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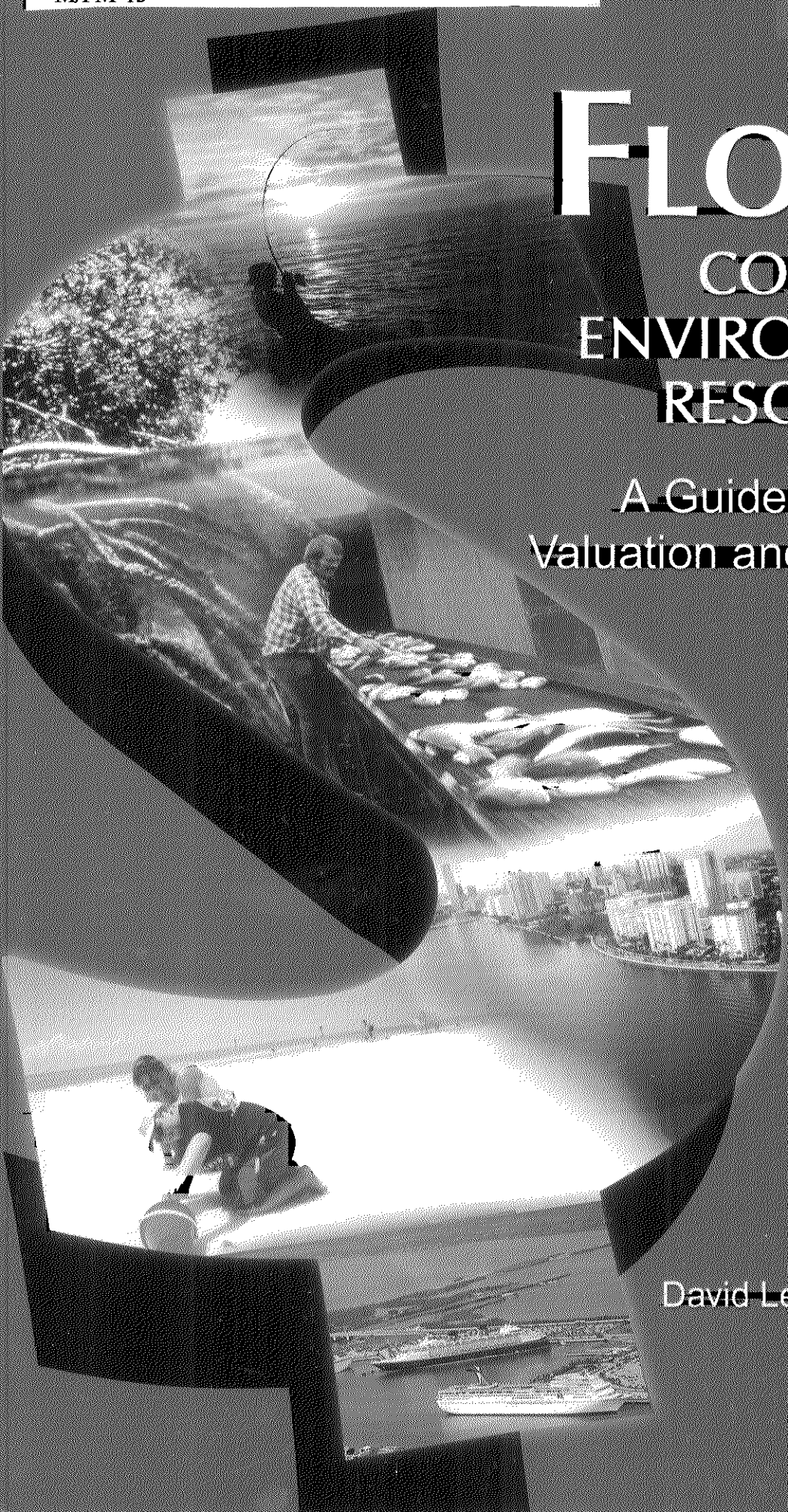

FLORIDA COASTAL ENVIRONMENTAL RESOURCES

A Guide to Economic Valuation and Impact Analysis

Edited by
David Letson and J. Walter Milon

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Florida Coastal Environmental Resources

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Authors and Affiliations

Chuck Adams
Food and Resource Economics Department
University of Florida
1193 McCartyHall
P.O. Box 112040
Gainesville, FL 32611-0240

Frederick W. Bell
Department of Economics
Florida State University
245 Bellamy Building
Tallahassee, FL 32306-2180

Nelson Ehrhardt
RSMAS/Marine Biology and Fisheries
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098

Alan Hodges
Food and Resource Economics Department
University of Florida
P.O. Box 112040
Gainesville, FL 32611-0240

Grace Johns
Hazen and Sawyer PC
4000 Hollywood Boulevard
Seventh Floor, North Tower
Hollywood, FL 33021

Sherry L. Larkin
Food and Resource Economics Department
University of Florida
P.O. Box 112040
Gainesville, FL 32611-0240

Vernon R. (Bob) Leeworthy
NOAA/NOS
Building SSMC4, Room 9115
1305 East-West Highway
Silver Spring, MD 20910-3281

David Letson
RSMAS/Marine Affairs
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098

Lisa A. McDonald
Hazen and Sawyer PC
4000 Hollywood Boulevard
Seventh Floor, North Tower
Hollywood, FL 33021

J. Walter Milon
Department of Economics
College of Business Administration
University of Central Florida
P.O. Box 161400
Orlando, FL 32816-1400

David Mulkey
Food and Resource Economics Department
University of Florida
P.O. Box 112040
Gainesville, FL 32611-0240

Christian Read Sawczyn
School of Law
University of Florida
Gainesville, FL 32611-0240

current address:
9100 East Florida Avenue
Apt. 10-305
Denver, CO 80231

Manoj Shivlani
RSMAS/Marine Biology and Fisheries
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149-1098

PREFACE

The genesis of *Florida Coastal Environmental Resources: A Guide to Economic Valuation and Impact Analysis* was a workshop sponsored by the National Oceanic and Atmospheric Administration in 1991. The workshop brought together state and local coastal and marine planners and representatives from non-governmental organizations and industry who were concerned with identifying, prioritizing, and incorporating social science research into NOAA's coastal ocean science research program. A major theme was the importance of environmental economics in coastal and marine management and the need for professionals in this community to better understand basic concepts such as trade-offs, willingness-to-pay, cost-benefit analysis, and environmental valuation.

Coastal and marine planners and managers at all levels reported being asked to respond to new demands that could explicitly account for the economic dimensions of their management decisions. At the Federal level, a series of Executive Orders and Guidelines now call for strict economic analysis of proposed Federal regulations and projects, especially those that impact water and related land resources. Of particular imporance to NOAA and other Federal and state natural resource trustees is the application of economic analysis for determining monetary restitution that responsible parties would have to pay for damages caused by oil spills and other releases of toxic materials. Related legislative and regulatory requirements are being put in place at state and local levels. Consequently, economic impacts — benefits and costs — are now at the center of many policy, management, and legislative debates, locally, regionally and nationally.

Based on more detailed discussions with the coastal management community, and in view of advances by economists in applying environmental economics to practical management problems, we concluded that balanced presentations of the pros and cons on the uses of economics in coastal decision-making was a key to improving coastal management. Consequently, we presented a series of workshops around the country on the role of economics in coastal and marine decision making. Feedback clearly demonstrated that these concepts and methods were important; the next step was to present them in the context of the day-to-day decisions that are being made at the local level.

With support from NOAA Line Offices and the National Sea Grant College Program, we developed regional projects that were intended to demonstrate the application of environmental economics; these projects used real data and focused on actual issues that are being addressed along the nation's coasts. *Florida Coastal Environmental Resources* is one of the regional activities we undertook. We hope it proves useful in improving the way in which Florida manages its coastal environmental resources.

Douglas Lipton
Associate Professor of Agricultural and Natural Resource Economics
University of Maryland

Rodney Weiher
Chief Economist
National Oceanic and Atmospheric Administration

Economic Valuation and Analysis

CHAPTER 1

Economic Value and Environmental Quality: Florida's Coastal Resources

David Letson

Florida's coastal resources serve many diverse interests. While its beaches, fisheries, barrier islands, wetlands and navigable waters have immense economic values, these same resources have important ecological and cultural values as well. Florida's 8,400 miles of tidal shoreline, the longest in the continental United States, is an attraction for more than 16 million residents and 80 million visitors each year (Trend Magazines, Inc. 2002).

Florida's coast supports both the state's economy and its quality of life. Like coastal areas nationwide, population growth, land development and expansion of businesses and industry have led to competing uses of the same natural resources, uses that have influenced aquatic ecosystems. In the past, Florida's coasts seemed vast enough that they could be used without concern for the future; we have known for some time now that such is not the case. The questions facing all of us — policy makers, resource managers, business and industry leaders, and citizens — are many. How can we best accommodate competing uses of the same resources? How can we balance economic growth with restoration and sustainability of coastal ecosystems? These are among the challenging issues we must deal with now and in the coming years.

FLORIDA'S COASTAL ECONOMY

The magnitude of Florida's market economy in coastal communities was summarized in a 1996 special report, which documented economic values associated with construction, commercial fishing, beach tourism, navigation and recreation. Construction in coastal counties plays a significant role in the state economy: in 1993, 87,717 building permits, 76 percent of all those issued in the state, had a net worth of $11.35 billion. Beach-related tourism, in 1996, was estimated at $15 billion to the state economy. While the value of commercial fish harvests was considerably lower, estimated at $202 million, fishing was noted as having great economic and cultural significance for local communities (State of the Coast Report 1996).

The shipping industry has the single greatest impact on the state economy of any other industry. The state is immensely attractive to the industry because of proximity to foreign markets. In 2000, for example, Florida's five largest seaports (Miami, Port Everglades, Jacksonville, Tampa, Palm Beach) handled more than 100 million tons of

cargo. This waterborne trade contributed more than $47 billion to the state economy, representing 64.5 percent of the state's $74 billion international trade. (Florida Seaport Transportation and Economic Development Council 2002).

Recreational uses of the coast are highly valued and include swimming, water skiing, diving, boating, fishing and beach access. Fishing and boating registrations are one index of the extent of these activities: in fiscal year 2000-2001, Florida residents bought 604,516 one-year saltwater fishing licenses; non-residents purchased 93,637 one-year licenses and 315,156 three- and seven-day licenses. Total revenue for all of these saltwater fishing licenses was $12.4 million. An additional $1.1 million accrued through the sale of five-year and lifetime saltwater fishing licenses (Florida Fish and Wildlife Conservation Commission 2002). In 2000-2001 there were 864,000 recreational vessels registered in Florida (Department of Highway Safety & Motor Vehicles 2002). Economists have estimated the effect of saltwater fishing on regional incomes. For example, in 1991, the economic impact of saltwater fishing by Florida residents was an estimated $1.327 billion, and those activities by non-residents generated for Florida a similar impact, $1.306 billion (Milon and Thunberg 1993).

Florida's economy has grown rapidly in recent years and population has grown as well, particularly in coastal areas, creating developmental pressures. Between 1950 and 2000, Florida's population increased from 2.7 million to nearly 16 million. Since 1990, population in Florida has grown by nearly one-fourth. By 2025, the state is projected to trail only California in population (Enterprise Florida 2001). The percentage of Florida's population living in the 35 coastal counties has been in the high seventies for the past 25 years, and that trend is expected to continue (Florida Department of Community Affairs 2000). Residential and commercial development has followed this increasing number of permanent and seasonal residents. In turn, new infrastructure, such as roads and sewers, supports the development. The resulting increase in impervious areas and storm water runoff, however, can impair surrounding coastal waters. Additional sewage treatment, waste disposal, water supply and electric power production also may cause degradation. Between 1989 and 2000, an average of 132,000 residential building permits was issued each year in Florida, with 155,000 in 2000. Growth continues to bring more users and increased competition for coastal resources.

MEASURING ECONOMIC IMPACTS

Not all benefits of coastal resources are as obvious as those associated with tourism and shipping. Some resource uses and values occur at a distance from the resource itself. For example, seagrass and wetland systems provide critical habitat for marine and estuarine fish, shellfish and mammals, including many highly valued, recreational and commercial species. Also, dune systems buffer inland areas from the effects of strong storms. Efficient coastal resource management considers off-site ecosystem and flood control benefits, despite their diffuse nature.

MEASURING THE IMPORTANCE OF COASTAL RESOURCES

Because many coastal resource uses are not traded in markets, their values cannot be measured in traditional ways. For example, a proposed housing development that could damage the ecological integrity of wetlands might indirectly hurt recreational and commercial fishing as well. The values of ecosystem "services" are frequently intangible but may also be important. Such values were often unaccounted in the past because economists could not estimate them; consequently in comparing costs and benefits of public works or other coastal development (e.g., housing, new industry, recreational facilities), these values were often ignored. Over the last 25 years, however, economists have developed a variety of techniques for estimating values of non-market goods and services. Though at times controversial, several such as contingent valuation, travel cost methods and hedonic analysis are used regularly, particularly in large public works projects.

ECONOMIC VALUATION AND LEGISLATIVE MANDATES

The use of economic analysis in natural resource policy making has been evolving with both the science of economics and our greater understanding of the wide-ranging impacts that human activities have on coastal ecosystems. In the past, even when decision-makers were aware that policy and regulatory actions might impact natural resources, the more conventional economic tools then available were not capable of valuing their implications. Economic theory now has techniques to address natural resource valuation; in some cases, federal laws and regulations stipulate cost-benefit analyses that require valuation which only these techniques can deliver (Lipton et al. 1995). For a detailed review of environmental legislation that is subject to cost-benefit analysis, see Morganstern (1997).

Economic valuation of natural resources gained its first statutory authority with the River and Harbor Act of 1902, which required engineers to review the costs and benefits to commerce of proposed projects by the Army Corps of Engineers. With time, the idea that federal projects should have economic justification gained support. The Flood Control Act of 1936 authorized federal participation where the benefits of flood control exceeded costs. Cost-benefit analysis spread to other agencies as a way to justify public works and determine who should pay for them. After World War II, federal agencies broadened their scope to include indirect benefits and costs, as well as intangibles.

Environmental statutes and executive orders vary as to how costs and benefits are to be considered in making decisions to protect the environment (Table 1.1). Two landmark commitments to pollution control by the federal government, the Clean Air Act of 1970 and the Clean Water Act of 1972, both explicitly prohibited comparisons of costs and benefits in setting environmental standards. Those standards were based primarily on public health criteria. Updates to the Clean Water Act, however, may sometimes require the application of non-market economic valuation. For example, Section 404 of

TABLE 1.1. MAJOR FEDERAL ENVIRONMENTAL STUDIES

- Clean Air Act of 1970
- Clean Water Act of 1972
- Safe Drinking Water Act
- Resource Conservation and Recovery Act
- Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
- Toxic Substances Control Act
- Comprehensive Environmental Response and Compensations and Liability Act of 1980 and Natural Resource Damage Assessment (CERCLA)
- National Environmental Policy Act
- Pollution Prevention Act

the Clean Water Act is a component of the permit process necessary for conversion of wetlands in development projects. (Lipton et al. 1995). In making permit decisions, the Army Corps of Engineers is now expected to take environmental values into account when comparing costs with benefits. In the case of Everglades restoration, however, the 1996 Water Resource Development Act contained a specific clause (Section 528) stating that the Army Corps of Engineers need not estimate environmental benefits so long as environmental objectives were achieved at least cost (Milon and Hodges 2000).

Economic valuation of natural resources has significantly grown in importance since the early 1980s. President Reagan's Executive Order 12291 of 1981 required cabinet-level departments to prepare cost-benefit analyses justifying major rules for review by the Office of Management and Budget's Office of Information and Regulatory Affairs. The Order required that "regulatory objectives shall be chosen to maximize the net benefits to society" and that for given regulatory objectives, "the alternative involving the least net cost to society shall be chosen" (Farrow and Toman 1999).

President Clinton issued Executive Order 12866 in 1993, which mandates cost-benefit analysis on any federal regulation costing more than $100 million (OMB 1994). As Farrow and Toman (1999) point out, the new Order extends and modifies Reagan's in important ways: it requires that benefits "justify" costs rather than "outweigh." It also requires that a number of qualitative factors be considered, in addition to cost-benefit analysis, such as distributional effects and factors that cannot be easily expressed in monetary terms. To improve the required cost-benefit analysis and make it more consistent, Executive Order 12866 convened an interagency group consisting of representatives from the Office of Management and Budget and the Council of Economic Advisors to provide guidelines for the preparation of the required cost-benefit analysis. For example, the group recommended that for "goods providing 'nonuse' values, contingent valuation methods may provide the only analytical approaches currently available for estimating values" (Farrow and Toman 1999). However, the group also cautioned, "value estimates derived from contingent valuation studies require greater analytical care than studies based on observable behavior."

The Toxics Substances Control Act (TSCA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA require some cost-benefit balancing so that costs are not disproportionate to the benefits (Cangelosi 2001). Cost-benefit and cost-effectiveness analyses are tools to assist decision making — they are not the basis of decision making. Amendments to FIFRA require that every five years, all pesticides be reauthorized for use by the government. The act requires manufacturers to prove that the benefits from a given pesticide outweigh the economic and environmental costs. Damages (lost or foregone benefits) to environmental services must be determined in this process.

In some cases federal legislation explicitly calls for economic valuation of natural resource damages. The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or Superfund) established the Natural Resource Damage Assessments Program, which explicitly calls for the estimate of interim lost values of damaged natural resources and resource services. The Oil Pollution Act of 1990 and subsequent natural resource damage assessment regulations have placed pressure inside and outside of government to improve the decision-making criteria that affect public funds and resources (Lipton et al. 1995). More recent amendments to environmental legislation have strengthened requirements for economic benefit-cost analysis as part of management and regulatory programs. The National Marine Sanctuary Act Section 312 Title III, for example, authorizes the National Oceanic and Atmospheric Administration to recover damages for the destruction, loss or injury of sanctuary resources in National Marine Sanctuaries (Cangelosi 2001).

CERCLA gives citizens the right to sue for natural resource damages that result from hazardous waste disposal and contaminate public resources, such as rivers, lakes, estuaries, or other aquatic or terrestrial resources. CERCLA's natural resource damage assessment provision explicitly calls for estimates of lost values from injured resources. Under CERCLA, compensation for contamination from hazardous waste disposal must make the public as well off as it would have been without the contamination. Resource trustees must determine lost resource values prior to restoration. Values may include those that society associates with the knowledge that a natural wilderness area exists (i.e., existence values). Regulations promulgated under authority of these statutes specifically discuss methods for measuring damages, including travel cost, hedonic valuation and contingent valuation, as well as the range of types of values, for instance, market-related and non-market use values.

In the past, development did not appear to threaten many coastal resources. With continued coastal population growth, however, the consequences of development will become more apparent. Balancing economic uses of the coast with our desire to preserve its natural character will require that we prioritize uses for our limited coastal resources. Economics can help identify resource uses that are mostly highly valued, and perhaps worthy of designation as priorities.

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CHAPTER 2

PRINCIPLES OF ECONOMIC VALUATION

David Letson

Why do we need to know economic values? The reason is that the availability of coastal resources is scarce relative to the demands we place on them. Because Florida's coastal resources are scarce, managing them is partly an economic problem. Economics can inform policy makers about the values of alternative and in some cases competing uses of our coastal resources.

If coastal resources like beaches and fisheries were available for everyone in any quantity, no economic problem would exist. We could all have what we want, without having to choose. But resources such as fish stocks are not unlimited. While resource management agencies may develop harvesting and creel regulations, other factors, for instance, the loss of wetlands, industrial discharges and runoff from new development can also affect fishery productivity. In public policy as in our daily lives, we frequently must make choices. Since we must choose, we should consider which resource uses are most highly valued. The key notion here is what economists call "opportunity cost," the idea that the resource use choices we make do restrict other opportunities.

