms of jobs and incomes. These industries—mining and metal processing, logging and lumber products, and agriculture—historically supported European settlement. They are still widely believed to be the economic lifeblood of the region's rural areas and small cities. Their decline still provokes deep anxiety. The fear is the region will become more depressed and more residents will be forced to leave.
>
> Despite these fears, the changing industrial structure has not triggered an overall decline in jobs, income, or residents in the region. On the contrary, as industrial transformation proceeded, in-migration, employment, and aggregate real income have boomed *(The Research Group, 2006, p. xxvi).*

We would add that, as a matter of policy, maintaining a healthy set of ecosystems to support the well-being of Coastal Oregon's residents and provide a resilient foundation for its economy appears to be a prudent course of action. The last sections describe why valuation of natural capital is important and how it can be done for the Coastal Oregon economy.

Photo by Ben Nieves

Figure 17. The full coastal economy: Economic sectors and ecosystem services

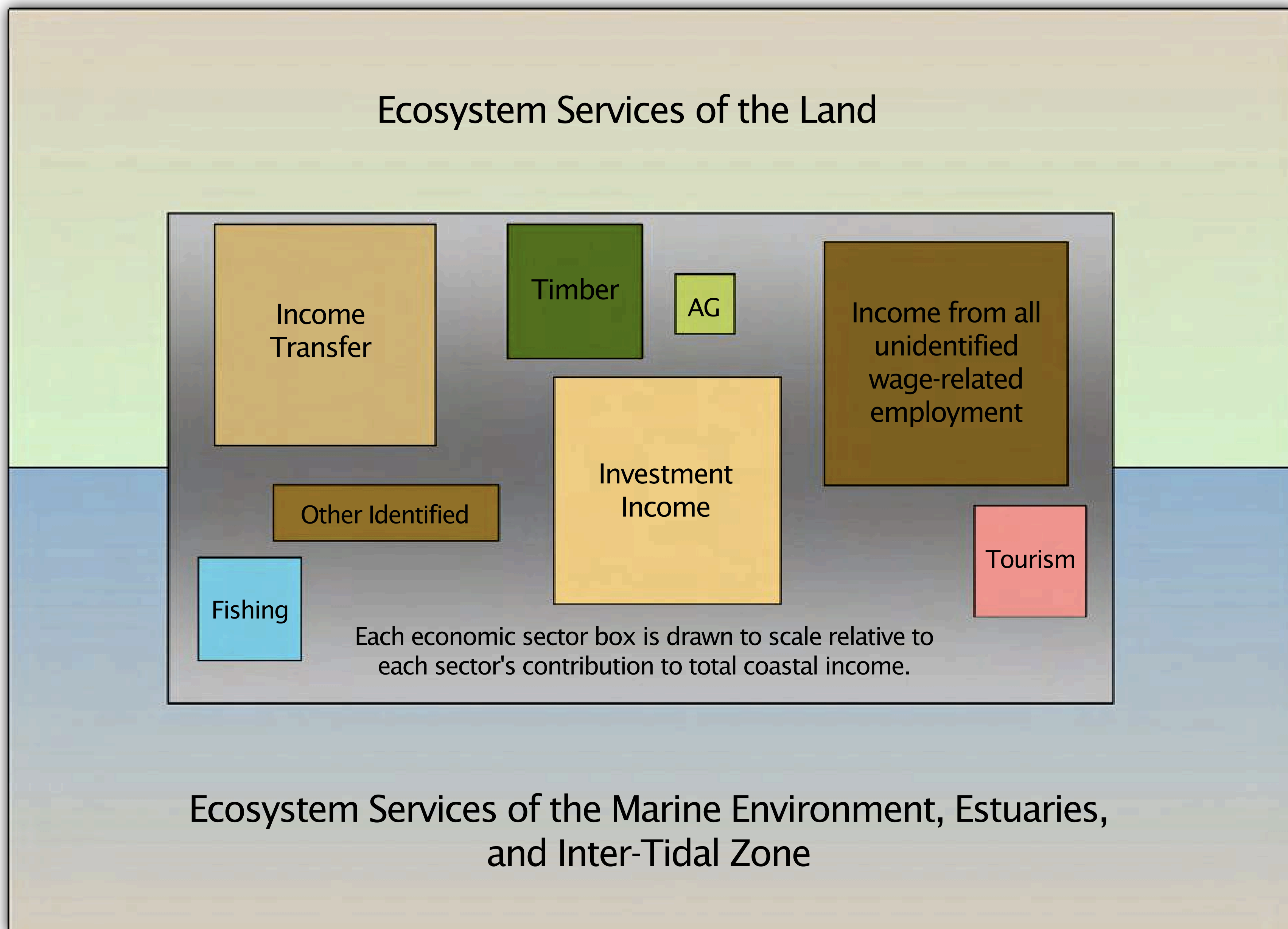
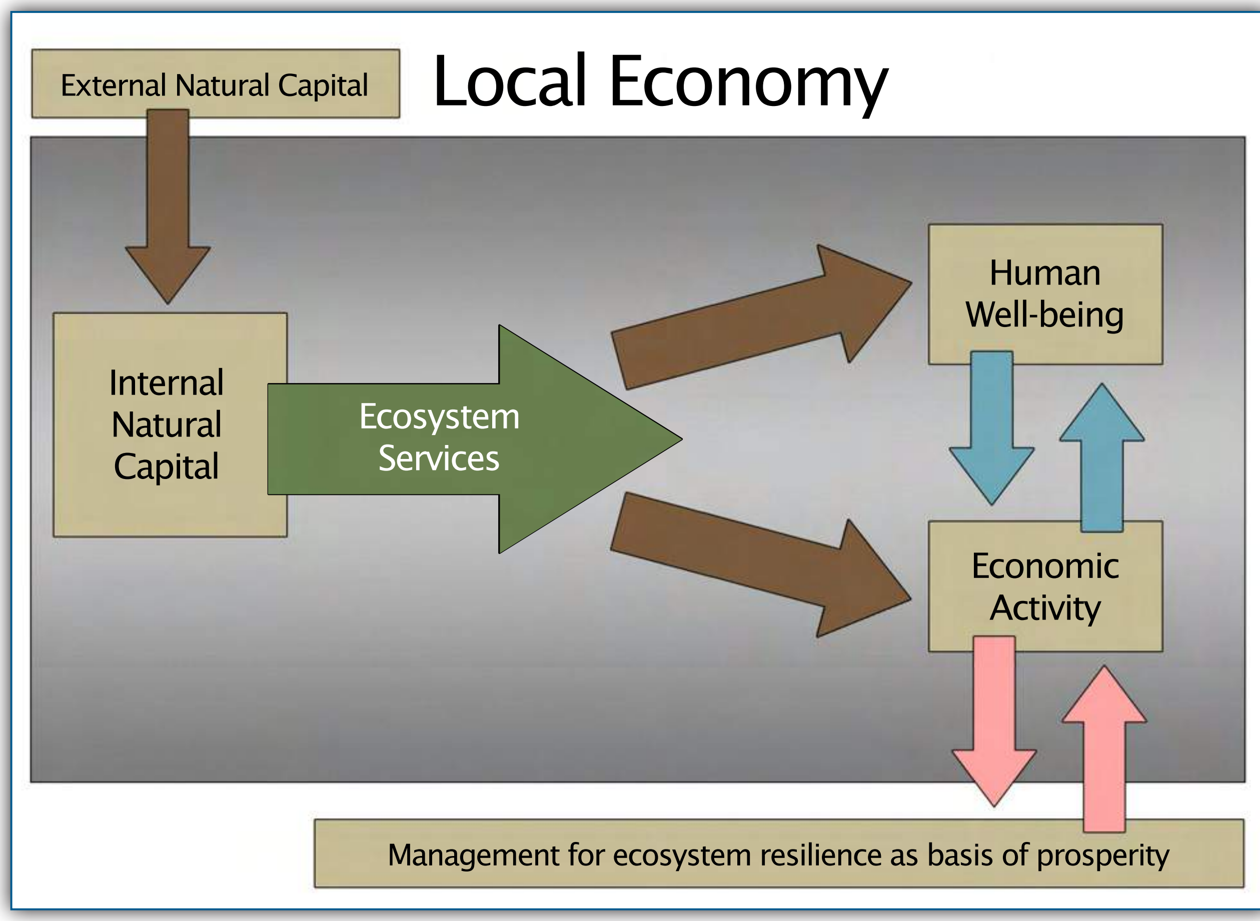
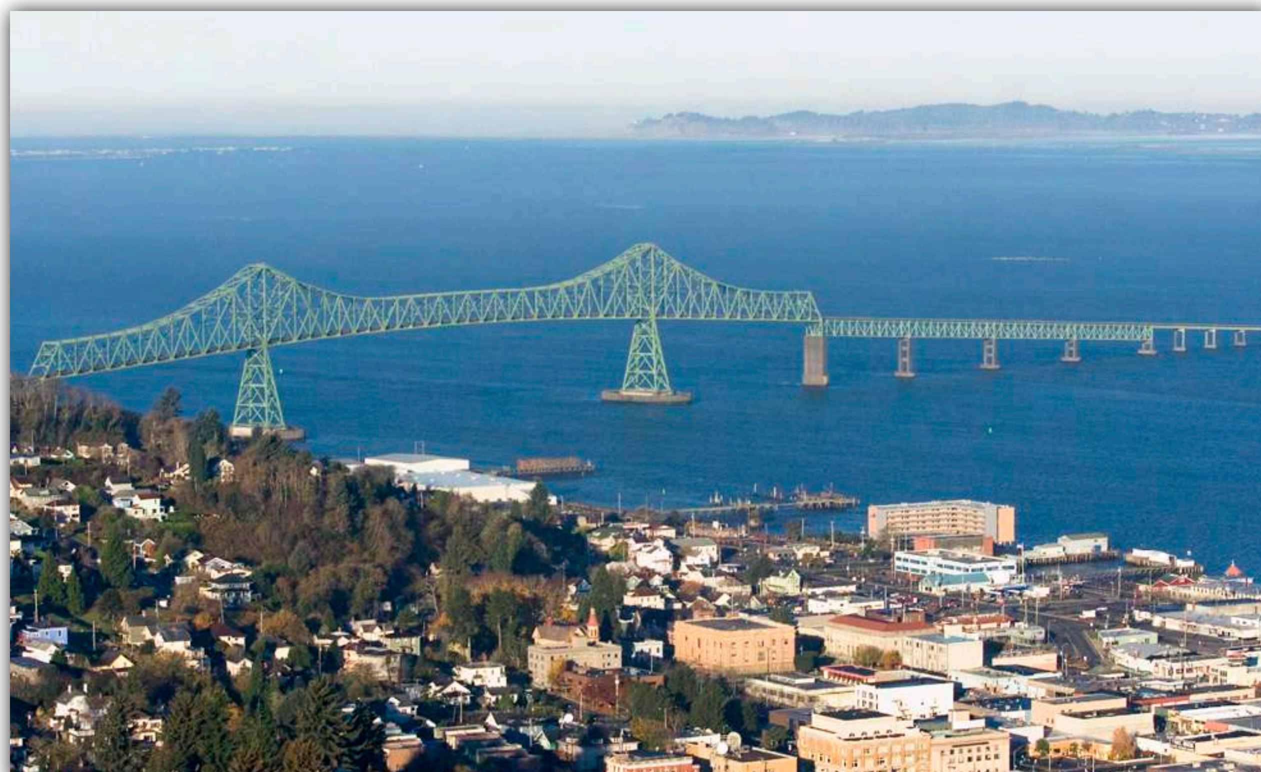