In economics, the term "value" means the price individuals are willing to pay to obtain goods and services. This chapter considers the various uses of Florida's coastal resources and how economics can inform policy decisions related to these resources. Estimating the value of goods and services not traded in markets — for instance, recreational fishers' willingness to pay for more abundant fish stocks — can be indirect and sometimes controversial. Because some economic values of natural resources have been difficult to measure, policy makers have sometimes ignored these values in the past. To cite one example, would the 103-mile Kissimmee River have been straightened into a 52-mile canal if economists and policy makers in 1954 had known the flood control and water quality benefits that would be lost (Pilkey and Dixon 1996)? We need to know the values of alternative uses of such resources because managing them is in part an economic problem.

COASTAL RESOURCES AND MARKETS

The scarcity of resources in relation to human demands implies choices and thus tradeoffs. In markets, we can make informed choices. Products are visible, have well-known characteristics and carry designated prices. In contrast, while they spawn a great deal of economic activity, uses of coastal resources such as beaches and commercial fisheries usually are not themselves transacted in markets. Registration fees for

boaters and entrance fees for beaches, for example, while not negligible, are intended to cover administrative costs and do not represent users' willingness to pay for boating or beach access. Consequently, much less information exists about these resource uses. Posted prices are lacking that would reflect user values.

Why don't markets exist for many uses of coastal resources? In part, market transactions never materialize because many coastal resources are *common pool resources*. That is, they are subject to *rivalry* in consumption and are *non-excludable* in provision. Both features are crucial to understanding the economic nature of user conflicts.

Rivalry occurs when one person's consumption of a good diminishes others' ability to consume that good. Rivalry often leads to user conflicts — in nearshore waters, for example, conflicts might arise between jet skiers and commercial fishermen or between recreational anglers and aquaculture operations. Non-excludability refers to a situation where a resource owner cannot prevent anyone else from using the resource, as in cases where public officials have difficulty enforcing fishing regulations. Taken together, the rivalry and non-excludability features explain why markets do not develop for many coastal resources. Users will not pay for what they can use for free; and without a price to ration access, crowding and conflict will result. Because their use is often free and rival, many coastal resources suffer from over-use.

The lack of markets for many coastal resources implies a lack of information for decision makers. We do not know as much as we would like about which uses of a fishery or beach are most important to protect. Yet if we are to make informed choices, we must have some measures of the economic values we are trading off.

ECONOMIC VALUE

Choices involving unpriced goods can be troubling for policy makers and for the public as well. For example, construction of a large new marina can affect manatee populations — how much do we value manatees as compared with boating access? To make comparisons involving unpriced goods, we can estimate the economic value in question. In markets, we choose by comparing our willingness to pay to the price of a product; we decide to purchase when willingness to pay at least equals asking price. Economic valuation of non-market goods or services means finding some measure of willingness to pay when markets fail to reveal that information directly.

Economics contributes an ability to quantify changes in society's well-being stemming from changes in the condition or availability of natural resources. Improving our knowledge of economic values can inform decision making in at least two ways: it can identify or at least approximate what the best economic choices may be; and, it can reveal the economic importance of previous choices. For example, in 1988 Dade County wanted to know if the artificial reef system it had built earlier for $1.4 million made economic sense. Milon (1988) showed that enhanced recreational fishing from the reefs was worth $17.5 million.

Economists usually measure value by summing individual willingness to pay for a good or service, which is a measure of preference for the good or service. In some cases,

the issue may be the economic value to compensate for a loss, in which case the appropriate concept is the willingness to accept compensation to tolerate the loss. In choosing between willingness to pay (WTP) and willingness to accept (WTA), the key consideration is the distribution of property rights.

With WTP, individuals do not possess property rights and must pay in order to secure a benefit or to avoid a loss. On the other hand, with WTA the individuals do have such property rights and must be compensated for parting with them. Some economists have argued that the choice between WTP and WTA is an ethical one based on which distribution of property rights is more fair (Mishan 1988). Choosing between the measures is important because they may not be equal; this is because WTP is limited by an individual's income, while WTA is not. For example, Mishan (1988) shows that an individual's WTP for a life saving operation would be income limited, while that individual's WTA compensation for not receiving the operation would be infinite. For resources with few substitutes, the difference between WTP and WTA can be large indeed. For decisions regarding unique resources — for example, Everglades restoration — the magnitude of value is partly determined by whether users own (WTA) or do not own (WTP) an entitlement to the resource improvement.

Economists evaluate the individuals' preferences for changes in the state of the environment, rather than of the environment in its entirety. Because economic valuation measures the preferences of people, it omits "intrinsic values" which relate to the interests and rights of non-human nature but which cannot be captured by people through their preferences. While economists do not deny the possibility of intrinsic value, they are unable to observe or measure it (Pearce 1993). Consider the example of a polluted coastal creek that supports a lower abundance of organisms than it formerly did. While an ecologist would consider the creek less valuable than before, an economist would first ask if individuals prefer the non-polluted to the polluted creek. (Though that is often true, citizens may take no notice nor care about the diminished productivity of the creek or habitat; if that is so, then no loss in economic value occurs.) The economic loss from the degraded coastal area is the maximum amount that individuals are willing to pay to free the area of pollution or, depending upon the distribution of property rights, the amount of compensation individuals would need to be as well off as they were prior to the degradation.

TYPES OF ECONOMIC VALUE

The different uses of coastal resources imply the range of values we have for them. The total economic value can be divided into its component parts of active use values, option values and passive use values (Table 2.1). The ways in which we appreciate coastal resources are many, with some categories more tangible than others, though all motivate economic behavior and are germane to the economics of resource management.

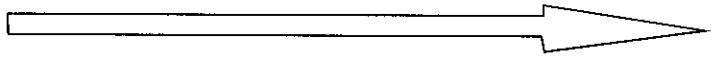
Active use values include those associated with aesthetic appreciation as well as recreational and commercial navigation. Active use values may be either direct (e.g.,

TABLE 2.1. TOTAL ECONOMIC VALUE OF COASTAL RESOURCES.

Active Use Values		Option Values	Passive Use Values
Direct Use	Indirect Use		
Outputs directly consumable	Functional benefits	Future direct and indirect use values	Value from knowledge of continued existence
Food, biomass, recreation, health	Flood control, storm protection, nutrient cycling	Biodiversity, conserved habitats	Habitats, species, genetic resources, ecosystems

Adapted from Pearce and Moran (1994).

INCREASINGLY LESS TANGIBLE



material inputs for production, such as fish stocks for commercial fishing) or indirect (e.g., water quality compatible with recreational fishing). Indirect use values in some cases correspond to what ecologists call ecological function. For example, many wetlands contribute indirect values in the form of wildlife habitat and nutrient cycling.

Option values are those expressed for preserving a resource use alternative. In other words, no use is currently made of the resource, but the individual wishes to preserve the option of using it in the future. For example, coastal residents who do not currently own boats may still wish to purchase mooring slips if they expect to own a boat in the future, knowing that the availability of slips will be limited. Option value may be significant if alternative use could change the resource irreversibly, as in the case of wetland conversion, and if the resource in question possesses unique attributes or there is a lack of substitutes for it. For option value to be positive, the future availability of the resource must be uncertain. In principle, if demand (income or preferences) is uncertain, then option value could be negative. In practice, option value — if relevant — is usually positive. It is important, for example, for biodiversity preservation: even if we do not recognize a use for a species of plant today, we may be willing to pay for its preservation because it could prove valuable for medical science in the future.

Passive use values, sometimes called existence or nonuse values, are unrelated to any current or potential active use and derive simply from the knowledge that a resource exists in a given state. Even if individuals were never to have sensory contact with the Everglades, they might value the knowledge that this unique asset exists. Additional fees for Florida automobile tags with manatees on them may be interpreted

in part as an expression of existence values since few people buying the tags are likely to see a manatee. Existence values are related to stewardship or human concern or respect for rights or welfare of non-humans. Total economic value is the sum of active and passive use values and option value (Pearce 1993).

COMPLICATING ISSUES

Economists use market and non-market information to assess values and thus to suggest priorities; however, several factors may complicate valuation:

- Costs or benefits occurring far into the future
- Moral obligations
- Uncertainty and irreversibility.

The first two concerns frequently appear in discussions of discounting, a procedure that compares value streams (benefits or costs) occurring at different dates in the future. In other words, future costs and benefits are diminished or "converted" so that they represent present values. The economic justifications for discounting are two-fold. First, we prefer consumption today and must be compensated for waiting; because we are impatient, a benefit occurring in the future must be larger than one occurring today, if it is to be just as attractive. Second, we have alternative investment opportunities. Because of the productivity of capital, as well, a future benefit must be larger than a present one in order to have the same present value.

To many, discounting is an unacceptable bias against future generations, and as such is inconsistent with most definitions of sustainability. A potential bias exists where the benefits or costs of the choice might accrue to future generations, because future generations are not present to have their preferences counted. Higher discount rates favor current resource use over that in the future and may result in less preservation of natural resources in near pristine states. The degree of bias is most critical for environmental concerns with a long time horizon, for example, climate change, ozone layer depletion, biodiversity loss (Portney and Weyant 1999). Discounting is perhaps best understood as the opposite of compound interest:

- Looking ahead, $100 today at a compound rate of 6% is $34K in 100 years.

- Looking back, $200 in 12 years is $100 today, if 6% is our discount rate.

To illustrate the generational asymmetry, Nordhaus (1999) offers the hypothetical example of an asteroid that could strike and destroy Florida in 200 years. He assumes the value of Florida's resources in 200 years will be comparable to the current value of its physical capital stock ($2 trillion) and applies the seven percent discount rate frequently used by the U.S. Office of Management and Budget. The implication is that the

present value of the lost resources, in this case $3 million, is the maximum amount that we would be willing to pay today to avert such a catastrophe. Clearly, discounting can be ethically troubling when considering long term issues.

Because discounting is used both to compare resource management alternatives and as an index of our obligation to future generations, some controversy in its use is perhaps inevitable. As a cautionary note, Brennan (1999) has argued for the importance of not confusing the time preferences that we choose with the sense of obligation that we may also have for future generations. Discounting is an important way of comparing alternative investments, to see if they pass the market test. But what we do in markets need not limit what we do as citizens for future generations.

Another complicating factor for economic valuation occurs if we cannot know decisively the outcome of a policy or resource management decision. Often we do not know, for example, if wetland creation will be successful in terms of the ecological functions sought. Frequently, coastal resource managers must deal with uncertainty, which can arise from a variety of sources. Economic valuation often is based on assumptions or predictions of future resource needs or availability. Clearly, we have a better idea of what the future will look like ten years from now than one hundred years from now. In addition, the use of biological or economic models may also introduce uncertainty. Fortunately, methods such as probability calculus and stochastic simulation can be employed for incorporating uncertainty into economic valuation. In any event, an essential aspect of interpreting the estimates of most economic valuation is in gaining some appreciation of the relevant probability distributions for uncertain outcomes of environmental actions. For example, to correctly interpret the worst case scenarios often reported in economic analysis (i.e., melting of the polar ice caps, as a result of global warming) we must know how likely it is that such a scenario will occur.

Finally, economic valuation is also complicated when some potential, negative effects cannot be undone by subsequent action such as losses of coral reefs or complex wetlands which may be physically impossible or prohibitively expensive to reverse. Irreversibility has the effect of raising the value of avoiding damages, thus making caution appear more efficient in resource management.

THE CASE FOR ECONOMIC VALUATION

Paraphrase the question that began this chapter: why estimate economic value? Certainly economic valuation has generated criticism. Some say that to place a value on manatees or the Grand Canyon, as if they were traded in markets, is to degrade them by removing their "not for sale" status (Kelman 1981). According to this view, expressing environmental values monetarily is immoral. Economics can assess the inefficiency of beaches or fisheries degraded by crowding but has little to say about any moral obligation we might feel regarding their use or condition. Clearly our desire for practical gain and our sense of duty both motivate our concerns about natural resource degradation. Thus, despite its important role, economics alone should not dictate deci-

sions regarding beach or fisheries access or any other natural resource management issue. On the other hand, in identifying tradeoffs, economics gives us a needed reminder that we usually have more things we want to do than resources with which to do them. Also, some valuation of environmental assets explicitly laid out for scrutiny by policy-makers and the public is better than none, since "none" may mean implicit valuation in a decision process that is shrouded from public view.

Economic valuation has also been criticized on the basis that its estimates are too imprecise and incomplete to be of use. While uncertainties often do impair estimation, choosing to ignore economic analysis does not lessen these uncertainties. Economic valuation at least provides a structured framework for highlighting uncertainty and suggesting its importance. Similarly, by providing estimates where we can monetize costs and benefits, economic valuation helps characterize other values that we cannot easily quantify.

Yet another criticism is that economic valuation overlooks equity considerations. While economic valuation is motivated by resource use efficiency and typically does not address distributional effects, it does not preclude such analysis from taking place. In fact, knowing overall net benefits from an intervention can be an important first step towards showing whether various sub-groups also benefit.

Economic analysis and valuation are controversial in part because their purpose and usefulness have not been made clear to non-economists; one attempt to do so is Fullerton and Stavins (1998). To some observers like Kelman (1981), the ethical basis for economics (i.e., right action is whatever satisfies human preferences), may transgress moral duty or violate individual rights (Randall 1999). Despite the controversy economic analysis and valuation sometimes generate, some conservation groups have become proponents of its use. "Today it is obvious that economic activity and environmental well-being are linked and cannot be separated," said Sharon Newsome, National Wildlife Federation vice president for resources conservation (quoted in Brandt 1993). "We must understand all of the economic implications of an issue and base our own positions on the best economic information we can gather."

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CHAPTER 3

METHODS OF ECONOMIC ANALYSIS

David Letson

Determining dollar values of natural and environmental resources is not an end in itself but a basis for generating the economic information that policy and management decision makers can use. The different approaches for employing this information will depend on what decision makers want to know, the kind of analysis a statute might call for, and just what gains and losses can be measured. This chapter examines four of the most important economic approaches: cost-benefit analysis, economic impact analysis, cost-effectiveness analysis and natural resource damage assessment.

COST-BENEFIT ANALYSIS

Cost-benefit analysis (CBA) compares the gains and losses associated with an investment project or a policy, for example, in evaluating various ways of designing a new seaport or assessing alternatives in setting an environmental standard for coastal water quality. CBA compares gross benefits of the project or policy (e.g., gains) with the opportunity costs (e.g., losses). In coastal zone management, CBA can give insights into the economic efficiency of management and regulatory actions. If the benefits exceed the costs of a management or regulatory action, then that action is considered economically efficient. Limitations to CBA include the choice of discount rate, which can have a significant impact on the results of the analysis (see Chapter 2 and Lipton et al. 1995).

Historically, cost-benefit analysis has been used for investment appraisal, though in recent years it has played an important role in policy as well. In CBA, the gains and losses are incremental changes in human well-being, which are measured as the individual's or the public's willingness to pay for a gain or to avoid a loss, or as the willingness to accept compensation to tolerate a loss or to go without a benefit. CBA includes the following process: (1) detailed project definition, (2) identification of the project impacts, (3) quantification of physical and biological impacts, (4) monetization, and (5) comparison of benefits and costs.

Project Definition

The first step in a project or policy is to define both the physical specification of inputs and outputs and the population of likely gainers and losers. Project appraisal must begin by stating what the project is. Consider a proposal to build a bridge that will replace a ferry service between an island and the mainland. This first step, then,

would include an engineering specification of the bridge, together with a listing of potential beneficiaries and losers. That population may be set by law or may be a matter of discretion. Perhaps we would want to consider only people who would use the bridge on a daily basis, or maybe we would want to extend the analysis to include occasional users in the county or region. The physical description and the list of affected parties help to define the boundaries of the analysis.

Identifying Project Impacts

Having defined the project, the next step is to characterize the economic impacts. Economic impacts in principle are relevant for cost-benefit analysis if they affect all or part of the relevant population by changing the amount (or quality) of a valued resource use. If some uses of coastal resources lack a market price, that does not mean CBA can ignore them. Bridge construction (from the example above) might limit traffic temporarily and thus may need to be considered in the analysis, even though the bridge eventually will result in reduced commuting times. In addition, while local property owners could benefit from the bridge because of increased property values, it could also affect wildlife habitat and, more elusively, the aesthetics of the landscape. CBA will include the additional gains or losses that occur as a result of the project. For example, the bridge pilings will likely become fish habitat; if they only draw fish from elsewhere and do not lead to additional biomass, the wildlife impact of the bridge would be a transfer or displacement rather than a benefit.

Physical and Biological Quantification of Relevant Impacts

We must quantify the physical flows of resources and fully describe when they will occur. For the new bridge, we would estimate the number of vehicles that make use of it each year, the time saved from using the bridge instead of the ferry, the number of years of useful life for the bridge, and the extent to which wildlife habitat would be disrupted. Because of the extensive time frame for many coastal resource management issues, completion of this step could well require an informed understanding of future growth patterns, technological changes, and potential shifts in consumer preferences.

Monetization

Physical and biological impacts alone are difficult to evaluate because each may be expressed in different units (e.g., tons of lost fish biomass versus hours of saved commuting time). Thus we need to estimate monetary values of the relevant impacts. To make such estimates, we must predict market prices for value flows occurring in the future, correct market prices where necessary (e.g., imperfect competition, government intervention or externalities), and estimate economic values where markets do not reveal them directly.

Markets generate relative prices that frequently can serve as an indication of the relative scarcity of traded goods and services. However, to value future resource flows, we

will need to predict future prices. We may also need to correct market prices if we have reason to believe they do not represent opportunity cost in resource use. When markets are imperfectly competitive, for example, producers tend to restrict output, so that prices rise and exceed opportunity costs. In addition, government intervention, for instance, as taxes or subsidies, may also cause prices to diverge from opportunity cost. Finally, externalities, or uncompensated resource uses, are relevant to opportunity cost but are omitted from market prices. Externalities such as pollution are also an example of where we must devise methods to estimate economic value since markets do not reveal that information directly. Chapter 4 discusses these methods in detail.

Comparison of Costs and Benefits

In this final step, total estimated costs are compared with total estimated benefits. An important step in making CBA widely applicable was the definition of an efficiency rule. One such rule in economics is the Pareto rule (named for the Italian economist Vilfredo Pareto), which states that society is better off if some individuals prefer the new situation to the old, while no one feels the opposite way. In the "real world," Pareto efficiency is impractical in that most investments or policies will make some individuals worse off than before, and no compensation scheme could likely offset these losses. Nikolas Kaldor (1939) and John Hicks (1939) offered another, less stringent definition of efficiency that could be applied more easily, namely that projects or policies have net benefits if gainers could compensate losers. This so-called "potential" compensation must be possible, though actual compensation need not occur. In other words, total gains must exceed total losses, regardless of who might actually receive or bear them.

If benefits exceed costs, then the project or policy may be deemed worthwhile, depending upon availability of budgetary resources. Thus, projects or policies passing an initial cost-benefit test might subsequently need to be ranked according to some other index, such as a measure of their distributive equity. Readers may consult Farrow and Toman (1999) or the Office of Management and Budget's Economic Analysis of Federal Regulations under Executive Order 12866 (OMB 1994) for the most recent federal guidance on performing CBA or Morganstern (1997) for a review of which environmental legislation requires CBA. While CBA is the most general and the most exacting of frameworks for economic analysis, at least three other approaches exist for addressing more specific issues or when available information is limited.

ECONOMIC IMPACT ANALYSIS

As the case studies in this volume demonstrate, many important natural resource allocation decisions are made by local governments or at least heavily involve local interests. Local decision-makers and stakeholders are likely to be more concerned about economic impacts in their locales and less so about net national benefits. Perspective is of clear importance to economic analysis. For example, a city or regional planning

agency would likely want its analysis to focus on costs and benefits accruing to people living in those areas, rather than costs and benefits in general. Economic impact analysis estimates how a change in policy or market conditions affects income, output, employment or expenditure in a region or economic sector. Coastal communities frequently are concerned about how national economic trends or proposed management rules may affect their regional economy.

Impact analysis differs from cost-benefit analysis in that it does not account for social benefits or values; that is, it does not account for opportunity costs. For instance, an impact analysis of recreational fishing does not analyze what individuals would do with their time and money if, as a result of a fishery closure or moratorium, they couldn't go fishing. Most importantly, economic impact analysis does not take into account resources or services not traded in markets.

When a local economy experiences an increase in spending, residents of that locality benefit by more than just the dollar amount of the goods and services that are purchased. Businesses serving those who spend the money must increase the amount of labor, goods and services they buy in order to produce the additional goods and services. Thus, the businesses that have experienced increased spending will have a ripple effect on the other businesses that supply them; in turn, those businesses affect others down through the supply chain. Economists call the initial spending activity the "direct effect," and subsequent ripples are "indirect" and "induced" effects. The indirect and induced effects are also called multiplier impacts. (See the sidebar Economic Impact Technology for definitions of these and related terms.)

In economic impact analysis, local growth results through increased expenditures from outside the region, which leads to increased demand for local goods and services. Purchases of local goods by outsiders bring outside dollars into the local region. Thus, impacts in an economy attributable to recreation, for instance, are traceable to visitor spending for locally sold goods and services while on recreational trips (English and Bergstrom 1994). In essence, food, lodging and similar items purchased during a recreation trip are "exported" to people living outside the local economy. In a case study in this volume (Chapter 9) that focuses on the economic impact of visitors to the Florida Keys, Leeworthy reports that visitors during Summer 1995 to May 1996 spent $1.19 billion, 30 percent of which ($357 million) purchased inputs from outside Monroe County, such as telephone service. The balance ($834 million) represented a direct output or sales effect that generated $316 million in direct income and 13,655 jobs in direct employment.

When considering which method of economic impact analysis to use, the authors of several case studies in this book chose input-output analysis, in most cases using the IMPLAN software for input-output modeling. Input-output analysis (I-O) is one of the most widely applied methods in regional economic analysis (Miller and Blair, 1985). I-O uses a system of equations to describe linkages among the productive sectors of an economy. With IMPLAN, we can construct an I-O model for any group of counties or states (Alward et al. 1985). Chapter 12 provides an example of this approach with an

analysis of the economic impact of the shrimp processing industry on Lee County. IMPLAN has 528 industrial sector categories that can account for a variety of expenditure patterns (Alward and Lofting 1985). It calculates the direct, indirect and induced effects of new spending. Inter-industry linkages in the local economy determine the total output, value added, personal income, and employment impacts. As generic software, IMPLAN has the advantage of being widely applicable, although it sometimes is unable to capture some specific economic circumstances. Leeworthy (Chapter 9), for example, takes the alternate route of using survey information to construct the input-output linkages between the various productive sectors of the Monroe County economy, since the generic IMPLAN software cannot account for large number of workers who commute from outside the county. For more details on the advantages and disadvantages of IMPLAN, see Alward and Lofting (1985), Alward et al. (1985), Propst (1985) and Hotvedt et al. (1988).

Although economic impact analysis has a narrower focus than cost-benefit analysis, and can concentrate more attention on a region or sector in question, it does have important limitations. First, because of its focus on an economic sector or region, economic impact analysis may

Economic Impact Technology

Direct Effects. The amount of the increased purchase of inputs used to manufacture or produce the final goods and services purchased by residents.

Indirect Effects. The value of the inputs used by firms that are called upon to produce additional goods and services for those firms first impacted directly by recreational spending.

Induced Effects. Result from the direct and indirect effects of recreation spending. Induced effects are related to persons and businesses that receive added income as a result of local spending by employees and managers of the firms and plants that are impacted by the direct and indirect effects of recreational spending. This added income results in increased demand for goods and services and, in turn, increased production and sales of inputs.

Total Effect. The sum of direct, indirect and induced effects. Typically, the total effects are between 1.5 to 2 times more than the amount that the visitors originally spent in the local economy.

Total Output. The value of all goods and services produced by the industries in a sector. For an economy as a whole, total output double-counts the value of production because it accounts for all sales; intermediate outputs are counted every time they are sold. In terms of direct impacts, the additional total output caused by visitor expenditures is equal to the increased final demand — the increased final demand will roughly equal the dollar value of visitor expenditures, minus the value of items that have to be imported into the region.

Value Added. Total output minus the value of inputs to a sectors' production. As such, value added is the net benefit to income.

Total Income. The sum of property income and employee compensation.

Employment. The number of full-time job equivalents or the sum of full-time and part-time employees.

Source: Leeworthy and Wiley (1997).

overlook many important gains and losses. As an extreme example, consider the high value such an analysis might have provided in 1992 on the benefits of Hurricane Andrew for the construction sector in southern Florida. Since its scope is deliberately selective, caution may be necessary in interpreting the results of economic impact analysis. Second, economic impact analysis rarely attempts to evaluate natural resource goods or services that are not traded in markets. Consequently, while impact analysis can show where the gains or losses occur from a change in policy or market conditions, only cost-benefit analysis can determine whether society has become better off as a result or if resources are now being allocated more efficiently.

The Fishery: An Application of Economic Impact Analysis

Fisheries are frequently the subject of cost-benefit analysis or economic impact analysis, and are an application of particular interest to coastal resource managers. The case studies in this volume on Florida's saltwater marsh (Chapter 5), and the spiny lobster fishery (Chapter 13) are both examples. As their point of departure, bioeconomic models of the fishery assume the fishery is an open-access resource, i.e., that no one owns the fish stocks. Use or property rights do not exist for fish in the sea, and fishers do not have to pay to take a fish. The individual fisher has little incentive to limit fishing effort because "he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another" (Gordon 1954).

Figure 3.1 shows the economic analysis of an open-access fishery. The curve is total sustainable revenue (TSR), or revenues that could be earned on a recurring basis at every level of effort (E). The straight line from the origin is the total cost (TC) of harvest at each level of effort. In fisheries economics, the term capital refers to vessels and gear, while effort is a combination of vessels, gear and labor. Maximum Sustainable Yield (MSY), the highest point of the TSR curve, is the maximum harvest that can be taken with the same level of effort on a recurring basis. MSY occurs only when the biology of fish stocks follows a Schaeffer growth model, i.e., biomass growth is a logistic function of existing biomass.

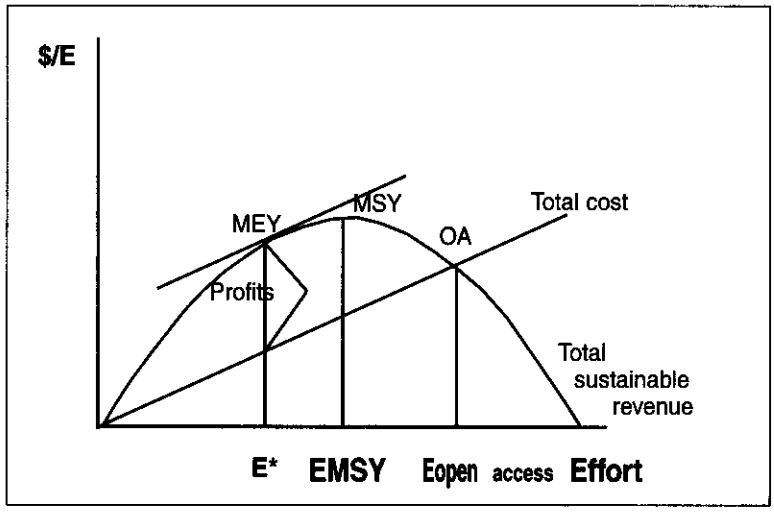

Figure 3.1. Maximum economic yield, maximum sustainable yield, and open-access yield (from Garstam et al. 1996).

In open-access fisheries, effort levels will tend to be at point EOA, where the revenue from fishing effort equals its costs. At every point from E=O to EOA, total sustainable rev-

enues are greater than total costs. Vessels continue to enter the fishery as long as the TSR curve lies above the TC curve, i.e., TSR>TC. Entry occurs up to the point where TSR=TC because fishers only consider the private costs of harvest, not the social costs. This oversight implies a market failure because the private costs of harvest are less than the social costs, which include the opportunity cost of all the resources used, including the fish stocks.

Maximum economic yield (MEY) is the harvest that provides the maximum economic benefits to society. MEY is located where the difference between the TSR and TC curves is at its greatest. This level is the most efficient because the cost of using an additional unit of effort to harvest (the marginal cost of effort) just equals the additional, or marginal, revenue or satisfaction (the marginal benefits) from using it. Moving in either direction from MEY reduces profits. At this point, the social costs of harvest are taken into account. Society would be better off here, because all resources would be put to their highest valued use. Less effort could be used to harvest the same level of fish that results in open access, and at lower cost.

Traditional fisheries regulations intended to restrict or reduce effort to the MSY level include catch quotas, trip limits, bag limits, gear restrictions, limits on fish size, and seasonal and area closures. These policies can lead to temporary improvements in stock levels but do so by raising harvest costs: the total cost curve in the figure up and to the left. But even if the total cost curve rotates all the way to the MEY point (E*), that would not increase net economic benefits. The total revenues would still equal total costs, with profits still zero. Over time, these methods generally do not sustain stock improvements because of the open-access market failure. If the regulations do succeed in improving stock levels, effort will eventually increase to take advantage of the improved stocks and catch rates. As long as profits exist (or TSR>TC), existing fishers will find ways to increase effort or new vessels will enter the fishery. The result is greater catch and effort and a need to regulate further. Lower levels of effort and harvest can be achieved when clearly defined and enforceable use rights for fish in the ocean exist (Gautam et al. 1996). [For more details on bioeconomic models of the fishery, see Gautam et al. (1996), chapter 1, and Iudicello et al. Wieland (1999), chapters 2 and 3.]

COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis is often employed when the benefits of an investment or policy either cannot be measured in monetary units or it is impractical to measure benefits, e.g., alternatives may all have the same monetary benefits. In addition, policies will at times mandate the achievement of an environmental goal, so that the cost side of the ledger becomes a great deal more relevant than the potential benefits. In these instances, the focus of the economic analysis is entirely on costs.

In cost-effectiveness analysis, the efficiency rule is either to minimize costs for a given output level or to maximize some measure of output for a given cost. For exam-

ple, we might wish to use cost-effectiveness analysis to minimize the costs of meeting a given water quality goal, expressed in units of dissolved oxygen, or alternately to maximize improvements in dissolved oxygen given our budgetary limits. Either way, the cost-side emphasis implies a focus on technological efficiency. Avoided altogether is the important prior question of how to select the appropriate water quality goal or budgetary size.

At times, as with the management of spent nuclear fuel, the importance of an environmental objective may seem to justify an economic emphasis on control costs. In other cases, though, the magnitude of benefits may not be so transparent. Everglades restoration provides an important example in Florida where federal law, the 1996 Water Resources Development Act, stipulated that managing authorities need only perform cost-effectiveness analysis. As Milon and Hodges (2000) have noted, the result of this restricted economic scope is that Everglades restoration will proceed with a presumption that benefits exceed costs, currently estimated at $7.8 billion, and without a clear indication of who might receive these benefits. A benefits estimate might help policy officials make decisions today and defend them in the future, while knowledge of who receives benefits could inform decisions about who (federal, state or local) should pay the hefty price for Everglades restoration.

NATURAL RESOURCE DAMAGE ASSESSMENT

Natural resource damage assessment is a technique for determining liability to natural resource resulting from the release of oil or other hazardous materials. Its aim is to estimate the value of damages to an injured resource so that these amounts can be recovered from those held liable by the courts. The most well-known example to date of monetary valuation of damages occurred with the Exxon Valdez oil spill in Prince William Sound, Alaska. The Clean Water Act, CERCLA and the Oil Pollution Act (see chapter 1) are three federal statutes that require liability assessments for injury to natural assets resulting from spills or hazardous wastes and other substances (Lipton et al. 1995). In the liability assessment process, as developed by U.S. Department of the Interior and the National Oceanic and Atmospheric Administration, economic valuation estimates recoverable damages as the sum of restoration costs, compensable value (that is, lost use values prior to restoration) and damage assessment costs. They have developed specific guidelines for damage assessments.

CONCLUSIONS

This chapter presents four different conceptual frameworks for economic analysis. The choice of approach typically depends upon what decision-makers want to know, what analysis existing statutes call for, and what gains and losses can be measured. Historically, values that are difficult to measure have often been ignored in the natural resources policy process. The use of economic analysis in natural resources policy has

evolved with both economic science and our appreciation of the resources at stake. Today, the opportunity has never seemed closer for comprehensive assessment of economic values for natural resources policy.

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CHAPTER 4

VALUING MARKET AND NON-MARKET GOODS AND SERVICES

David Letson

We usually think of the economy in terms of market economic values such as spending, sales, output, income, employment and tax revenues generated. However, the economic values we observe in markets may well be conditioned by others not directly transacted in markets. Beach use, for instance, often is not allocated by markets, although beach recreation indirectly may generate a great deal of market-based economic activity. Both market and non-market values are important in determining which alternative uses of coastal resources will yield the greatest net gain to society. Who receives that gain is also important. Economists break market values and non-market values down into two categories, according to the group receiving the value, consumers or producers.

Economic methods are available for evaluating changes in the quality or availability of natural resources, whether or not the uses of resources are commonly transacted in markets. If the resource uses are traded as goods or services in markets, well established empirical techniques exist for measuring changes in individuals' well-being or welfare. Economists use directly observed information from market transactions to evaluate *consumer surplus* and *producer surplus* as approximations of the satisfaction that society derives from the good or service. Consumer surplus is the excess of what consumers are willing to pay over market price. Producer surplus is the excess of market price over production costs.

Because much of economics relies on the ideas of supply and demand, this chapter defines them first. An understanding of market valuation methods is also helpful, by analogy, in appreciating the economic valuation methods appropriate when the resource uses are not transacted in markets. Three nonmarket valuation techniques — hedonic price, travel cost and random utility — use indirect market information to infer what values a market might reveal if it did exist. A fourth, the contingent valuation method, estimates welfare changes directly through surveys. Finally, benefits transfer seeks to adapt existing natural resource valuation estimates to another context in order to avoid the expense of a full-scale study.

CONSUMER AND PRODUCER SURPLUS

How much better off would we be if a policy or technological change improved the quality or availability of a resource, such as beach access? Economics evaluates ques-

tions such as this one by comparing economic surplus — the sum of consumer surplus and producer surplus — with and without the policy.

In discussing consumer surplus and producer surplus, we need to first recall what markets do. Markets are simply the setting where buyers and sellers meet to discuss sales of goods or services. The Chicago Mercantile is an important market, and increasingly the Internet is one as well. The prices that buyers and sellers agree upon dictate who gets resources, since well-functioning markets allocate resources toward their most highly valued uses. Markets use prices to coordinate economic activity, employing the information flows or bids from individual buyers and sellers. The supply and demand of natural resource goods and services are a visual display of that bidding behavior.

Supply curves relate the quantities producers offer and the prices producers receive. The amounts producers are willing to make available usually increases with higher prices. For example, we might expect the incremental costs of whale watching trips (e.g., fuel, crew wages) to increase with the quantity of such trips. Thus, supply curves tend to be upwardly sloped (Figure 4.1). Market supply curves are the summation of supply curves of individual firms.

Demand curves relate the amount that consumers wish to buy at various prices. As consumers go on additional whale watching trips, their willingness to pay for an additional trip will eventually decline, perhaps because of familiarity. Thus, demand curves tend to slope downward (Figure 4.2). Market demand curves are the summation of individual demand curves.

Buyers and sellers enter into voluntary exchange because they both expect to benefit. The intersection of market supply and demand curves is the equilibrium price and quantity for the good or service. (Figure 4.3) At this quantity, the price that consumers are willing to pay equals producers' incremental production costs. The equilibrium price is the unique price paid by all consumers. The excess of the consumers' willingness to pay over what they actually do pay for the quantity transacted is the consumer surplus (ABC), and is the area under the demand curve, bounded by the equilibrium price. The excess of what producers earn over their production costs for the quantity transacted is the producer surplus (BCD), and is represented by the area over the market supply curve, bounded by the equilibrium price.

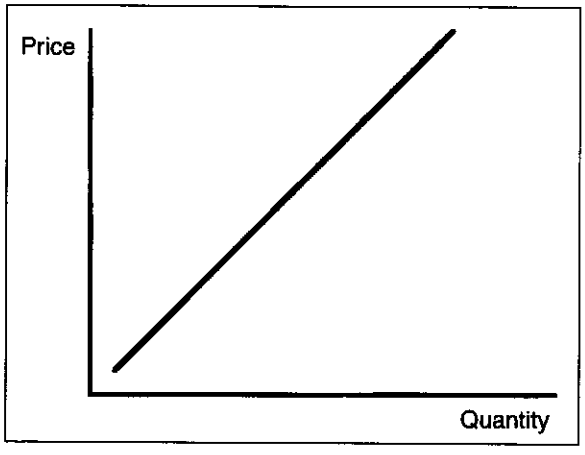

Figure 4.1. Market supply curve.

Estimates of consumer and producer surplus can be useful approximations of benefits that the buyers and sellers receive from a good or service. However, some care is necessary in interpreting these measures. A change in price alters the amount of spending on the good or service and, indirectly, the incomes of buyers and sellers. For example, a

change in a fisher's boat mortgage payments, because it may represent a significant portion of buyer and seller incomes, could fundamentally change supply and demand relationships, limiting the usefulness of consumer and producer surplus as welfare measures.

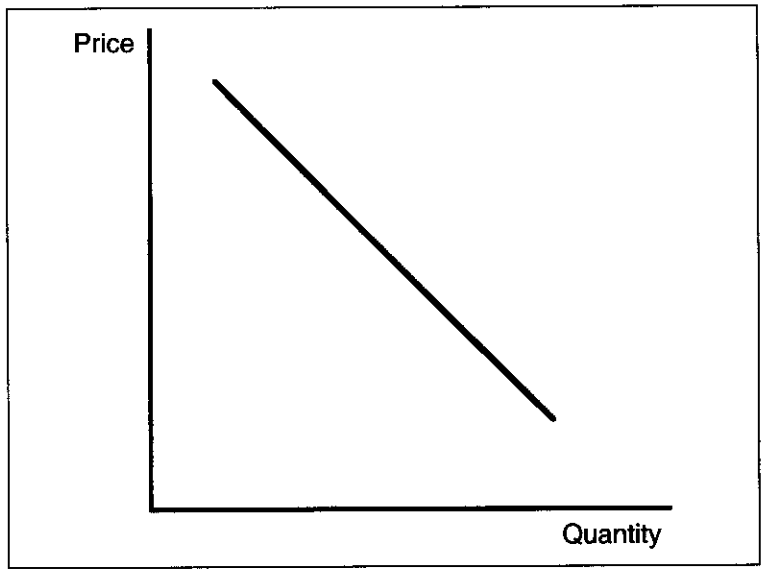

Figure 4.2. Market demand curve.

Another reason to consider estimates of producer surplus with caution is their assumption that businesses and industries operate in competitive input markets. That is, firms are said to be able to purchase labor and other productive factors at fixed prices. Producer surplus will overstate actual welfare changes when the price of a necessary factor increases as industry use of the factor expands. Finally, producer surplus will also be inappropriate as a welfare measure if the supply curve does not reflect the opportunity cost of all resources used. Consider the open access fishery, where the fisher considers only harvest costs, and not other social costs, such as the foregone value of future biomass implied by catches today. Here producer surplus would represent accounting profits, and only that portion that represents economic returns above all production costs would be appropriate as a welfare measure. For more detail see Hanley and Spash (1993) and Mishan (1988).