Figure 18.


External Natural Capital
Local Economy
Human Well-being
Internal Natural Capital
Ecosystem Services
Economic Activity
Management for ecosystem resilience as basis of prosperity



Ecosystem Service Valuation and its Relevance to Decision- Making

Valuation of Ecosystem Services Background

As is obvious from the above discussion about ecosystem services, the economic reality of the Oregon Coast cannot be understood without examining the contribution of natural capital and its associated flows of ecosystems services to the economy and well-being of people (see Figures 12 and 17 above). Our economy and communities reside within the landscape as part of the environment. Most decisions are made however without taking into account the explicit contribution of functioning ecosystems to economic activity and output. Interest in identifying, describing, and quantifying the economic value of ecosystem services has grown tremendously over the past 20 years, expressly for the purpose of improving environmental decision-making (Daily 1997, Costanza et al. 1997b, Balmford et al. 2002). This is particularly relevant for coastal areas given that preliminary estimates of the global economic value of coastal and nearshore marine ecosystems demonstrated that two-thirds of total ecosystem service value of all systems on earth come from coastal and marine systems (Costanza et al., 1997b, Costanza 1999). Understanding the nature of this economic value and how it changes and is reduced through ecosystem change and degradation is also crucial because coastal systems are under the highest amount of development and extraction pressure relative to other biomes (UNEP 2005, Vol. 1, Ch. 19).

Deriving economic values for ecosystem services is a complex undertaking. Ecosystem services do not lend themselves to pricing and markets because they lack basic characteristics of private goods. Private property is a pre-condition for the existence of markets. Things that can be both private property and tradable in a market have two main characteristics: they are excludable and rival. Excludability means that people other than the owner/s can be prevented from taking or using a good or service. An excludable good or service has both the physical attributes that make exclusion possible, i.e., it can be contained, fenced, or otherwise restricted, and there is a legal institution that backs up the claim of exclusion. For example, if someone were to find a way around a barrier to use a private good or service without paying for it, they could be fined or jailed. The other characteristic is rivalness. Goods or services are rival when their use precludes someone else from using them. If I am driving my car, you cannot drive my car at the same time. If I drink a glass of water, you cannot drink that same glass of water. These goods are rival. Markets arise for excludable and rival goods and services because people who undertake their production can be more sure of getting their investments back and of making a profit.