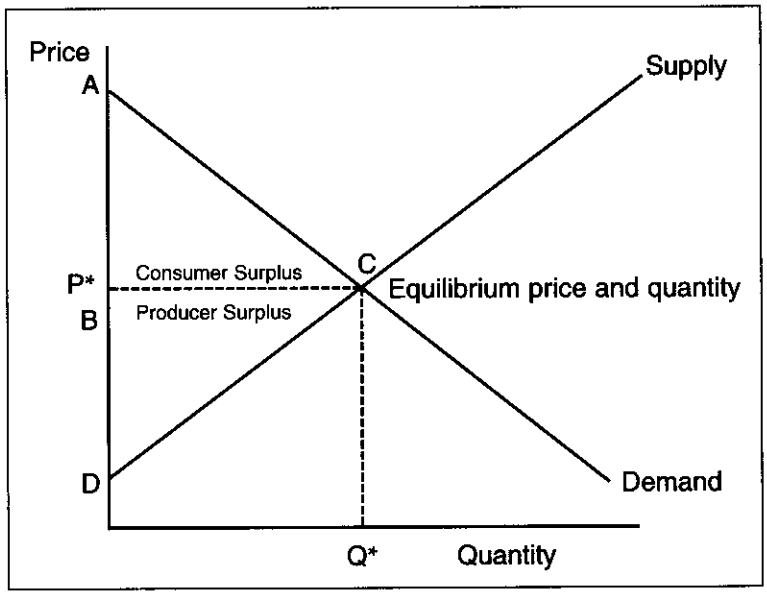

Figure 4.3. Consumer and producer surplus.

Supply and demand curves can also indicate the responsiveness of consumers and producers to price changes. When a one percent change in price causes a reduction in quantity purchased of more than one percent (that is, when the demand curve is rela-

tively flat), demand is price elastic. Consumers often exhibit elastic behavior when the purchase in question would represent a large portion of their income or when substitutes exist, as in the case of housing. Alternately, when a one percent change in price causes a change in quantity purchased of less than one percent (i.e., the demand curve is relatively steep), demand is price inelastic. To cite an extreme example, a diabetic's demand for insulin is inelastic since price changes induce little or no changes in the quantities consumed. Similarly, supply is price elastic (inelastic) when a one percent change in price leads to a change in quantity supplied by producers of more than (less than) one percent. Producers often exhibit elastic behavior if they can easily change their scale of production or if firms can enter and leave that industry easily. Estimates of price elasticity can help determine the magnitude of changes in consumer and producer surplus when prices change (Gautam et al. 1996).

Net economic benefits are the sum of consumer and producer surpluses, or the difference between the total benefits and total costs of an action. Net economic benefits are at a maximum when all resources are in their most highly valued use. Economic efficiency occurs when net economic benefits cannot be increased by reallocating available resources.

MEASURING THE VALUE OF GOODS AND SERVICES TRADED IN MARKETS

To illustrate the concepts of consumer surplus and producer surplus, consider the following example of decreased abundance of mackerel stocks and the resulting economic losses. As an expedient, we'll consider a single commercial fisherman whose harvests have dropped. The demand curve characterizing his loss is relatively flat since he does not influence price significantly (Figure 4.4). Before the decrease in stocks, the area between the supply curve and the equilibrium price is area ACH. The decrease in stocks has the effect of shifting the supply curve to the left, because production costs have increased. With the decrease in stocks, producer surplus shrinks to ABG, losing the area CBGH.

In estimating the effect of the mackerel loss on consumers, we can geometrically determine the change in consumer surplus (Figure 4.5). Here, since we assume multiple buyers and sellers, the demand curve has a downward slope. The area under the demand curve, bounded below by the equilibrium price, is the initial consumer surplus, area BEC. Following the decrease in mackerel stocks, the supply curve will shift to the left because it is now more expensive to catch fish; consequently, the price increases. In response, consumers reduce the quantity of mackerel they purchase. The decrease in consumer surplus following the change in fish stocks is area BCGF; the new consumer surplus is EFG.

The concepts of supply and demand — in effect, consumer and producer surplus — provide the basis for economic analysis and valuation. For natural resource goods and services that are transacted in markets, price and quantity information enable us to determine supply and demand and thus changes in producer and consumer surplus. For environmental goods and services as well as other benefits that are not transacted

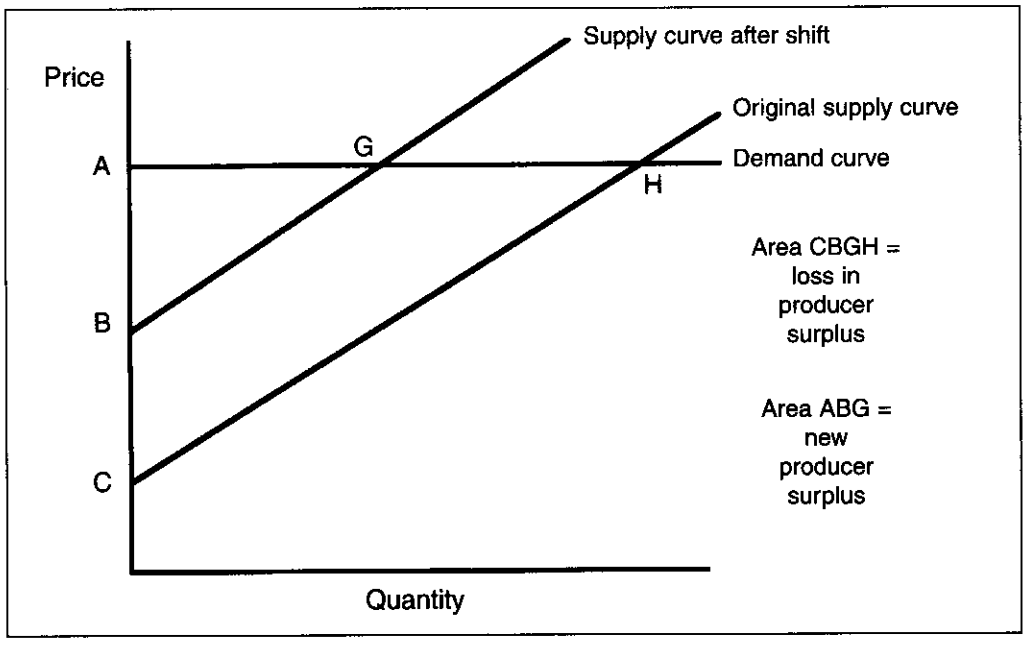

Figure 4.4. Change in producer surplus resulting from a decrease in mackerel stocks.

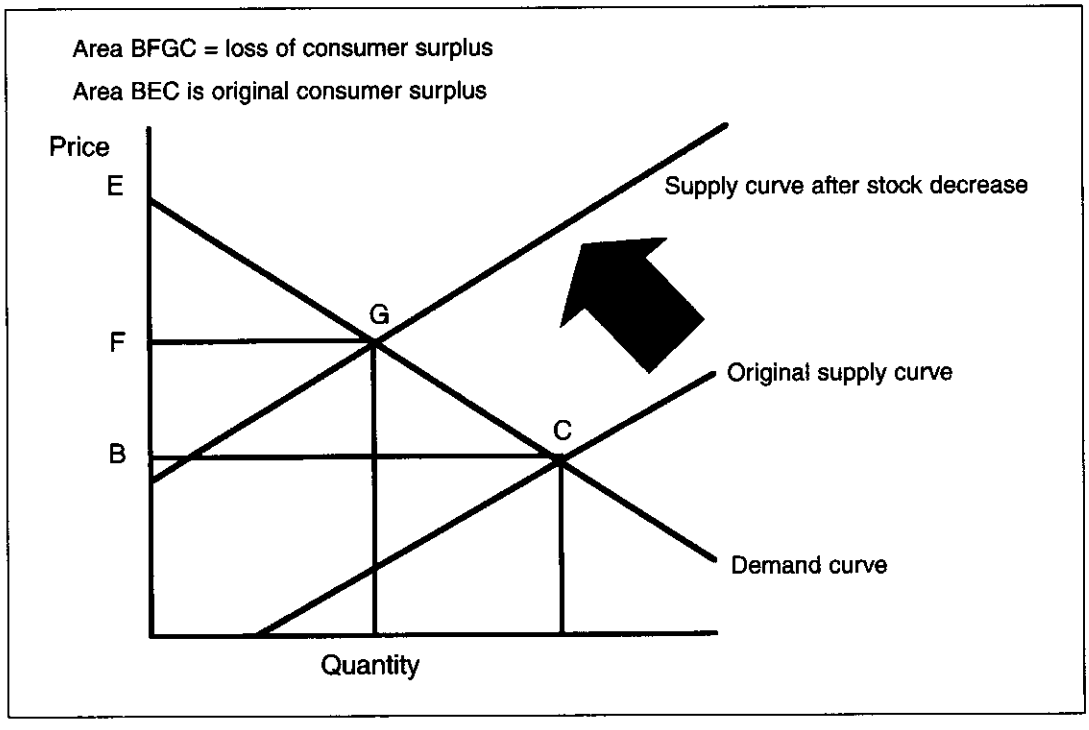

Figure 4.5. Change in consumer surplus resulting from a decrease in mackerel stocks.

in markets — that is, they do not reveal economic information directly — economists have developed a number of methods for estimating changes in producer and consumer surplus.

MEASURING ECONOMIC VALUE WHEN MARKETS DO NOT EXIST TO REVEAL IT DIRECTLY

Economists link resource conditions, use patterns and related market information to estimate market values (e.g., spending, sales, income, employment and tax revenue) and non-market values (direct, indirect and passive use values). Figure 4.6 is a conceptual model that summarizes linkages between the economy and the environment. As the model indicates, actual conditions related to the quantity and quality of facilities and services, the quality of the environment, the abundance and diversity of natural resources, and the degree of crowdedness are important factors in determining individual perception of these conditions.

Individual perception is complex and can differ significantly depending on experience, cultural frames of reference, education, income and other factors. For example, individuals from urban or rural environments with no experience of coastal environments may have quite different perceptions of environmental quality than those who either live in or have wide experience of visiting such environments. Even among those who live in coastal areas, there are widely different perceptions of the environment, perceptions which condition behavior and thus demand and, implicitly, non-market value. The level of demand for various uses of coastal resources may then have a feedback effect on the actual conditions of facilities, services and environmental quality and the abundance and diversity of natural resources.

Because resources are scarce relative to human demands on them, choices or trade-offs must be made. In the market place we have clear information (e.g., our incomes, the relative prices we must pay) on which to make choices. Where markets do not exist for an environmental good or service, its value (i.e., opportunity cost) is not evident. However, environmental economists have methods of estimating economic values for environmental goods and services to help inform the choices we must make.

Methods for estimating economic values are numerous, as documented by a recent volume of applications to marine resources (Colgan 1995). The first three methods we discuss (hedonic price, travel cost, random utility) use indirect market information to infer what values a market might reveal if it did exist. Contingent valuation is a direct method that evaluates value based on user preferences expressed through surveys. Benefits transfer is a method that draws upon and adapts already-existing valuation studies in order to make estimates and avoid the time and expense of a full-scale, new study.

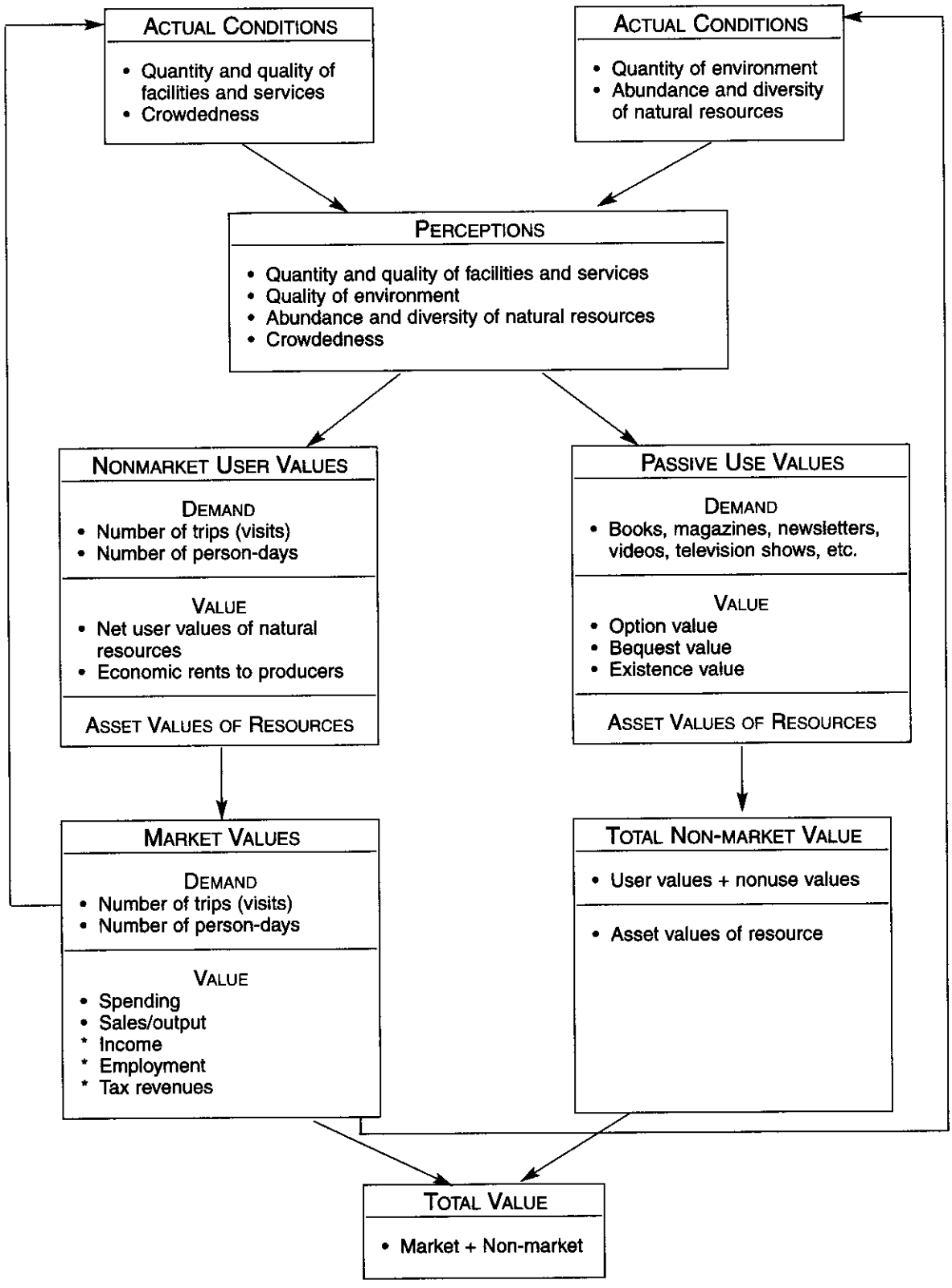

Figure 4.6. Conceptual model linking the economy and environment (adapted from Leeworthy and Bowker 1997).

INDIRECT METHODS FOR VALUATION OF NON-MARKET GOODS AND SERVICES

Hedonic Price Method

With hedonic pricing, researchers compare property prices (or wage rates) to assess values for attributes such as air quality or noise (or with wages, the value of workplace safety). For example, if two houses are otherwise similar, except that the first is located in the vicinity of a hazardous waste site and the second is several miles away, the lower value of the first house will likely reflect the disamenity of the waste site. The hedonic method can be used to estimate these differences in value when a non-market amenity or disamenity is implicit in the price of a marketed good. Thus, property prices may serve as indirect indicators of user value. The hedonic method identifies how much of a property value differential between alternatives is due to a particular environmental quality difference and how much people are willing to pay for that environmental improvement. The estimated values include both active use and option use values. Recall that active use values include those associated with aesthetic appreciation as well as recreational and commercial navigation, and may be either direct (e.g., material inputs for production, such as fish stocks for commercial fishing) or indirect (e.g., water quality compatible with recreational fishing). Option values are those expressed for preserving a resource use alternative. In other words, no use is currently made of the resource, but the individual wishes to preserve the option of using it in the future.

A notable application of the hedonic price method in the coastal zone assessed the damages of polychlorinated biphenals (PCBs) to property values near New Bedford Harbor in Massachusetts during the early 1980s (Mendelsohn et al. 1992). The PCBs derived from the manufacture or disposal of electronic transformers and were found in the harbor's sediments, leading to restrictions on fishing and contact recreation. To estimate lost active use and option use values, as a willingness to pay to secure a set of benefits declining over time, the authors considered homes with repeat sales since the degradation had become well known, which the authors assumed was 1982. They used regression techniques to control for housing price variation due to home improvements, interest rate changes, length of time between sales, property tax changes, and per capita income, and found that houses closest to the harbor, where lobstering, fishing and swimming were prohibited, had prices depressed by $9,000 (in 1989 dollars). Houses where these activities were restricted but not banned had prices decline by $7,000. The total estimate of $36 million in damages contributed to the $20 million in settled damage claims.

Like other non-market valuation techniques, the hedonic price method has both advantages and disadvantages. Perhaps its greatest strength is its reliance on observable market data. Market data on property sales and characteristics are available through real estate services and municipal sources and can be readily linked with other

secondary data sources. However, the hedonic approach is not widely applicable because most environmental incidents have only small effects on housing prices. Even where such effects do exist, it may be difficult to estimate them using econometric methods because of difficulties in controlling for the host of other factors that may influence housing prices (Lipton et al. 1995).

Travel Cost Methods

Travel cost methods have been used extensively to estimate the value of recreation. Using these methods, researchers can calculate the economic costs necessary to reach a recreational site as an estimate of user willingness to pay for recreation. That economic cost may include entry fees, monetary costs of travel, and foregone earnings. In effect, these travel expenses represent the "price" of the recreational experience and are an indirect but observable indicator of user value. By comparing the number of visits that individuals make at different levels of travel cost, economists are able to estimate economic value for site attributes, such as improved environmental quality. Travel costs are linked to consumption in order to estimate demand for recreational trips. The recreational value of the environmental improvement is the change in consumer surplus following the change in trip demand. (For a discussion of the various forms of the travel cost model and their comparative merits, see Leeworthy and Bowker 1997.)

In one application of the travel cost method, Bell and Leeworthy (1990) assessed the economic value of a Florida saltwater beach day. They focused on the behavior of tourists who travel significant distances principally to use beaches. Because of the travel distances to the resource, tourists must trade off the length of trip and number of trips in a way that residents do not. They found that travel cost is positively and strongly related to trip length; thus, tourists facing the highest travel costs economize by taking fewer but longer trips. Bell and Leeworthy (1990) estimate daily consumer surplus for tourist beach use to be nearly $34. When multiplied by the 70 million annual tourist beach days spent in Florida, the resulting estimate for the annual value of tourist beach services is $2.374 billion. Such an estimate of value can inform a variety of resource management decisions, ranging from beach renourishment to energy exploration.

The chief advantage of travel cost approaches is their reliance on observable market behavior. Individuals routinely spend their money and time to attend recreational sites, and easily obtained visitation records offer much of the data needed to deduce economic values. As for disadvantages, travel cost models cannot be used to estimate option or passive use values, which in some cases may be important. In addition, the estimates of travel cost models are sometimes sensitive to fairly arbitrary choices of the functional form of the estimating equation and to the treatment of time. Finally, while travel cost models can estimate the number of trips made to a given site, they are not designed to evaluate the choices recreationists make between alternative sites (Lipton et al. 1995).

Random Utility Models

The difficulty in portraying the degree of substitutability between alternative sites in the traditional, or single site, travel cost model motivated the development of alternative approaches. The random utility model (or multiple site travel cost model) attempts to explain the choice of a recreational site or activity on any given occasion as a function of the characteristics of all the available sites. Rather than focus on the number of trips recreationists make to a given site each year, as a single site travel cost model would, a random utility model focuses on the choices recreationists make among alternative sites. Utility offered by a choice is the sum of an observable component (related to site characteristics) and an unobserved random component that is state dependent.

In one application of the random utility approach, Greene et al. (1997) estimated the demand for recreational fishing in Tampa Bay. Their approach models the likelihood that an individual will visit any particular site as a function of the travel cost to all sites, the demographic characteristics of the individual and the characteristics of that site. They found average annual values for Bay fishing to be $18.14 for participants and $0.48 for non-participants. The latter is an option value, representing the value of potential, future access to Tampa Bay fishing grounds for a typical non-angler. Recall that individuals may be willing to pay a sum in order to preserve the option for using a resource in the future, despite not using it now. The low value of these estimates in comparison with others reported in the survey by Freeman (1995) is probably due to the proximity of alternative fishing locations, such as adjacent Pinellas County. Again, such estimates of value can help inform the environmental managers of resources like Tampa Bay who must balance the needs of recreational fishers with those of competing resource users, such as commercial fishers, wastewater dischargers and shippers.

Like the traditional (or single site) travel cost approach, the chief advantage of the random utility model is its reliance on observable market information, which makes it easier to apply and its findings easier to replicate. The random utility model also shares many of the disadvantages of travel cost methods (e.g., inability to evaluate option or passive use values; sensitivity to choice of functional form or treatment of time). In contrast with the traditional travel cost approach, the random utility model is able to evaluate the choices recreationists make among alternative sites, though it has more difficulty estimating the number of visits to a given site (Lipton et al. 1995).

DIRECT METHOD FOR VALUATION OF NON-MARKET GOODS AND SERVICES: CONTINGENT VALUATION

Contingent valuation develops non-market values by directly surveying individuals on their willingness to pay for a good or service. A critical element is a questionnaire that is based on a hypothetical description of the good, available substitutes, and how it would be paid for. Contingent valuation, or CV, overcomes the lack of formal markets for public goods by presenting consumers with hypothetical markets in which they have an opportunity to buy the good or service in question. The method takes its

name from the fact that the elicited values are contingent upon the hypothetical market described to respondents. Economists have used CV to measure the benefits of a wide variety of goods, among them, aesthetic and health benefits of air quality, hunting, recreational benefits from water quality, government support for the arts and decreased mortality risk from a nuclear power plant accident (Mitchell and Carson 1989). The sidebar on page 36 discusses a particular CV of interest.

The main advantage of contingent valuation is its flexibility, since unlike other methods it does not rely on observable economic behavior to deduce values. CV is also the only method that can estimate existence values, namely the values individuals place on simply knowing the natural resource exists in an improved state. While the hypothetical nature of CV enabled its use for damage assessment following the Exxon Valdez oil spill in Prince William Sound, Alaska, it was also a source of criticism, since survey respondents were reacting to hypothetical rather than real events (Carson et al. 1992). The disadvantages of CV are several; three warrant mention here. First, respondents may be unfamiliar with the good or service being valued and not have an adequate basis for articulating their true value. Second, respondents may express a value for the satisfaction of giving (a "warm glow") rather than for the goods or service in question. Third, while biases such as these often can be eliminated by careful survey design and implementation, doing so is extremely expensive (Lipton et al. 1995).

BENEFITS TRANSFER

Benefits transfer is an application of data or results from one or more valuation studies of a particular resource to another context or intervention. The original study would likely be one of the types that we have already discussed, namely, market, hedonic pricing, travel cost, random utility or contingent valuation. For example, using benefits transfer, the recreational use value of artificial reef construction in Broward County, Florida, might reasonably be inferred from an existing study of the same intervention for adjacent Dade County. In 1988 Dade County wanted to know if the artificial reef system it had built for $1.4 million made economic sense. Milon (1988) showed that enhanced recreational fishing from the reefs was worth $17.5 million. The techniques of benefits transfer could adjust the Dade County value estimate for possible differences in the scale of the resource and in the demographics of the user population to produce a value estimate for a similar project in Broward County. In many circumstances, time and resources may not exist for a full-scale valuation study. If conditions are similar in the current intervention site and the original study site, benefits transfer can be a reasonable and inexpensive way to estimate the value of the intervention.

Benefits transfer applications can be separated into two types. The first and simplest uses the average estimated results of a study, such as willingness to pay or consumer surplus, adjusted for known differences between the sites. A second, more detailed approach uses the statistical model from the original study to re-estimate willingness to pay and consumer surplus for the intervention site. An example of the

CONTINGENT VALUATION AND GALVESTON BAY WATER QUALITY MANAGEMENT PLAN

As part of the Galveston Bay National Estuary Program, a contingent valuation study was undertaken to help develop a management plan for the Bay. Whittington et al. (1995) estimated economic values of changes in environmental quality that might result from a proposed management plan. They were also interested in the reliability of mail surveys and in the use of visual aids. Some researchers have questioned whether mail surveys can be as reliable as personal interviews, which are more expensive to conduct. Visual aids can help researchers describe environmental amenities within the time limits of an interview but may also give misleading impressions to respondents.

At least two major problems confronted the study effort. A source of uncertainty that complicated survey design was the ecological response to the management plan. In describing the proposed management plan to survey respondents, Whittington et al. (1995) noted expert opinion on the possible environmental improvements but also noted that "the economy and ecosystem of Galveston Bay are too complex to predict precisely the effects such a plan would have."

Secondly, the plan did not exist at the time of the survey. Whittington et al. (1995) created a plan based on ongoing discussions of policy-makers. To the extent that this assumed plan differs from the one that will be implemented, the study evaluates a different "good." For example, the Whittington et al. (1995) plan would tighten water quality standards for point sources and boats, recover damages from those spilling oil or chemicals, restrict development in wetlands, restore some wetlands, test Bay seafood and establish educational and public clean up programs.

Respondents were told that if a management plan for improving the environmental quality of Galveston Bay were adopted, it would cost money and that citizens in the Greater Houston-Galveston area would be asked to help finance the plan. The payment vehicle would be a surcharge on monthly water bills. Respondents were asked the following:

> Given your current monthly income and expenses, if the implementation of the management plan cost your household [$X] per month for five years, would you vote for the management plan or against it?
>
> (1) I would vote for it.
> (2) I would vote against it.
> (3) I'm not sure.
>
> Note that the authors varied the price by respondent in order to avoid biasing responses.

To test the reliability of mail surveys and visual aids, the authors conducted two separate surveys. The first included a mail survey followed by in-person interviews, while the second was conducted entirely by mail. About half the respondents in each survey were asked to watch a 13-minute video about the conflicting uses of Galveston Bay prior to answering questions.

The mail-only survey had a lower approval rate of the plan, which Whittington et al. (1995) argue is either because mail-only survey respondents lived closer to the Bay or because the in-person respondents may have been trying to please the enumerator. The video treatment had no effect on value of responses, although it did make them less likely to be non-respondents.

Mean monthly willingness to pay estimates are $19 for interview respondents and $11 for those contacted by mail only. The difference between estimates by survey format is significant, although Whittington et al. (1995) cannot adequately explain it. They argue that the uncertainty introduced by the CV method is small relative to that from other sources.

second approach is meta analysis, in which a statistical function relates economic value estimates from a set of studies to a set of characteristics about those studies. For example, consumer surplus estimates for recreational fishing might be expressed as a function of fish species, average income, year of study, and estimation method.

In general, the defensibility of the transferred benefits estimates will depend in large part upon the quality and relevance of the underlying research. Clearly, if questions exist about the original study, then it may not be a good candidate for benefits transfer. Preferably, the original study should have appeared in a scholarly journal or received some other form of peer review. Even if the research methods in the original study do not reflect the current state of the art, it may be possible to make suitable adjustments to its estimates. Also, the original study should be closely relevant to the case at hand, both in terms of resource conditions, the availability of substitutes and user preferences. In the absence of similarity in both resource and socio-economic characteristics between sites, benefits transfer can be more misleading than illuminating. If carefully performed, however, benefits transfer can inform decision making even when the time and money do not exist for an original study (Lipton et al 1995).

ECONOMIC VALUATION BUILDS UPON OTHER KNOWLEDGE OF COASTAL RESOURCES

The choice of which non-market valuation method to use depends partly on which uses are to be valued. For example, to determine the existence value of preserving a coastal wetland as a sanctuary, only contingent valuation can be used since this set of preferences is not related to market activity. On the other hand, courts of law tend to favor estimates derived from observable behavior, as with hedonic pricing and travel cost methods, and the availability of relevant, observable market information.

The limitations of each of these methods are not trivial but must be interpreted in a larger context. In a survey of marine water quality valuation, Freeman (1995) notes a more general problem with valuation: linking behavior to user values. In an example of the economic value that marine water quality contributes to recreational fishing, he notes that while we do know pollutant discharges and recreational catches, in between those two activities are critical gaps in our knowledge of coastal resources. We do not know, for instance, how discharges affect ambient contaminant levels; how those concentration levels might affect stock abundance; and how changes in stocks affect the likelihood of recreational catch. Thus, major obstacles to economic valuation are limitations in our knowledge of physical and biological linkages.

Non-market valuation and other forms of economic analysis, when applied to coastal resource use and allocation, can do much to inform public decision making; however, they must be accompanied by subjective notions of risk taking and equity. Recognizing the capabilities and limitations of economic analysis in identifying priority uses of coastal resources can help us meet the challenge of balancing growth and coastal environmental quality.

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Case Studies of Coastal Resource Valuation

CHAPTER 5

THE ECONOMIC VALUE OF SALTWATER MARSH TO FLORIDA'S COMMERCIAL FISHERIES

Frederick W. Bell

Wetlands have ecological benefits that can potentially be assessed for their economic value. Employing marginal productivity theory, this chapter examines the external benefits of saltwater marsh for commercial fisheries on the west coast of Florida. While marshes provide external benefits to commercial and recreational fisheries as well as to other users, there is significance in comparing such external values per acre to the organized market value of an acre of land purchased by the State of Florida through programs such as Preservation 2000 or the Conservation and Recreational Lands program. In this way, we can better understand the economic benefits and costs of coming to grips with the market failure in land through land acquisition and compensation of owners as an element of government policy.

RESOURCE MANAGEMENT ISSUE

Many people have viewed Florida's coastal wetlands as desolate, mosquito-infested and worthless in themselves; often referred to as swamps, many of these ecosystems have been drained, dredged, filled-in, built on or used as depositories for human-generated pollutants and refuse. Meanwhile, many other people have strongly opposed this view, arguing that wetlands serve important ecological functions, that they are critical habitat for sea life and for sustainable restoration of degraded waters. These differences of opinion have led to difficult policy questions about the preservation and restoration of wetlands, particularly with regard to their "real" economic value. The resource management dilemma is created by a classic "market failure" in which human resources such as labor and capital are misallocated because of flaws in the marketplace — such flaws are similar in kind to those plaguing the oceans with overfishing of valuable fishery stocks.

Just why preservation and development are at odds can be seen by a simple example. Suppose one inherits an undeveloped acre of saltwater marsh or "swamp land." If the owner has the legal right to alter or convert the marsh, it could then be developed for residential and commercial use. Several problems may emerge, however, all related to the fact that the wetland performs many useful functions that would be lost if development takes place — on the other hand, if the wetland cannot be altered because of its ecological value, the owner is not likely to receive compensation. If it is assumed that an additional acre of wetland increases commercial fishery production, the marsh is

providing a service and is certainly worth something to the fishing industry. While the owner of the wetland could profit by charging fishers for this service, how is that to be done? The market process will not generally work to help the swamp owner capture a share of the benefits transferred to the fishers. There are two market problems. First, fishers will be unwilling to pay for something they get free — the wetland service. Second, even if the fishers recognized the vital importance of wetlands to their industry, at what price should they pay the owner? If 1,000 individuals own wetlands, how are they to negotiate a wetland rental fee with numerous commercial fishers? Thus, there is no organized market in wetland services and the person inheriting the acre of wetland would be attracted to organized markets for his or her land such as marinas and/or condominium developments. Because markets fail to reveal the true social value of wetlands to fishers, economists would predict that the level of conversion would exceed the socially efficient amount.

One means often followed in dealing with such policy issues is to regulate wetland owners. In effect, the importance of wetland functions, other than conversion to alternative uses in which case they cease to be wetlands, is now embedded in regulatory law that affects behavior relative to wetland use. A zoning regulation, for example, may restrict or prohibit commercial development of certain wetlands. In this case, the regulation implies that other values (they may be related to ecological function) are more important than the economic value that would come with the development. The regulation changes the property right. Unfairly or not, others in society such as environmentalists and legislators would determine who benefits and who pays the costs of wetland use and what that use, if any, will be.

Florida has three kinds of wetlands along its coasts: (l) estuarine-intertidal forested (e.g., mangroves); (2) estuarine intertidal emergent (e.g., salt marsh) and (3) and non-vegetated. Many ecologists argue that wetlands provide at least two external benefits to fish populations. First, they are important for the export of nutrients and support of aquatic food chains; the detrital food chain, for example, is based on the decomposition of plants such as mangrove leaves that in turn provide a rich source of vitamins and proteins for organisms in the coastal zone. Second, wetlands provide important refuges for smaller organisms such as larval fish and molting crabs; these protective habitats are thought to be conducive to greater survival.

Despite arguments for the ecological "value" of coastal wetlands, many developers and others claim that the economic value of development for agriculture and population growth outweigh the habitat and ecological functions that wetlands are presumed to have. The failure of the market in this area has led to attacks on those who want to restrict or prevent the conversions of wetlands into what is called the "taking issue."

Is it fair to depreciate the market value of potentially developable wetland to those holding a valid title to such lands? This question has led to two recent policies for dealing with the issue. The first policy involves the direct purchases of land and, more specifically, wetlands by the State of Florida. The Conservation and Recreational Lands (CARL) program has led to the purchase of undeveloped lands in numerous counties in Florida. State land purchases are at market rates so the potential development value for

the owner is embedded in the price. A second policy on the "taking issue," due in part to recent U.S. Supreme Court rulings, has involved direct compensation to land owners for regulations that restrict the highest and best use of environmentally sensitive lands. The Florida Keys have instituted a "no growth" policy with respect to such lands and must purchase lands where regulations restrict development. What began as uncontested conversion of wetlands for development has gone through at least two transitional phases: (1) a prohibition on wetland development principally through zoning, and (2) a recognition that owners suffer economically through government prohibition, which has led to state purchases of lands and compensation to owners of environmentally sensitive lands.

Despite these attempts to deal with the basic market failure with respect to wetlands, we still do not know much about the economic benefits they have for commercial fisheries as well as other potential beneficiaries, for example, recreational fisheries. Does the State of Florida have a benefit-cost ratio greater than unity for lands purchased under CARL? Put differently, when an owner is paid the market rate for environmentally sensitive lands for preservation purposes, do the economic benefits from the presumed environmental functions outweigh the cost of owner compensation? If the answer to these questions is "Yes," then purchase and/or compensation may not only increase economic efficiency, but contribute greatly to the resolution of a major conflict involving the resource management of wetlands.

In the following sections, we examine a recent valuation approach, the marginal productivity method (Lynne et al. 1981; Bell 1989, 1997, 1998), for assessing external benefits of wetlands, and then summarize a case study of the benefits of saltwater marsh for commercial fisheries. Although saltwater marsh provides external benefits to commercial and recreational fishers and to many others, there is a great significance in comparing such external values per acre to the organized market value of an acre of land purchased by the State of Florida through programs such as P2000 (Preservation 2000) or CARL. In this way, we can better understand the economic benefits and costs of coming to grips with the market failure in land through land acquisition and compensation of owners as an element of government policy.

MARGINAL PRODUCTIVITY METHODS FOR ECONOMIC VALUATION

Because there is no organized market for wetland services, we can use the marginal productivity method to assess the external economic benefits that accrue to commercial fishermen from Florida wetlands. This theory is based on the premise that the value or price in an organized market is the sum of the marginal contribution of each of the factors of production such as capital and labor. The harvesting of fish, for example, involves vessels, deckhands and, of course, wetlands. According to marginal productivity theory, a wetland or saltwater marsh is a third factor of production for those species of fish that depend on the marsh for food and protection during at least some of their lifetime. More than 90 percent of the commercial species harvested in Florida depend on wetland habitats at some time in their life cycle (Bell 1989). We first give a sketch of

the theory and then progress to more complex expressions that are actually used in obtaining the results.

According to marginal productivity theory, the combination of labor and capital (i.e., fishing effort) by harvesters with fish habitat services determines the number of fish caught. Consider the following linear production function, equation, which relates harvests to effort and wetland productivity:

$$Q(i) = c(o) + c(l)\ E(i) + c(2)\ W(i), \text{ where} \qquad (1)$$

Q(i) = harvest (pounds) of the i'th estuarine-dependent fish species
E(i) = fishing effort applied to the i'th species in question (e.g., standardized fishing days)
W(i) = wetland acres (e.g., saltwater marsh) affording services to the i'th, species in question,
c(l), c(2) = positive coefficients

We begin with the assumption that the coefficient c(2) = 10. This means that an increase (or decrease) in one acre of wetland will increase (or decrease) the catch by 10 pounds, if fishing effort and other environmental factors are held constant. To arrive at an estimate of the value of one more acre, we ask what consumers are willing to pay for the additional 10 pounds of fish. Assuming the additional 10 pounds do not depress ex-vessel price (because it is a very small addition to the entire market), the marginal value product of wetlands (MVPW) may be calculated as:

$$MVPW = P \times MPW, \text{ where} \qquad (2)$$

P = Ex-vessel value of a pound of fish
MPW = Marginal productivity of saltwater marsh

Assuming that P = $2, then for an MPW of 10 pounds, the MVPW = $20. In effect, the $20 represents the marginal fish value for the i'th species from adding one single acre of wetlands. This is a simplified example and does not account for such complexities as the relation between fish catch and fishing effort, which has been assumed to be linear.

In any ecosystem, a biomass of the i'th estuarine-dependent species is limited to some maximum size such as "B." Space, predators and, of course, the abundance of wetlands providing food and protection services limit the size of any biomass. So a biomass will usually grow rapidly if relatively small, but slowly if relatively large. If we eliminate some saltwater marsh or mangroves from the ecosystem, this will potentially reduce the maximum size of the biomass or B*. Thus, there are two relationships to consider. How does fishing effort impact the fish harvest when the size of the habitat or wetlands is held constant? If the size of the wetlands changes, what is the effect on the maximum value for B*? Using the Schaefer (1954) model of population dynamics for fish, we have the following expression for the catch function for fish:

$$Q(i) = B^* \{AE(i) - C\,E(i)\}^2, \text{ where} \qquad (3)$$

Q(i) = harvest (pounds) of the i'th estuarine-dependent fish species
E(i) = fishing effort applied to the i'th species in question (e.g., standardized fishing days)
B* = the maximum size of the i'th fish population given a fixed or constant amount of wetlands.
A, C = constants that are parameters of the production function
(see page 48)

This Schaefer catch function is parabolic in nature and has a maximum sustainable yield at the peak of the function. This function is depicted in Figure 5.1. Notice that if the biomass B* is increased, then the fish yield function will shift upward; if it is decreased, the fish yield function will shift downward. Thus, at any level of fishing effort, E(l), the catch will be higher the greater the biomass (B*), or lower the smaller the biomass. The upper level of the potential biomass is determined by how favorable or unfavorable environmental conditions are.

As wetlands or saltwater marsh are increased, the potential upper limit of the biomass would be expected to increase; conversely, if the wetlands decreased, the biomass would likely decrease. Not knowing what this functional form is from either a theoretical or empirical basis, we use a simple equation:

$$B^* = D\ln M, \text{ where} \qquad (4)$$

ln M = the natural logarithm of saltwater marsh
D = a positive coefficient

The equation indicates that B* will rise as the natural logarithm of M increases. By using the logarithm, the function and other functions derived from this relationship will be non-linear, which has been suggested by some as the approximate relationship. The last step in getting the fishery yield curve is to substitute the above equation into the traditional Schaefer yield curve, which leads to the following function:

$$Q(i) = D\ln M\,\{AE(i) - CE(i)\}^2 \qquad (5)$$

The marginal productivity of saltwater marsh (MPW) is simply the first derivative of the above function with respect to lnM, holding the level of fishing effort constant. This is nothing more than the incremental contribution of one acre of saltwater marsh to the production of the i'th species of commercial fish and represents the external economic benefit of wetlands to fishers.