Ecosystems produce goods and services. Ecosystem goods like fish or trees can be excludable and rival while ecosystem services, like the production of climate protection, or hurricane storm protection are non-excludable and non-rival. Markets for fish and timber can exist because people can be excluded or once a fish is caught, no one can catch that same fish. Markets for breathable air cannot exist because people cannot be excluded from breathing air, and breathing air is not rival: other people's breathing does not restrict your access.

Ecosystem functions and the services they produce are the result of many interacting factors that operate across large landscapes (storm buffering) or in some cases the whole planet (carbon sequestration). What makes life possible on the planet—the operation of climate, oxygen production, nutrient cycles, water and energy flows, the movements of seeds, pollen, and pollinators, the distribution of different types of plants and soils, and the availability of decomposer organisms such as bacteria and vultures to clean up natural waste products, just to mention a few—are highly interdependent. Oceans operate in a similar way with some organisms spanning large parts of the globe, and ocean nutrient cycles taking place over very large spaces and long time frames. This interdependence and the scale of operation make excluding people from the benefits of some ecosystems and their services, and thus the ability to privatize and market them, both impractical and undesirable.

In addition, the fact that a person's use of an ecosystem service like storm protection or protection from solar radiation does not reduce the ability of another person to benefit from those services makes them non-rival. Non-rival and non-excludable goods and services are what economists call pure public goods and services. The combination of non-rivalness and non-excludability makes establishing private property rights to ecosystem services impractical; it would be very expensive if not impossible to establish the institutions required to exclude people from receiving benefits of these services (Daly and Farley, 2004).

Valuing services which are "public goods," that are not excludable, therefore unmarketable but which contribute to our common wealth, is more difficult. However, a number of techniques have been developed to derive economic values for ecosystem services.

Valuation Techniques

Ecosystem goods and services may be divided into two general categories: marketed and non-marketed. While measuring market values simply requires monitoring market data for observable trades, non-market values of goods and services are much more difficult to measure. When there are no explicit markets for services, more indirect means of assessing values must be used. A spectrum of valuation techniques commonly used to establish values when market values do not exist is identified in Table 8.

As the descriptions in Table 8 suggest, each valuation methodology has its own strengths and limitations, often limiting its use to a select range of ecosystem goods and services within a given landscape or seascape. For example, the value generated by a naturally functioning ecological system in the treatment of wastewater can be estimated using the Replacement Cost (RC) method, which is based on the price of the cheapest alternative way of obtaining that service, e.g. the cost of chemical or mechanical alternatives. A related method, Avoided Cost (AC), can be used to estimate value based on the cost of damages due to lost services. Travel Cost (TC) and Contingent Valuation (CV) surveys are useful for estimating recreation values, while Hedonic Pricing (HP) is used for estimating property values associated with aesthetic qualities of natural ecosystems. Contingent valuation surveys and conjoint analysis can be used to measure existence value of ecosystems and charismatic animals.

The manner in which ecosystems and the services they produce are related to economic value and techniques used to value them can be seen conceptually from Figure 19.

While original studies are desirable for context and accuracy, such data are often simply not available within the desired time frame. In addition, costs can be prohibitive to conduct original empirical work for all services and all ecosystem types in a study area.

To address this difficulty, economists can use a methodology similar to a house appraisal and called value or benefit transfer (see below for a more detailed discussion of this method). Valuations are based on established values of other houses in the same location but sharing similar attributes as well as the particular aspects of the house being appraised. The number of bedrooms, condition of the roof, a finished basement, and a mountain view comprise additive values for estimating the appraised value of the house. Similarly, values derived from studies of similar ecosystem types in other parts of the country or world can be used to estimate values in the target study area. This method is called benefit transfer and is accomplished through conducting a careful analysis of economic values for the appropriate ecosystem type, determining applicability to the target area,

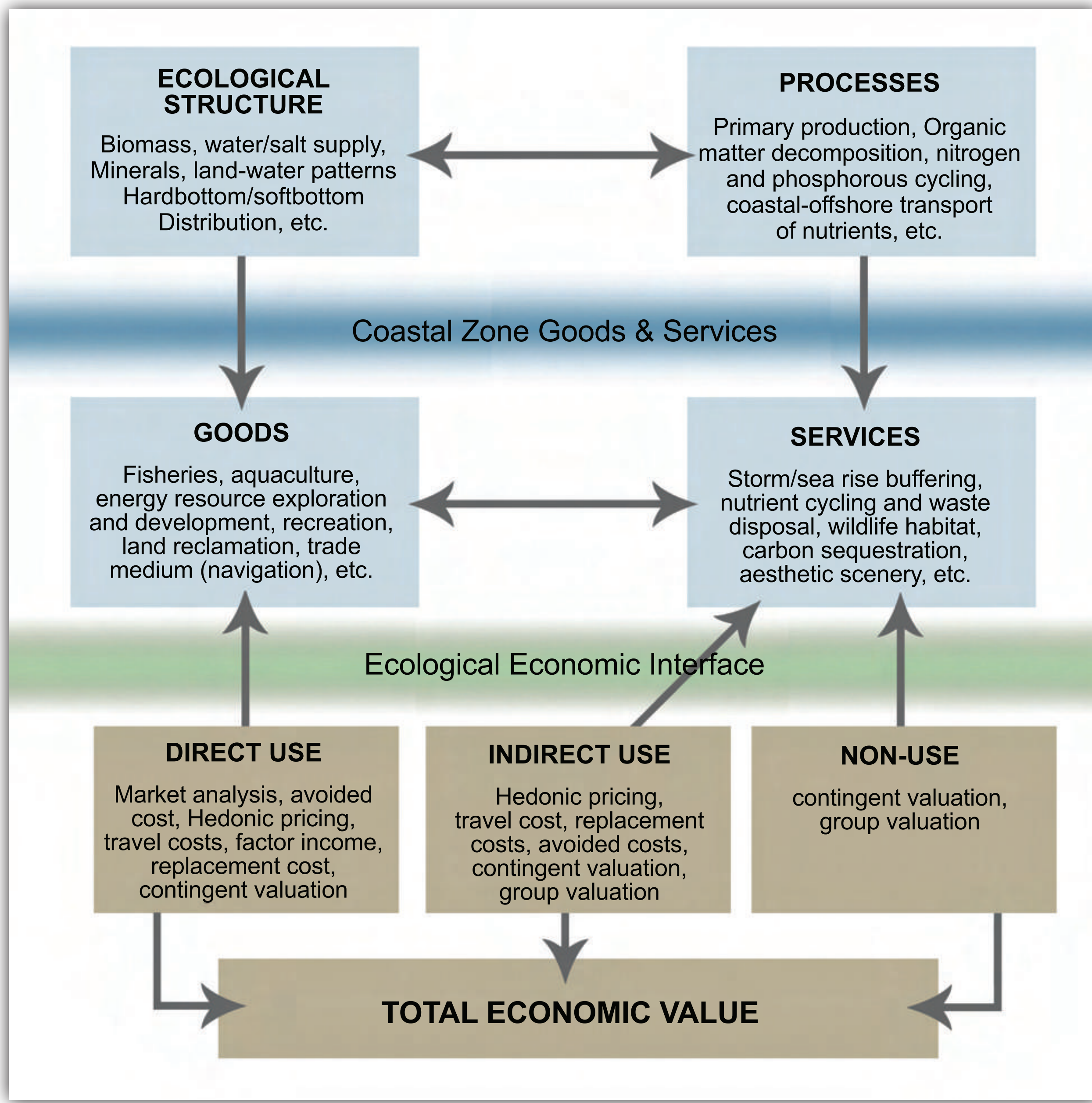
Table 8. Non-Market Economic Valuation Techniques

Avoided Cost (AC): services allow society to avoid costs that would have been incurred in the absence of those services; flood control provided by barrier islands avoids property damages along the coast.
Replacement Cost (RC): services could be replaced with man-made systems; nutrient cycling waste treatment can be replaced with costly treatment systems.
Factor Income (FI): services provide for the enhancement of incomes; water quality improvements increase commercial fisheries catch and incomes of fisherpeople.
Travel Cost (TC): service demand may require travel, whose costs can reflect the implied value of the service; recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it, including the imputed value of their time.
Hedonic Pricing (HP): service demand may be reflected in the prices people will pay for associated goods: For example, housing prices along the coastline tend to exceed the prices of inland homes.
Marginal Product Estimation (MP): Service demand is generated in a dynamic modeling environment using a production function (i.e., Cobb-Douglas) to estimate the change in the value of outputs in response to a change in material inputs.
Contingent Valuation (CV): service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; e.g., people generally state that they would be willing to pay for increased preservation of beaches and shoreline.
Group Valuation (GV): This approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from open public debate.

converting values to common units – usually dollars per acre per year, then applying them to acres of ecosystem type based on GIS analysis.

There is currently a robust discussion in the academic literature about using benefit-transfer methods (see e.g., Wilson and Hoehn, 2006 and Spash and Vatn 2006) due to the wide ranges of value that can emerge from these studies and other issues involving incommensurability. It is important to understand the limitations of the studies, but also to understand their appropriate decision-making context. The purpose of even estimating the values is to show that services that had a prior implicit economic value of zero are worth substantially more than that. Estimates from value transfer studies can often be shown to be underestimates of actual value, and can therefore demonstrate that ecological services in an area are worth at least x much, which is quite often

Figure 19. Calculating total economic value of the coastal zone: Ecosystems, ecosystem services, and valuation methods.



more than costs of restoring or maintaining those systems. Furthermore, there is no reason that economic values should ever be the sole decision-making criteria. There are techniques to formally incorporate economic values with other social and policy concerns called multi-criteria decision analysis. Having economic information on ecosystem services usually helps this process because traditionally, only opportunity costs of forgoing development or exploitation are counted against non-quantified environmental concerns.