Owners of saltwater marsh cannot easily charge for such benefits because of the market failure discussed earlier. The marginal productivity of saltwater marsh (MPW) will vary with the level of marshland and fishing effort. If fishing effort is held con-

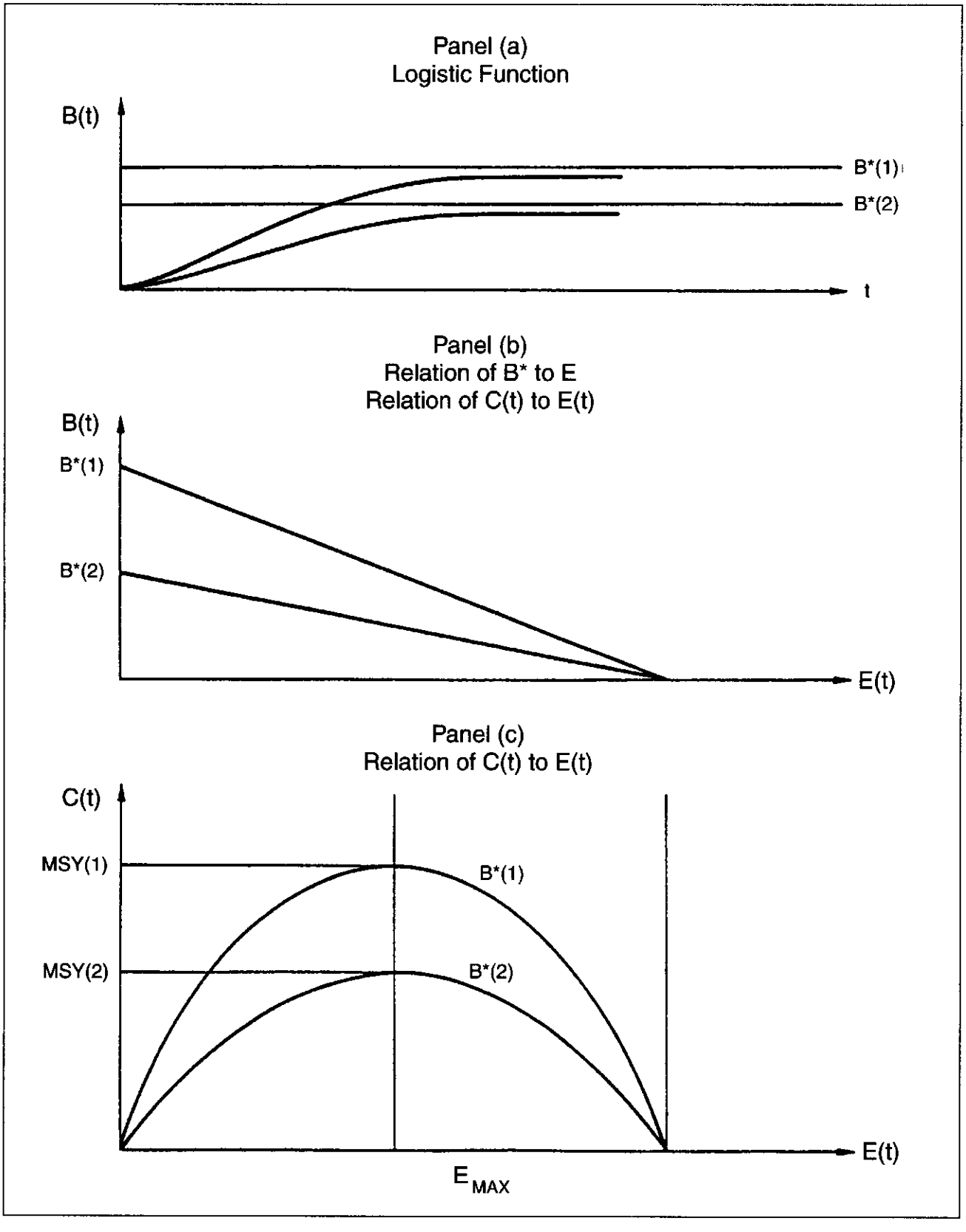

Figure 5.1. The impact of change in carrying capacity, B*, on the fishery catch.

stant, while aggregate marshland is increased, the MPW will decrease in a nonlinear fashion, illustrating the principle of diminishing returns to more and more marshland. In other words, the fish catch or harvest will rise as marshland is increased, but by decreasing increments. When the change in catch induced by a change in marshland, or the MPW is multiplied by the ex-vessel price for the i'th species, we have the marginal value product or MVPM(i) as discussed earlier. In this next section, we turn from theory to application.

APPLICATION OF THE MARGINAL PRODUCTIVITY VALUATION MODEL

The relationships between the commercial fishery catch and fishing effort and habitat (e.g., wetlands) is referred to as a production function. To obtain the marginal productivity of saltwater marsh (MPW), we must first estimate parameters discussed in the last section. To begin with, the analysis requires cross-section data (i.e., at different geographical points at one point in time) and/or time series data on catch and fishing effort for estuarine-dependent species as well as wetlands supporting such species. For this analysis, time series data were collected for eight estuarine-dependent species between 1952 and 1975 for the west coast of Florida: these included blue crab, stone crab, spiny lobster, red snapper, grouper, oyster, black mullet and shrimp. This period was selected because of the availability of annual observations on saltwater marsh (Conroy 1979).

The eight commercial species satisfied the following criteria: (l) they are all estuarine-dependent; (2) some measure of fishing effort is available; and (3) they are a significant component of the total estuarine-dependent catch off the west coast of Florida. In 1984, the eight species selected constituted 78 percent by weight and 90 percent by value of all species dependent on wetlands of the west coast of Florida, which ranges from the Panhandle to the southernmost tip of Florida.

It is important to distinguish between mangrove and saltwater marsh because of their differences in primary productivity (production of carbon for detritus export). The mangrove acreage on Florida's west coast is twice that of the saltwater marsh, with 26 percent more primary productivity (Harris et al. 1983). The State of Florida as a whole lost 3.9 percent of its mangrove area and 10 percent of its saltwater marsh between l953 and l973 (U.S. Fish and Wildlife Service 1984a, 1984b), largely due to residential development and agricultural filling. Ideally, we would like to include some measure of the mangrove loss in the analyses; however, only data on saltwater marsh are available for statistical analyses. Saltwater marsh declined by 2.7 percent over the l952-1976 period or 0.11 percent a year (Conroy 1979).

Such small declines raise questions about the credibility of the data, compared with that from the U.S. Fish and Wildlife Service (1984b), which show a decline of 0.5 percent a year for the entire state between l953 and 1973. Since the east coast of Florida developed more rapidly than the west, the Conroy (l979) time series may not be unreasonable. In addition, if the statistical analyses does reflect an adverse impact of a small loss of saltwater marsh on the commercial fishery catch (that is, if the parameters

are statistically significant at some acceptable level), this would lend credence to the external economic benefits of wetland preservation.

Before estimating the results, two qualifications must be made: first, the effect of the loss in mangrove acreage is not controlled and second, a number of the eight commercial species have important recreational components. Long-term time series data on recreational catch and effort are not available for grouper, red snapper and black mullet, which do have significant recreational angler participation. This problem may not impact the results discussed below for shellfish as much as they do for finfish species, which are primarily caught by commercial fishers.

Using data on catch and effort for each of the species plus the overall saltwater marsh series (Conroy 1979), the method of ordinary least-squares was used to estimate the parameters A and C of the production function (see equation 3). Notice that the saltwater marsh series has been lagged one year since there was no expectation that an immediate loss in marsh would instantaneously impact fishery production. Also, the catch or dependent variable was lagged as an independent variable to isolate the potential of a short-run from a long-run adjustment of the fish catch to the loss in saltwater marsh.

Based on the statistical analyses for these data, the following marginal value product of wetlands (MVPW or MPW*P) where marginal physical product of wetlands (MPW) and the ex-vessel prices (P) were obtained (Table 5.1).

The species selected constitute 90 percent by value of the estuarine-dependent catch on the west coast of Florida. Production function estimation was not possible for the remaining species, primarily because of the lack of fishing effort data. The sum of the estimated MVPW was increased accordingly or ($45.91/.09) = $51.01. This value is a linear extrapolation to the total estuarine-dependent species. Therefore, the *ninth* category of all other estuarine-dependent species is valued at $5.10 (1998 dollars). The magnitude of the MVPW for the i'th species depends on both the size of the marginal physical product and the ex-vessel price. Red snapper and shrimp had the largest combination of these two variables and were by far the largest contributors to the external economic value of an addition (or subtraction) of an acre of saltwater marsh. The MVPW is the flow over a period of one year. This external economic benefit to the commercial fishing industry off the west coast of Florida will be a flow into perpetuity. Of course, the flow will change if consumers place a higher value

TABLE 5.1. MARGINAL VALUE PRODUCT OF WETLANDS FOR COMMERCIAL SPECIES.

Species	MVPW (Saltwater Marsh) in 1998 Dollars[1]
1. Blue Crab	$ .59
2. Stone Crab	.57
3. Spiny Lobsters	2.09
4. Red Snapper	15.81
5. Grouper	2.46
6. Oyster	1.09
7. Black Mullet	5.41
8. Shrimp	17.89
Total	$ 45.91

[1]MVPW are calculated as the means of all variables used in the statistical analysis.

on fishery products, though to be conservative, we assume a constant flow of $51.01 per acre of saltwater marsh.

The flow of economic benefits to the commercial fishing industry from the existence of an acre of wetlands can be expressed in terms of the capitalized value of this acre expressed as follows:

$$CV = \frac{\sum_{i=1}^{9} MVPW(i)}{r}, \text{ where} \qquad (6)$$

CV = capitalized value of an acre of saltwater marsh
r = discount rate

In effect, capitalized value is the asset value to the commercial fishery of the existence of one acre of saltwater marsh. If there is no market failure, the capitalized value is the current market value that fishermen would pay the owner of the saltwater marsh for a transfer of ownership from the present owner to the "collective" called the commercial fishing industry. Thus, the capitalized or asset value of one acre of saltwater marsh in providing economic benefits to just commercial fishing off the west coast of Florida with a 3 percent real discount rate is ($51.01/.03) or approximately $1,700.

This value of wetlands to commercial fishers is only one of many economically important functions that wetlands perform. It is important to note that the value to recreational fisheries is not included in this analysis. Bell (1997) has indicated that the capitalized value of saltwater marsh is worth about $1,639 per acre (1998 dollars) to the recreational fishermen off the southeastern U.S. Wetlands also are habitats for waterfowl and other animals of commercial and recreational value. In addition, saltwater marshes perform a variety of other economically important functions such as water purification (i.e., pollution filter), oxygen production, sediment removal, nutrient recycling and nutrient absorption; they also serve as a defense against flooding and wave damage.

The approach used here is by no means the only way of relating wetlands functions to commercial fisheries. For example, Gosselink et al. (1974) have used what they term the "life support" valuation methodology. This method takes the sales of animals such as fish and divides the sales by the number of acres of wetlands. This method is thought to overstate the contribution of wetlands in producing fish simply because it ignores the contribution of capital and labor in the process (i.e., fishing effort). For an extended discussion of the variety of valuations techniques, see Bell and Lynne (1997).

APPLYING VALUATION RESULTS IN RESOURCE MANAGEMENT DECISIONS

Government may use general revenue or revenue from specific sources to purchase land on the open market to preserve whatever external economic or other benefits that are judged to be in the public interest. Florida's conservation land acquisition program is the largest in the country, with an excess of $300 million appropriated annually to purchase environmentally sensitive land through its Florida Preservation 2000 (P2000) and Conservation and Recreation Lands (CARL) programs. In August 1998, Florida reached a major milestone — one million acres of land were acquired under the P2000 program. P2000 began in 1990 and is supported through bonded funds. In 1998, the State of Florida acquired over 56 thousand acres of land at a cost of almost $191 million.

In part, these land acquisition programs aim at preserving wetlands that support commercial and recreational fisheries, though these are only two of its many objectives. Thus, acquisition of land may have diverse objectives, from protecting open spaces to preserving animal habitat. The following analyses are suggestive of how external economic benefits compare with the cost of land acquisition; they are illustrative in nature since we are dealing with aggregate data on such acquisition. The aggregate data represent beaches, wetlands and uplands and the appraisal method is primarily based on comparative property sales, presumably for some kind of development by the private market.

The Florida Department of Environmental Protection (1999a), which administers the state land acquisitions, claims one acre of generic wetlands provides slightly less than $2,000 annually. Though the components of this dollar amount are unknown, they would certainly include the external value accruing to fisheries as well as all other external benefits produced by wetlands. At a real discount rate of 3 percent, this would imply that the asset value of one acre of wetlands would be over $66,000. On average, acquisition of land that is considerably above this price would appear to be uneconomic.

It is important to stress that no proof is required in P2000, CARL or other land acquisition programs as to their estimated benefit-cost ratio. Still, the Florida Department of Environmental Regulations *implies* a favorable relation between economic benefits of preservation and the cost of land acquisition. By implication then, the government does employ such economic evidence to make management decisions (e.g., quantity and kinds of land acquisitions) regarding resource management. In fact, the Florida Department of Environmental Protection (1999a) asserts, "A successful conservation program is fundamental to Florida's economic future." Next, we examine how a rough test of this implication would work out by comparing the estimated external economic benefits generated by saltwater marsh for the commercial fishing industry with costs of land acquisition on the west coast of Florida.

Table 5.2 summarizes 1998 land purchases under all of Florida's state acquisition programs for counties on the west coast. Because purchases are not made every year in each county, not all counties are included. Cost or value per acre on the open market

ranges from nearly $85,000 in Manatee County to only $881 in Levy County. Such a variance in per acre cost reflects a multiplicity of variables beyond the scope of this case study. The data do represent a full year's activity of land acquisition in 14 counties and almost $112 million in purchases involving nearly 39,000 acres. Assuredly, these acres are not all wetlands and are bunched together in Collier County near the tip of the west coast of Florida.

TABLE 5.2. COST OF ACQUISITION, ACREAGE AND COST PER ACRE OF LAND BY THE STATE OF FLORIDA FOR SELECTED COUNTIES ON THE WEST COAST OF FLORIDA, 1998.

County	Acquisition Cost ($)	Total Acres	Acquisition Cost Per Acre ($)
Monroe	$ 7,132,427	633.56	$ 11,256
Collier	40,421,716	23,128.66	1,748
Charlotte	8,686,500	2,992.50	29,028
Manatee	254,800	3.00	84,933
Hillsborough	104,000	6.55	15,878
Pasco	725,000	9.03	80,288
Hernando	10,498,870	3,082.48	3,406
Citrus	20,751,835	6,227.29	3,332
Levy	1,088,000	1,234.59	881
Franklin	662,650	364.84	1,816
Bay	196,725	2.47	79,646
Walton	7,353,500	150.05	49,007
Santa Rosa	75,690	8.74	8,660
Escambia	13,600,000	900.90	15,096
Total	$ 111,551,713	38,744.75	$ 2,879

Source: Florida Department of Environmental Protection, personal communication with Robert Hicks (1999b).

A more refined thrust just toward wetlands, or mostly wetlands, is potentially possible, but is not only beyond the scope of this example, but really unnecessary in light of results from this exposition. Using all the land acquisitions and their cost (Table 5.2), the purchase cost of the average acre was found to be about $2,879. Assuming that this amount is the approximate cost of an acre of saltwater marsh on the west coast of Florida, an economic assessment would want the flow of ecological services over time or more precisely into perpetuity to justify this acquisition.

Using the saltwater marsh flow of services to the commercial fishing industry on the west coast of Florida as one kind of service flow (other kinds could include the recreational fishing industry), it has already been established that this asset value — that is, the capitalized value — is $1,700. With just one of many services provided by saltwater marsh having an asset value of 59 percent of the acquisition value, the evidence is that the land acquisition programs in Florida have a favorable benefit-cost ratio.

In a related study in the southeastern United States, Bell (1997) found that an acre of saltwater marsh had an asset value of $1,637 to recreational fishermen alone. Since the commercial and recreational fishermen share in varying degrees the same estuarine-dependent species (Table 5.1), it would appear that the saltwater support of just the marine fisheries for commercial and recreational fishers has an asset value of about $3,337, which is greater than acquisition cost used in this example. Based on information from the Division of State Lands (Personal communications, Florida Department of

Environmental Protection, 1999b), there is every reason to believe that the acquisition of undeveloped saltwater marsh by the State of Florida would cost less than the average as summarized in Table 5.2.

A cautionary note about this conclusion is in order: the prudent researcher should gather precise data on acquired saltwater marsh by the Florida Department of Environmental Protection in specific areas to be linked up with marginal productivity studies (such as those described in this chapter) for well defined areas over a considerable period of time. Though not conclusive, the case of the market failure in the most efficient allocation of saltwater marsh gives rise to the tentative and preliminary conclusion that government can possibly intervene creating a scenario where external economic benefits from wetlands can be captured while greatly exceeding the cost of acquisition. Such an apparent move toward greater efficiency may be accomplished while holding out the olive branch of equity and fairness to those owners of wetlands who might otherwise feel trapped by both the failure of the market and the caprice of government regulations.

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CHAPTER 6

DAMAGE ASSESSMENT OF THE TAMPA BAY OIL SPILL: TRAVEL COST METHOD

Frederick W. Bell

A collision between two vessels, one of them a barge carrying heavy oil, in Tampa Bay, Florida, resulted in a massive oil spill that came ashore along a 13-mile coastline in Pinellas County, Florida. The beach was closed to residents and visitors until the cleanup was completed. Under federal statute, the State of Florida sued the oil company for damages. A travel cost method, the random utility model, was employed to estimate the dollar impact, or damages, of the spill on residents who would normally have used the affected beaches but incurred additional costs because they had to travel elsewhere.

RESOURCE MANAGEMENT ISSUE

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) established the legal right of natural resources trustees to collect damages from those responsible for the release of hazardous materials into publicly owned rivers, lakes, estuaries, oceans or other aquatic and terrestrial habitats. Under the CERCLA provisions, the Federal Government provides guidelines for economic valuation methodologies to estimate the costs of such damages — both the travel cost and contingent valuation methods (see Chapter 4) have been approved and their use cannot be challenged by parties to the dispute, though how these methodologies are used may be challenged. This chapter describes how a version of the travel cost method was applied in estimating the damages to Treasure Island Beach on the Gulf of Mexico from an oil spill in Tampa Bay, Florida on August 10, 1993. These estimates were conducted under the provisions of CERCLA. One of the most prominent cases in which CERCLA techniques were employed occurred in the EXXON Valdez oil spill in Alaska.

In a collision between a tank barge carrying heavy fuel oil and a freighter, one of the tanks ruptured and spilled 328,440 gallons of oil, which then drifted into the Gulf of Mexico. Because of winds and currents, the oil came ashore along a 13-mile stretch of beaches in Pinellas County. The largest beach along this oiled area is known as Treasure Island (Figure 6.1). These beaches and their recreational services were shut down from August 14 to September 2, 1993, while clean-up took place. In addition to beach damage, numbers of natural resources species and habitats were damaged; these included the oiling of sea and shore birds, sea turtles, mangrove habits, submerged seagrass beds, oyster reefs and areas of salt marsh. Though the company was sued on a number

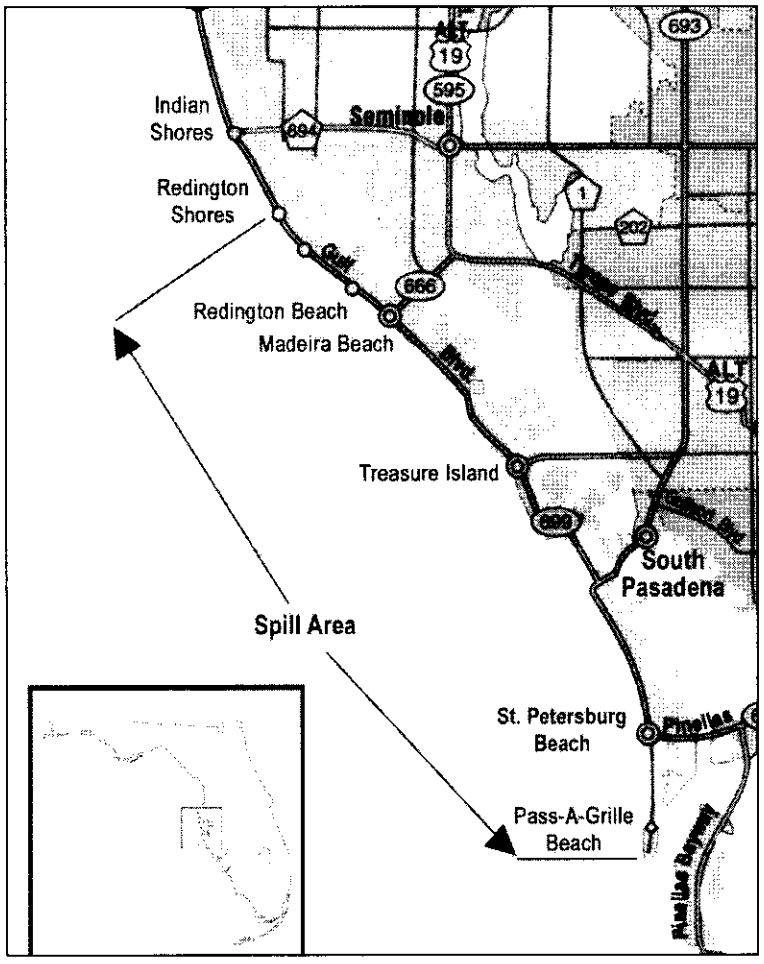

Figure 6.1. Geographical area in Pinellas County, Florida (Tampa Bay) where the 1993 oil spill occurred.

of counts, a final settlement has so far resulted only from damages based on the loss in value to residents who could not use Treasure Island beaches and had to go elsewhere for recreation.