There are also social issues involved with the entire exercise of assigning monetary values to nature. Discussions of the economic value of ecosystem services are often laden with concerns of privatizing nature (e.g. McCauley, 2006) or worries that the act of putting dollar values on what ecosystems do will lead private landowners to demand payments for the services their lands provide without regard for wider social or legal obligations. It is important to frame the discussion of ecosystems and their services with an analysis of both the ecological economic and legal underpinnings of ecosystems services as public and/or common property resources. Understanding that ecosystems produce services that are of value, both socially and economically, does not mean that ecosystem services can or should be privatized. In fact, because most ecosystem services operate in a way to make them non-excludable, they are public goods by nature (or by definition). Thus it is appropriate for public institutions to manage them. However, decisions still need to be made on how to allocate scarce public funding, and what development activities need to be forgone to keep natural capital intact (Costanza, 2006).

Marine and Coastal Ecosystem Service Valuation Work to Date

Primary research on the value of ecosystem services in coastal and marine environments has been conducted over the past 20 years. However, there still remain many gaps in information on specific ecosystem services. There are also only a small number of studies that have been completed in the Pacific Northwest of the United States. Table 9 shows which services and ecosystem types have valuation data for non-marketed services. Provisioning services provide goods that are typically marketed, though there are subsistence activities that do not enter markets.

An examination of the table shows there are many important ecosystem services in the marine and coastal environment for which there is little or no valuation data. Nutrient cycling, carbon sequestration, human disease control, and waste processing, for example, have very little economic valuation data but are very important to human well-being and the ability of the economy to function. On the other hand, recreation, tourism and aesthetic value have a richer record of study. These services, which we know from the above discussions are important to Oregon's coastal economy, have been shown to provide high values for the ecosystem types in which they have been analyzed. For example, studies on the east coast show recreational and aesthetic values from the hundreds to the tens of thousands of dollars per acre for recreation on beaches and estuaries and for value added to water front properties (e.g., Edwards 1991, Kline 1998, Pompe and Rinehart, 1995, Silberman et. al. 1992, Johnston et al. 2002). We also found a study of the value of whale watching in Scotland in which the authors found that this activity added 7.8 million Sterling pounds to the western Scotland coastal economy per year (Parsons et al. 2003), and a study of how people value protection of ecosystems afforded by marine protected areas in California (Hall et al. 2002). This latter study estimated a total willingness to pay of $3.6 to $4.8 million dollars per mile of coastline in southern California for the ecosystem protection benefits of well-enforced management of marine

Table 9. Peer Review Study Coverage of Non-Market Marine and Coastal Ecosystem Services[1]

	Beaches and Dunes	Headlands and Rocky Islets	Estuaries, Bays, and Marshes	Intertidal	Kelp	Rock Reef	Eelgrass	Near Shore Ocean	Near Shore Open Space	Seamounts and Mid-Ocean Ridges	Deep Sea Gyres
Biodiversity				**1**	**1**						
Provisioning Services[2]											
Food											
Fiber, Fuel											
Medicines											
Regulating Services											
Shoreline stabilization/ erosion control											
Storm protection	**3**	**1**	**2**								
Water flow regulation and storage	**7**		**17**					**5**	**4**		
Human disease control											
Waste processing											
Carbon sequestration			**1**								
Supporting Services											
Nutrient cycling											
Habitat	**1**	**2**	**5**		**1**			**4**	**1**		
Primary Productivity			**1[3]**								
Cultural											
Spiritual	**3**		**1**								
Scientific and Educational											
Tourism/Recreation	**11**	**1**	**20**					**24**	**13**		
Aesthetic	**1**		**9**		**1**			**1**	**2**		

1. Some studies examine more than one ecosystem service and or more than one habitat type.
2. Provisioning services are not covered in this table because their values can be measured through direct markets.
3. Study specifically looked at saltwater marshes.

protected areas. A value transfer study in Oregon then would be able to draw from this literature but would produce a known underestimate due to lack of knowledge of the economic value of many ecosystem services in several ecosystems.

What a Full Valuation for Coastal Oregon Would Entail

The most accessible and timely approach to conducting an ecosystem service valuation of coastal and marine ecosystems of Oregon would be to conduct a value transfer or benefit transfer study. Value transfer involves the adaptation of existing valuation information or data to new policy contexts[1]. In this analysis, the transfer method involves obtaining an economic estimate for the value of non-market services through the analysis of a single study, or group of studies, that have been previously carried out to value similar services. The transfer itself refers to the application of values and other information from the original "study site" to a new "policy site" (Desvouges et al. 1998; Loomis 1992; Smith 1992).

With the increasing sophistication and number of empirical economic valuation studies in the peer-reviewed literature, value transfer has become a practical way to inform decisions when primary data collection is not feasible due to budget and time constraints, or when expected payoffs are small (Kreuter et al. 2001; Moran 1999). As such, the transfer method is a very important tool for policy makers since it can be used to reliably estimate the economic values associated with a particular landscape, based on existing research, for considerably less time and expense than a new primary study.

The raw data for a value transfer exercise would come from previously conducted empirical studies that measured the economic value of ecosystem services. Studies would be reviewed by a research team and the results analyzed for value transfer to the coastal and marine ecosystems of Oregon. The original results would be entered into a relational database format, then each dollar value estimate could be identified with unique searchable criteria (i.e., type of study, author, location, etc.), thus allowing the team to associate specific dollar estimates with specific conditions on-the-ground. For example, all estuary-related value estimates would be chosen to come from economic studies that were originally conducted in temperate cool-water systems similar to those in Oregon and the Pacific Northwest. To achieve this, once analyzed, the valuation data would be integrated with land and marine cover data and habitat types for Oregon. Tables and maps would then be generated from this fusion of economic and geographic information.

The research team would develop a set of decision rules for selecting empirical studies from the literature that allowed us to estimate the economic value of ecosystem services in the coastal and marine environment in Oregon. Using scientific data search engines and by cross-checking the value transfer databases, the research team would review the best available economic literature

1 Following Desvouges et al. (1998), we adopt the term "value transfer" instead of the more commonly used term "benefit transfer" to reflect the fact that the transfer method is not restricted to economic benefits, but can also be extended to include the analysis of potential economic costs, as well as value functions themselves.

and select valuation studies which were:

1. Focused on marine and coastal environments similar to those in the Pacific Northwest of North America.
2. Focused primarily on non-consumptive use. Consumptive use of provisioning goods would be added separately, given that this data is readily available.

The quality of the original studies sets the limits on the accuracy of the final value estimate (Brouwer, 2000). Oftentimes, important information is missing from original studies that make assessment of quality difficult or impossible (Rosenburger and Stanly, 2006).

The geographic landscape for full ecosystem service valuation could be just the marine and coastal ecosystems as described in this report, or it could also be expanded to include all land cover types in the coastal counties, including forests, riparian areas, agricultural land and urban areas. Satellite imagery mapped into Geographic Information Systems (GIS) provides a powerful tool for understanding and using large amounts of geographic data with the full range of land uses and vegetation types as well as other aspects of the landscape and seascape. Some of this data is available, especially for the coastline and nearshore (e.g., as summarized in Johnson and O'Neil, 2001). However, detailed mapping of marine ecosystems, especially seafloor areas, has not occurred (Scientific Consensus Statement for Mapping the Oregon Territorial Sea Floor, 2005).

The total ecosystem service value (ESV) of a given land- or marine-use/land- or marine-cover type for a given unit of analysis (i.e., watershed) would be determined by adding up the individual, ecosystem service values associated with each land use/land cover type. The following formula is used for this calculation (Costanza et al., 2007):

$$V(ESVi) = \sum_{k=1}^{n} A(LU_i) \times V(ES_{ki})$$

Where:
A(LUi) = Area of Land cover (i)
V(ESVi) = Annual value of Ecosystem Services (k) for each Land Use (i)

Total ESV flow estimates for each land cover category would then be estimated by taking the product of total average per acre service value and the area of each land/marine-cover-type in the coastal area of the state (see e.g., Costanza et al. 2007).

A study using this overall method could produce the following outputs:

1. Tables synthesizing the results of all of the primary studies on the value of each ecosystem type and ecosystem service flow included in the study;
2. tables compiling the value of ecosystem service flows for the entire coastal and marine ecosystem;
3. maps of the current value of ecosystem service flows in coastal Oregon and the territorial waters based on these estimates;
4. an analysis of the effects on ecosystem service values of differences in spatial patterns of marine reserves and coastal zone land use; and
5. the results of converting annual flows of ecosystem service values to estimates of the value of Oregon's coastal and marine stock of natural capital.

Additional Approaches

Value transfer methodology would produce an estimate of the value of ecosystem services for which data exists. The estimate would however produce a snapshot based on assumptions of current conditions. Additional work could be done in which models are constructed to project ecosystem recovery based on potential management options, including establishment of marine reserves, or various alternatives with more or fewer marine reserves or larger or smaller marine reserves. The models could estimate the contribution to ecosystem services that recovered habitat, biodiversity, and fish populations make to the value of those services. Such models have been constructed (GUMBO - Boumans et al. 2002), and are being improved upon in current research (*Models of Ecosystem Services in the Earth Systems*, Gund Institute of Ecological Economics, 2006).