Working with the Federal Government, the Florida Department of Environmental Protection contracted with an economics consultant to estimate the diminution in value to residents of those beach resources damaged by the oil spill. The consultant chose to employ the random utility model (RUM), a variation of the travel cost method, to estimate those damages.

THE RANDOM UTILITY MODEL

The travel cost method is generally employed to determine recreational values that are based on travel expenses and other costs involved in visiting particular sites (see Chapter 4). It has been used to measure the effects on an individual's willingness to pay because of changes in access costs to a recreational area, or the elimination of a site, or changes in environmental quality. Random utility models, though similar, do not focus on the number of recreational trips but on the choices individuals make among alternative sites. The random utility model is especially useful when substitutes are available, though they may be farther away and more costly.

In Pinellas County, residents who ordinarily would make a certain number of visits to area beaches could no longer do so because the beaches were closed until the clean-up was completed. People who would normally visit them would have to go to a different beach or simply cancel their trip and do something else. If they chose a different beach, they would incur two kinds of additional costs: those associated with travel to the new beach and the potential of a less attractive beach, which might decrease their enjoyment. Many beach goers would choose an alternative beach that is closest, thus minimizing additional costs in travel and enjoyment.

The goal of the analysis was to determine what attributes people consider when going to a beach and their willingness to incur additional travel costs for going to alternative beaches. In using the random utility model (RUM), it is practical to estimate a high and a low dollar amount for economic costs (i.e., losses) resulting from the oil spill. The consultant used the bounded approach for simplification since the analysis was limited to asking residents only about their choices among alternative beaches, not all choices, for instance, a trip abroad or somewhere else in the U.S. That is, in the RUM, a number of beaches must be removed from the choice set since they are oiled.

Travel cost methods begin with a survey questionnaire; in this case, the survey asked all beach goers to first prioritize their choice of beaches before the spill; they were then asked to choose a "second best" beach or beaches. It is in these alternatives that additional costs or economic losses may be incurred. Notice that for this example, beach goers are not given a choice of "not going" as a response to the oil spill. To determine the "upper bound," the loss incurred from having to take the next best choice is then multiplied by the number of trips without the oil spill. Over the duration of the oil spill and clean-up, there will be trips to the closed beaches that are lost; these trips are then subtracted from the original number of trips before the oil spill and multiplied by the same lost per trip to obtain the "lower bound" due to oil spill losses. The rationale for this "bounded" formulation is to simplify the model as will be explained in greater detail in the next section.

The random utility model is based on the premise that every beach goer gains enjoyment (utility) from visiting a beach that depends on the following: the characteristics or quality of the beach visited; the travel costs incurred; the possibility of consuming other goods constrained by the beach goer's income. For a conceptual understanding of the RUM, consider the following example in which we suppose there are two characteristics of beach quality, the width of the beach (W) and shoreline development (S). Assume further that a beach goer's enjoyment is related to the travel distance from home and that the greater the distance the less enjoyment. We can then say that recreational satisfaction is positively related to favorable beach characteristics and inversely to travel cost. Income is assumed as a given for each beach goer while the consumption of all non-beach goods (M) may vary up or down depending on whether the beach goer wishes to spend more or less income on beach activities. If a beach goer from Tampa on the Gulf of Mexico moves to Orlando in Central Florida, he or she may wish to frequent the beaches on the Gulf less than before and spend the money saved on travel cost on other goods (M). This is the general idea behind the random utility model where each beach is governed by these interrelationships.

If we assume there are five alternative beaches to choose among (Figure 6.2), a person using Beach A must pay the travel price which consists of the driving or related transportation costs: miles traveled multiplied by the cost per mile, or P(A). The beach goer then gets to consume an amount of the other good, M (e.g., food, tolls, lodging), equal to the available budget, Y, minus the travel cost to the beach: $Y - P(A)$.

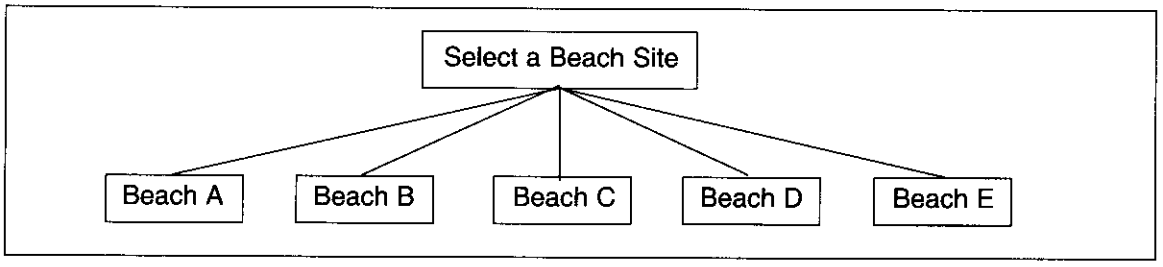

Figure 6.2. Decision factors: Beach characteristics; distance to the beach.

The travel price is more than just the costs associated with the vehicle and includes the value of time to the individual, which will increase as the need to travel farther to an alternative beach increases. If a beach goer earns $25 an hour but foregoes work to travel the additional time it takes to get to the beach, then foregoing work has a cost. At an average speed to the beach of 50 miles an hour, the time cost per mile is $0.50 ($25 an hour divided by 50 miles an hour), which is added to the total travel price. This general process is applied to other alternatives. Assume a beach goer is choosing between beaches A and B — if P(A) and P(B) are $10.50 and $30, respectively, and the utility of each is the same, the beach goer is likely to select beach A over beach B. To determine the decision making among beaches A through E, this process would have to be undertaken for each beach goer to assess how beach selection is made.

To obtain these relations, we use statistical tools that ask the following: what combination of these decision factors most closely predicts the pattern of beach visitation that we observe in our data? We can select one set of parameters such that the model predictions of where people go best reproduce the observed pattern of travel to beach sites with varying travel cost and beach quality in the data.

If site A is Treasure Island, the expected demand curve (DD) for Treasure Island can be traced out as the travel price of A is raised from zero to higher and higher prices. As discussed in Chapter 4, consumer surplus is the area under the demand curve or the value of the beach to beach goers (Figure 6.3). Economic losses to the beach goer when Treasure Island is oiled is the hatched area under the Quantity (A) demand curve minus the consumer surplus for the "second best," or alternative, beach B.

In summary, the random utility model estimates a "utility function" or the relation between utility or beach satisfaction and travel cost and beach characteristics given the beach goer's income and consumption of other non-beach goods. The model provides a quantitative estimate of how individuals value beach characteristics as well as how they value savings on travel distances. The RUM assumes that individuals choose the best beach for themselves, in that they balance the additional cost of travel with the enhanced attributes that can be obtained. While choices by the individuals are not random, analysts cannot observe all factors that go into making them; thus, from the perspective of economic analysis, choice is inherently random. For this reason, we estimate expected demands or the chance that a trip is taken to a given site. Using probabilities, the RUM identifies the group of people who would have visited the spill site had the spill not occurred. For instance, it identifies the probability of a beach goer in Lakeland

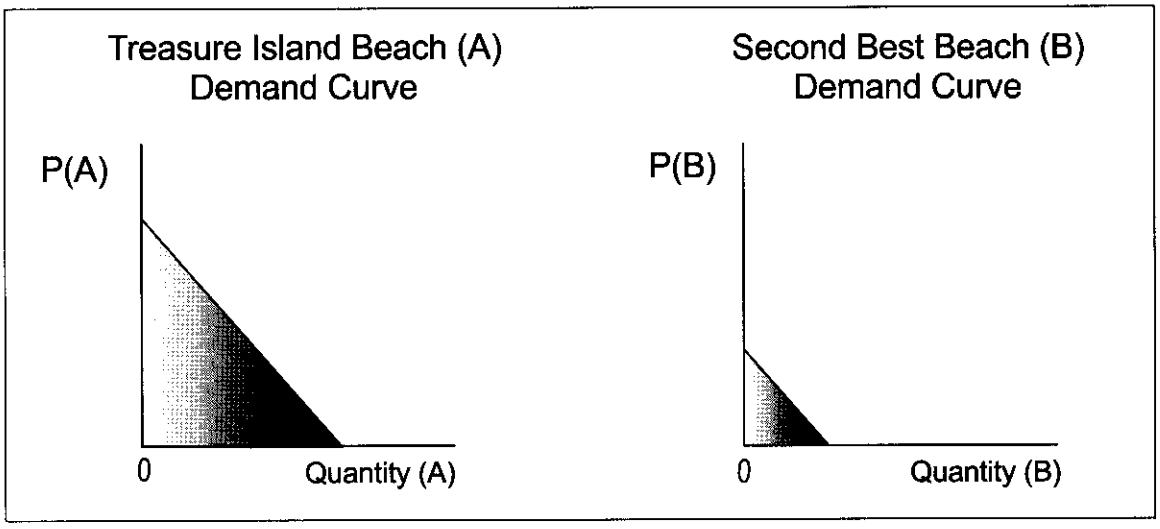

Figure 6.3. Change in consumer surplus (i.e. economic loss) as a consequence of the unavailability of beach (A) and choosing to go to beach (B).

or Orlando taking a trip to Treasure Island Beach. When the set of beaches to visit changes, with the spill-area beaches no longer available, the RUM can predict where those people would go as the next-best alternative destination and, most importantly, the loss (or additional cost) that results as a consequence of increased travel distance and/or lost enjoyment.

For a particular beach goer, suppose that as in our example Beach A is oiled and becomes unavailable for recreation. Then B becomes best and we need to compute the net economic loss from having to go to B instead of A which is the difference in consumer surplus. This involves the concept of "willingness to pay" or WTP, which is the amount of income that could be taken or lost by a person when the choice is site B as opposed to site A or the WTP (A-B). Thus, the WTP is the difference in utility converted to dollars before the spill and then after the oil spill where choices yield less utility.

APPLICATION OF THE RANDOM UTILITY MODEL

The random utility model (RUM) employed in this analysis focused on Florida residents and not out-of-state tourists. Rather than the two beaches used in the previous example, residents could choose among 297 beaches, ranging from North to Central Florida, including the beaches that were affected by the spill. The variables used in the utility function were trip price, including both driving and time cost. The former was $0.233 a mile, while the latter was based on whether the beach goer received "flexible" or "fixed" wages. Those in the flexible wage category could rearrange their work hours in order to earn income from working additional hours — this is called the marginal wage rate. Those in the fixed wage rate category are assumed to not have time valued at the marginal rate and it is suggested that this group be included with just the amount of time taken for the trip. The second major term in the utility function is site attributes, which preliminary testing identified as beach frontage and width, parking, walkovers, facilities, vehicle, and beach location, i.e., the Gulf or Atlantic Ocean.

To obtain data on individuals and their beach habits (sites visited), a telephone survey was conducted in the fall of 1994 or a year after the oil spills had closed the beaches for nearly a month. The random sample of 2,772 was drawn from the general population in the 16 counties (Figure 6.4) whose residents would ordinarily go to Treasure Island and other beaches that were oiled during the spill; of these, 718 or 26 percent (referred to as the participation rate) were beach goers.

Overflights of the spill area were made in 1994, one year after the spill, in order to estimate or hindcast the number of trips that might have been taken prior to the spill in August 1993; these data were used in conjunction with individual surveys to obtain the percentage of trips that residents took. Of the 284,000 total visits estimated by the overflights, 61.6 percent of those interviewed were residents or about 175,000 resident-visits to the beaches were impacted by the oil spill.

As discussed earlier, there are upper and lower bounds on estimated damages for each individual in the welfare analysis sample. To clarify these relationships, assume that the number of trips (T) a person took in the absence of an oil spill (i.e., no spill or NS) is denoted by T(NS). In the random utility model, the beaches affected by the oil spill are removed from the choice framework so that the beach goer must make a second choice, thereby incurring an economic loss per beach trip (this is the willingness to pay to recoup best choice losses expressed in dollars). These losses or WTP/trip are multiplied by T(NS) to get the upper bound estimates of economic losses incurred during the duration of the oil spill. This is an upper bound estimate because, according to the RUM, beach goers cannot do something else, such as take a cruise with their income thereby reducing the calculated actual losses resulting from the spill. The RUM is limited to choices within the set of beaches (i.e., 297 beaches) so that the beach goers must, under this condition, spend all their days at beaches and nothing else.

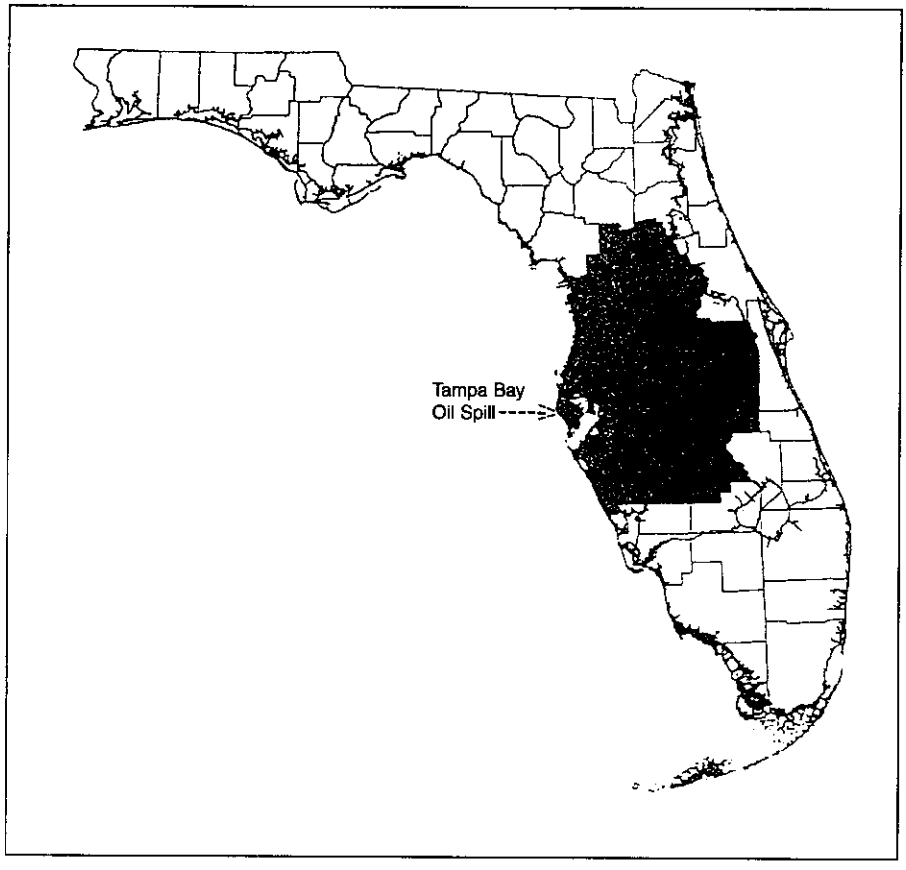

Figure 6.4. Geographical area in Florida served by saltwater beaches in Tampa Bay, Florida.

The lower bound case assumes that all trips to the oiled beaches would be cancelled outright and that people would be diverted to other beaches or destinations. The WTP/Trip or losses from selection of the second best beaches would be determined as follows:

WTP/Trip X [T(N) – T(SA)], where

WTP/Trip = losses from selection of second-best beaches
T(N) = total number of trips
T(SA) = number of trips to the spill area

The lower bound estimate assumes that beach goers to the oil-spilled beach will find an alternative allocation of their time to non-beach areas that does not decrease utility and thereby create additional losses. Consider the following example.

Assume that a beach goer's willingness to pay per trip (WTP/Trip) is $1.00 for the upper and lower bound damage estimate when an oil spill occurs and that she must redistribute all her days to a second choice beach. Assume further that in the absence of an oil spill, the beach goer ordinarily takes 10 trips to all beaches. If a spill occurs, however, she would lose $10 — this is the upper bound. Now, assume there is an oil spill that affects two of her trips, which were to the oiled beach; she is left with only eight trips per year (two had to be canceled), and a lower bound damage of $4 (8 X $1). Note that "Don't go to the beach" is not an option for the upper bound case since the beach goer will make 10 trips despite the oil spill in establishing the WTP/Trip. This simplification is not unreasonable since it assumes that the oil spill will not cause the beach goer to give up or do something else rather than use other beaches for recreation. In the lower bound case, the beach goer quits going to all oiled beaches and finds a comparable non-beach activity yielding the same utility.

The best variation of the RUM model computed that the upper bound estimate of damages is $5.53 for each beach goer during the oiled beach period while the lower bound estimate is $3.52; the average of both is $4.53; all of this information is summarized in Table 6.1 and can be used to estimate damages from the oil spill. Multiplying the resident population of 3.4 million (shown geographically in Figure 6.4) by the participation rate for beach goers gives the number of individuals incurring economic losses as a result of the Tampa Bay oil spill. This number is then multiplied by the upper and lower boundaries of the losses per beach goer as given by the random utility model; this yielded two estimates of the total damages, the upper bound of $4.87 million and lower bound of $3.10 million, the mean of which is $3.98 million. Dividing this total by the estimated 175,000 on-site visits during the same period in 1994, we estimate an average $22.75 per visit. This average damage estimate can be compared with results of other studies. A study by Walsh and McLean (1990), for example, found that across 11 studies, the value of swimming was $30 and picnicing was $22.60 per visit (in 1994 dollars).

TABLE 6.1. RANGE OF ESTIMATED RECREATIONAL DAMAGES FROM TAMPA BAY OIL SPILL, AUGUST 14–SEPTEMBER 2, 1993.

Range	Resident Population (Millions)		Part. Rate		Damages Per User		Total Damage ($ Millions)
Upper	3.4	X	.259	X	$5.53	=	$4.87
Lower	3.4	X	.259	X	$3.52	=	$3.10
Mean	3.4	X	.259	X	$4.53	=	$3.98

From another perspective, the random utility model results suggest that if there is a "perfect" alternative or substitute for the oiled beaches in terms of physical characteristics, the damages cannot exceed the additional travel cost of gaining access to that substitute. The mean travel cost for the sample in this study is about $0.71 per mile; thus, the estimate of $22.75 a visit (above) represents about 32 miles of additional driving to get to a perfect substitute. This dollar amount compares favorably with the observed distances that people drive to get to favored beaches based upon the survey of the area. That is, individuals routinely forego a closed beach and travel considerable distances to get to a favored one. For example, those who live within 20 miles of a beach averaged an additional 40 miles of travel to go to one they preferred, while those living farther away traveled an additional 40 miles as well; individuals living farther from the beaches were willing to drive an additional 50 to 60 miles for one they favored. These findings compare well with the per visit estimate of damages.