Another option could be to complement the above approaches with original empirical research which studied how much people are willing to pay for the multiple benefits of a network of marine reserves off the Oregon Coast. A contingent valuation approach could get at hard to assess values of multiple ecosystem services and be more specific to Oregon, which is important given the likelihood that there is a strong relationship between the current structure of the coastal economy and the quality of the marine and coastal environment. Monetary values that would be produced through such a study could be complemented with studies of other aspects of peoples' values around marine protected areas (e.g., Villa et al. 2002).

In summary, an ecological economics study of the coastal and marine environment in Oregon could help decision-makers understand the value of the area's natural capital and flow of ecosystems services. It could also help define a research agenda to fill in important data gaps that need to be addressed to produce the fullest estimations of value possible. The monetary estimates would then provide a comparison to potential costs of contemplated management actions such as establishing marine reserves or other measures for restoring the coastal and marine environment. It would also help decision-makers and citizens understand how natural capital and ecosystem service flow contribute to the overall health of Oregon's coastal economy.

Photo by Ben Nieves

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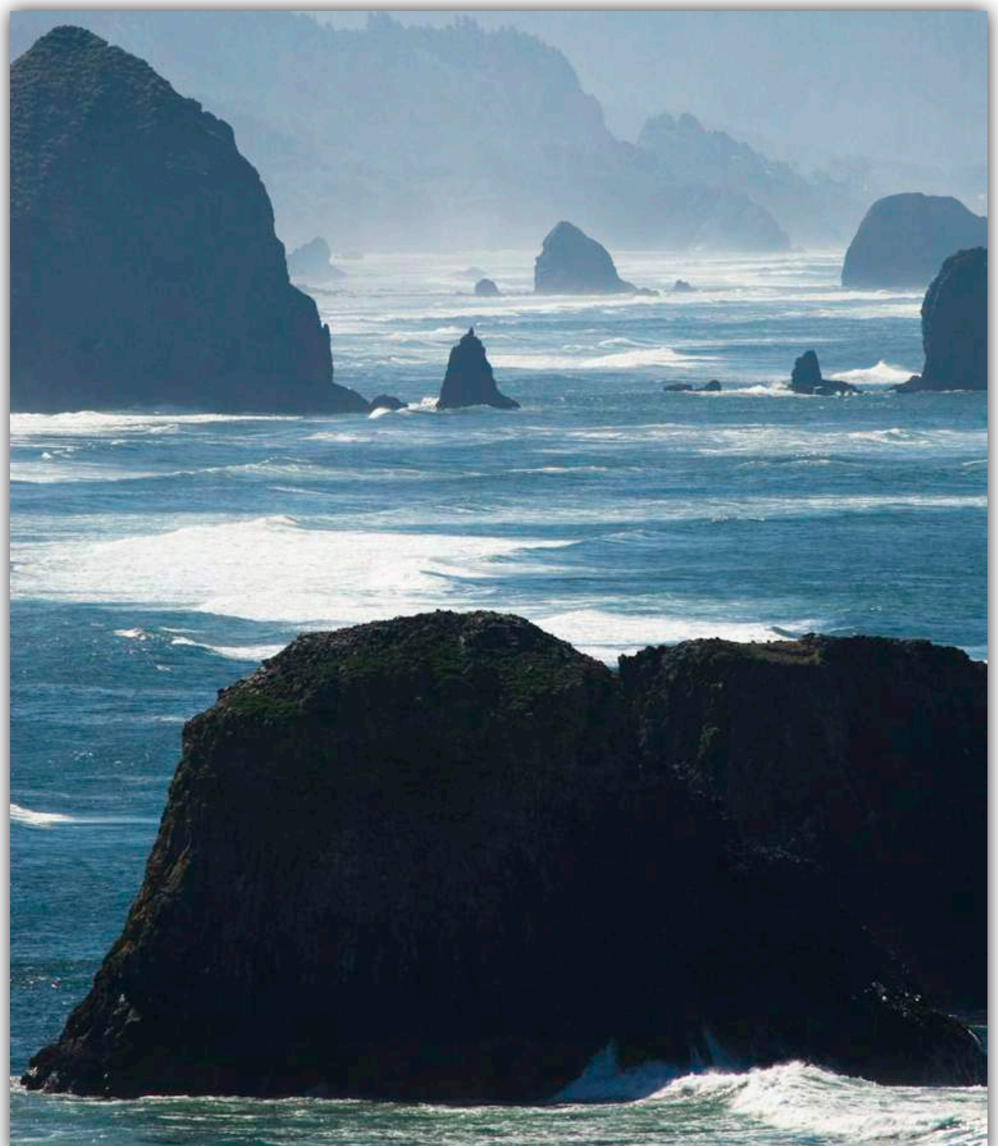

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