APPLYING VALUATION RESULTS IN RESOURCE MANAGEMENT DECISIONS

Under CERCLA, the State of Florida and the Federal governments could seek two kinds of compensation for the lost beach value, compensatory and punitive damages. Compensatory damages are meant to reimburse those impacted by the spill, while punitive damages are meant to deter further accidents by encouraging greater precaution and preventative actions. The random utility travel model is intended to measure compensatory damages; in this case, the model was restricted to use value only and did not include nonuse values (option or existence values), which are important factors in estimating damages.

In general, nonuse value is the value of knowing that something exists in a particular state, even though there is no contact with the resource. Option value in this case is the value to those who do not use the beach, but want to preserve their "option" to use it; for this group, when a beach is damaged by an oil spill they lose value. Existence value is the value to those who state they would never visit the beach, though they want it preserved for its own sake or others. Environmental organizations receive support for projects from members who have no involvement in such projects but have an interest in preservation or restoration. The Save the Manatee Club in Florida, for

example, receives a majority of its contributions from out of state and even from abroad; many contributors will never see a manatee in the wild — however, they are willing to pay to have this creature preserved. In the case of the Tampa Bay spill, the use damages represent only a small part of other damages, for instance, to wildlife and the functioning of the beach ecosystem.

The mean damage estimate of $3.98 million has been presented to the potentially responsible parties. In addition to the beach damages, the polluter would be asked to pay for clean-up operations. A joint settlement resolving all claims between the United States, the State of Florida and the parties responsible for the spill was approved and became final in May 1999. Under the settlement, the Trustees received $2.5 million in compensation for the lost recreational services of the injured beaches, waterways and shellfish beds. The $2.5 million settlement is about 37 percent lower than the mean estimates of the damage to injured beaches of $3.98 million. The trustees failed to recover damages for losses to out-of-state tourists during the oil spill.

The problem with this kind of a settlement is that the potentially responsible party is inclined to stall while the government lacks the proper incentives to exact a price by an out-of-court settlement or immediately go to court. The reason is the disconnect between those that were responsible and those who were affected by the oil spill, namely the stakeholders. In this case, it is not clear that the stakeholders know who they are. Remember that the government is estimating damages for literally thousands of beach goers who became stakeholders when the oil spill occurred. Since the spill was cleaned-up in a little over three weeks, it may be difficult for beach goers in the 16-county region to even identify themselves as stakeholders. Thus, there is little if no pressure on government to compensate them through a settlement. The government is restrained since it must go through a series of meetings with those stakeholders it can identify to determine how they wish to be compensated or if they agree with the level of compensation. In most cases, they are not likely to have knowledge of the random utility model — all of these are obstacles that cannot easily be overcome.

In a related case, three years before the Tampa Bay oil spill in 1993, the steam tanker American Trader spilled 416,598 gallons of crude oil off Huntington Beach, California. Similar in magnitude to the Tampa Bay oil spil, the trustees did not use the random utility model approach of this study, but a "benefits transfer" approach (see chapter 4), in which the use value of comparable beaches was taken from a study of Florida along with the number of estimated beach trips lost during the oil spill in California. Although occurring before the Tampa Bay oil spill, the American Trader case is the only damage in the United States to go through a jury deliberation. The Tampa Bay oil spill case was settled out of court. Lost recreational damages awarded by the jury in the American Trader case were $11.42 million. Although Huntington Beach in California was closed for 34 days, almost twice as long as Treasure Island in Florida, it appears that trial by jury may be a significant factor in gaining more damage payments from the principal responsible party. For more on the American Trader case, see Chapman et al (1998).

By law, the funds collected in the Tampa Bay case are to be used to plan and implement actions to restore, replace, rehabilitate or acquire resources or resource services like those that were lost. This plan will identify the restoration actions which are preferred for use by the Trustees to compensate for the recreational services of area beaches, shellfish beds and surface water which were lost as a result of the incident. The trustees might consider the beach attributes from the random utility function to ascertain the highest and best use of damages collected in terms of increasing the utilityof beach goers to the beach area affected by the 1993 spill. For example, additional parking or beach access may be provided through the use of the damages collected. Even though imperfect, the thrust of the process under CERCLA is to use monies collected as damages from the polluter and in some way compensate those individuals whose use of the damaged beaches was curtailed.

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CHAPTER 7

EVERGLADES RESTORATION PLANNING: MULTIATTRIBUTE UTILITY ANALYSIS

J. Walter Milon and Alan Hodges

Restoration of ecosystems such as the Florida Everglades presents one of the most difficult challenges in contemporary science and environmental decision making. In addition to the technical challenges related to ecological restoration of such a complex ecosystem, the goals of restoration can also be problematic because of competing points of view on just what constitutes a restored ecosystem. One means of trying to assess public preferences and economic values for alternative restoration goals is multiattribute utility analysis, a variation of contingent valuation methods, which can be used to help clarify decision making issues, assess public preferences for different objectives and relate measures of economic value to those objectives.

RESOURCE MANAGEMENT ISSUE

The Florida Everglades ecosystem stretches from south of Orlando to the Florida Keys and covers more than 69,000 square kilometers (Figure 7.1). This complex mosaic of hydrologically interrelated terrestrial, freshwater and marine systems was the focus of the federal interagency South Florida Ecosystem Restoration Task Force charged with presenting a plan to Congress in July 1999 to restore the ecosystem.[1] The essence of the planning problem was characterized in a study by the U. S. Army Corps of Engineers (1994): "The vision of the future wetlands in south Florida is influenced by different views of how we determine restoration goals for the system. The future Kissimmee River, Lake Okeechobee, Everglades, Big Cypress, and Florida Bay ecosystems can be, to some extent, what we want them to be, based on our value systems, and our decisions about what conditions and components constitute a restored ecosystem." At the same time, restoration planners must consider competing demands for

[1] Federal participation on the Task Force includes the Army Corps of Engineers, the Departments of Agriculture, Interior and Justice, and the Environmental Protection Agency. Other official participation includes three state agencies as well as the Miccosukee and Seminole tribes. The Water Resources Development Act of 1996 (P.L. 104-303, Sec. 528) placed lead responsibility for developing the plan with the Army Corps of Engineers (Milon et al. 1998; Vogel 1998).

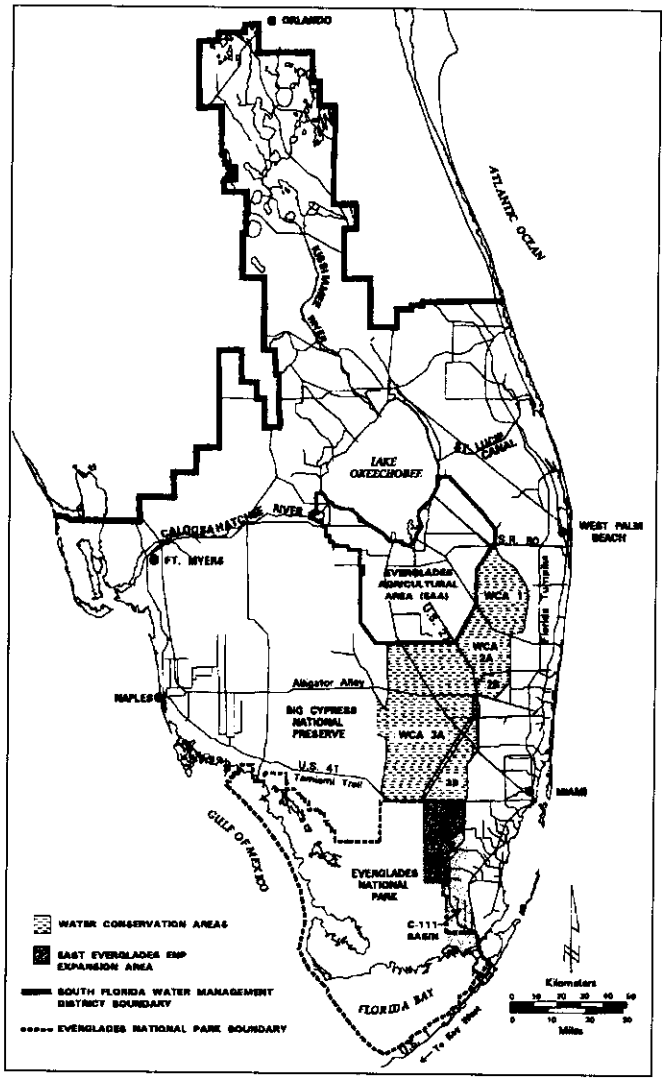

Figure 7.1. The South Florida/Everglades ecosystem.

water from urban and agricultural users and the cost of redesigning one of the most extensive water management systems in the world (Vogel 1998).

A key factor in these considerations was determining the economic implications of restoration options. One means for doing this is by multiattribute utility (MAU) surveys, a technique for measuring public preferences and economic values for alternative restoration plans. A variation of contingent valuation techniques (see Chapter 4), MAU surveys can be used to value environmental resources. MAU procedures have been used in a number of complex, multiple objective problems (Keeney and Raiffa 1976; Giocoechea et al. 1982; von Winterfeldt and Edwards 1986) but applications to ecosystem restoration planning have been limited. The next section provides a brief overview of MAU theory and describes the development of a MAU survey for the Everglades/South Florida ecosystem restoration problem. This overview is followed by a discussion of results from the survey and an application of the results to evaluate alternative restoration plans. We conclude with some broad observations on the role of MAU surveys in other types of coastal and environmental decision-making. More complete details about the survey and results are available in Milon et al. (1999).

MULTIATTRIBUTE UTILITY THEORY

In their simplest form, multiattribute utility (MAU) surveys consist of one or more alternatives that can be evaluated by decision makers, who may be a small group of specialists or a large group comprising members of the public (Keeney and Raiffa 1976; Kleindorfer et al. 1993). Alternatives are described by sets of attributes that are deemed essential to the decision process and are understood by decision makers (Louviere 1988). For example, assume that prospective automobile buyers are asked to evaluate

two prototype automobiles based on five attributes: fuel economy, seating capacity, performance, safety and price. Figure 7.2 illustrates this type of comparison using different levels of the attributes for each alternative.

Attribute	Model A	Model B
Price (new)	$25,000	$15,000
Safety	Has air bags	No air bags
Horsepower	250	200
Fuel Economy	20 miles per gallon	25 miles per gallon
Seating Capacity	6 persons	4 persons

Figure 7.2. A multiattribute description of car model choice.

A pairwise choice process, in which the most preferred model is selected from the two alternatives, requires each consumer to prioritize (weight) the attributes in importance and choose between tradeoffs in the attribute combinations that make up each alternative. Decisions by a number of individuals can be evaluated statistically to identify the relative importance of each attribute.

For a problem with two alternatives, A and B, it is assumed an individual would choose the alternative with a higher level of utility or, in symbolic terms,

$U(X^A) > U(X^B)$, where
$U(.)$ represents the individual utility function, and
X^A, X^B represent sets of attributes for alternatives A and B.

Utility can be decomposed into a systematic component, $v(.)$, determined by the attributes, and a random component, ε, such that

$$U(X) = v(X) + \varepsilon$$

The probability that A is preferred to B depends on the probability that the difference between the systematic component of A and B is greater than the difference between the random components, or

$Pr(A) = Pr(D > \delta)$, where
$D = v(X^A) - v(X^B)$
$\delta = \varepsilon^A - \varepsilon^B$

With data from a representative sample of decision makers, statistical techniques such as conditional logit (Ben-Akiva and Lerman 1985; Green 1990) can be used to estimate the relative weights assigned to each attribute. These weights provide information

about the preferences of decision makers and can be used to compute utility "scores" and marginal values to rank alternatives with new combinations of attributes.[2]

APPLICATION OF THEORY TO PRACTICE

An important issue in any multiattribute utility survey is the choice of attributes and attribute levels to describe the decision problem. To evaluate how a set of attributes could be used to represent public perceptions and preferences for restoration of the Everglades/South Florida ecosystem, focus groups were conducted in 1997 with members of the general public. Discussions were held also with various state and federal agency staff involved in restoration planning to identify their perceptions of the planning problem and the hydrological/ecological models being used in the planning process.

Survey Design

On the basis of these focus groups and discussions, a set of attributes was developed that described the hydrological characteristics (water levels and timing) in three major subregions of South Florida: Lake Okeechobee, the Water Conservation Areas, and Everglades National Park (Figure 7.1). In addition, because ecosystem restoration objectives in the Everglades/South Florida setting must be considered with other social objectives, three additional attributes were developed as elements of possible restoration plans:

- The annual cost of the restoration to households in Florida;
- Possible restrictions on outdoor and indoor water use in South Florida;
- Changes in farmland acreage in South Florida through conversions to wetlands.

Table 7.1 summarizes descriptions and the levels of each attribute used in the survey design. The levels for each of the attributes were selected in consultation with scientists and agency staff knowledgeable about the restoration effort. Because of considerable uncertainty about the effects of any restoration plan (U.S. Army Corps of Engineers 1998), three attribute levels were selected to represent (1) baseline (status quo), (2) intermediate, and (3) maximum possible restoration relative to historical conditions. This comparison of existing and potential with historical conditions was a convenient

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[2] One form of the utility function that is commonly used to weight attributes and score/rank alternatives is the additive function: $U(x_j) = \Sigma W_i U_i (x_{ij})$, for $j = 1, ..., n$, where $U(x_j)$ is the utility of the jth alternative, W_i is the weight for the ith attribute, U_i is the utility function for the ith attribute, and x_{ij} is the score given to the jth alternative on the ith attribute. Utility is a linear combination of the weighted values of each attribute. The alternative with the highest score would be the most preferred. The additive function is convenient because it reduces the number of choice repetitions necessary to derive reliable statistical results (Louviere 1988).

method to allow individuals to consider the implications of alternative attribute levels and was consistent with current ideas about restoration philosophy (Bratton 1992).

The combination of three levels for each of the six attributes described in Table 7.1 provided 3^6 or 729 unique possible attribute combinations. After an extensive period of pretesting, attribute sets for the survey were reduced to 27 combinations using an optimized factorial design to evaluate all main effects and first-order interactive effects (SAS Institute 1996). A household interview process[3] was designed that consisted of the following: (1) a general introduction and explanation of the nature and purpose of the survey; (2) a set of questions to elicit respondent attitudes about environmental and public policy issues; (3) an informational video providing general background about the Everglades ecosystem and changes in the system; (4) a pairwise choice process in which respondents selected a preferred alternative from each of seven paired alternatives[4] and (5) questions to identify the respondent's socioeconomic background. An informational video, approximately 11 minutes in length, was a key part of the survey design and interview process because it provided a common source of background information for respondents. Also, interviewers used a notebook to provide complete descriptions of the attributes along with graphical representations of the attribute levels.[5]

Table 7.2 is an example of the pairwise choice process used in the survey. Plans A and B represent two possible combinations of attribute levels that resulted from the factorial design. Respondents chose the preferred plan from choices A and B and then proceeded to evaluate six additional pairs of alternative plans during the interview.

A total of 480 interviews were conducted in 1998 in Miami, West Palm Beach, Ft. Myers, Orlando and Tampa using randomly selected households from a stratified design based on census tract median income and ethnic composition. The first three cities were selected to represent the opinions of citizens most directly impacted by restoration plans since they reside in South Florida. The latter two cities represented the opinions of urban Floridians in other parts of the state. The overall margin of error for the survey was +/- 4.5 percent. A professional market research firm conducted the interviews and included bilingual interviewers when necessary.

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[3] Due to the complexity of the survey and the need to assure that respondents drawn from the general population understood the attribute descriptions, household interviews were necessary for this survey. Other MAU based surveys have used other types of data collection methods with good success (e.g., Adamowicz et al. 1994; Opaluch et al. 1993).

[4] While there were 27 possible attribute combinations in the optimized factorial design, pretesting indicated that more than ten pairwise choice tasks was too burdensome for respondents. Therefore the 27 attribute combinations were split into two groups of 7 pairwise choices (2 groups x 7 pairwise choices equals 28 alternatives with 1 alternative repeated in each group) so that each respondent only made 7 repeated choices. Respondents were randomly assigned to choice groups.

[5] Also, an incentive of $10 per respondent was offered as compensation for time and cooperation. Interviews averaged 57 minutes. Interviewers rated each respondent in terms of their seriousness about the survey, level of attentiveness to the choice task, understanding of the choice tasks and general comments about the interview.

TABLE 7.1. DESCRIPTION OF ATTRIBUTES AND LEVELS FOR THE EVERGLADES MULTIATTRIBUTE MODEL.

Attribute Description	Levels
Water Levels in Lake Okeechobee. The water management system controls the water levels and fluctuations in Lake Okeechobee. Too much water in the lake causes flooding of the shoreline and marsh areas. Too little water causes these areas to dry out. Part of a plan to change the South Florida water management system could include ways to control the levels of the lake and timing of fluctuations to be similar to historic, predrainage conditions. The possible water level controls that could be included in the plan are:	60%, 75% and 90% of the time, lake levels are similar to historic, predrainage conditions
Water Levels in Water Conservation Area. The water management system controls the water levels and fluctuations in Water Conservation Areas. Too much water in these areas causes flooding of wetlands, upland areas and tree islands. Too little water causes these areas to dry out. Part of a plan to change the South Florida water management system could include ways to control the water levels and fluctuations in the Water Conservation area to be similar to historic, predrainage conditions. The possible water level controls that could be included in the plan are:	50%, 75% and 90% of the time, water levels in the Water Conservation Areas are similar to historic, predrainage conditions
Water Levels in Everglades National Park. The water management system controls the water levels and fluctuations in Everglades National Park and the flow of fresh water to Florida Bay. Too much water causes flooding of wetlands, upland areas and tree islands. Too little water causes these areas to dry out and increase the salinity in Florida Bay. Part of a plan to change the South Florida water management system could include ways to control the water levels and fluctuations in the park to be similar to historic, predrainage conditions. The possible water level controls that could be included in the plan are:	50%, 75% and 90% of the time, water levels in Everglades National Park are similar to historic, predrainage conditions
Annual Cost per Household. All Florida residents pay utility taxes as part of their water, electric and telephone bills. Part of a plan to change the South Florida water management system could include additional taxes and all Floridians would pay for these changes over the next ten years. Proceeds from these taxes would go into a special trust fund that would be used only to change the South Florida water management system. Possible tax payments that could be included in the plan are:	No change in utility taxes; $25 increase; $50 increase
Restrictions on Water Use. Changes in the water management system can affect the availability of water for households in South Florida. The primary effect would occur during years with low rainfall. These dry years occur, on average, in one out of every five years. Possible levels of restrictions on outdoor and indoor water use that could be included in the plan are:	3 days per week outdoor use/10% reduction in indoor use; 2 days per week outdoor use/25% reduction in indoor use; 1 day per week outdoor use/40% reduction in indoor use
Farmland. Farmland acreage can be converted to water storage to increase the flexibility of the water management system, increase the extent of natural areas, and reduce irrigation demand for water. Part of a plan to change the South Florida water management system could include reductions in existing farmland acreage in the Everglades Agricultural Area and in western portions of Broward and Dade counties that are adjacent to the Water Conservation Areas and Everglades National Park.	No change in farm land acreage; 100,000 acre reduction; 200,000 acre reduction

TABLE 7.2. EXAMPLE OF PAIRWISE CHOICE FOR THE HYDROLOGICAL ATTRIBUTE MODEL.

Plan Component	Plan A	Plan B
Lake Okeechobee, Water Levels and Timing.	60% of the time, Lake levels and timing are similar to historic, predrainage conditions	60% of the time, Lake levels and timing are similar to historic, predrainage conditions
Everglades Water Conservation Areas, Water Levels and Timing.	50% of areas have water levels and timing similar to historic, predrainage conditions	50% of areas have water levels and timing similar to historic, predrainage conditions
Everglades National Park and Florida Bay, Water Levels and Timing.	90% of the area has water levels and timing similar to historic, predrainage conditions	50% of the area has water levels and timing similar to historic, predrainage conditions
Annual Cost Per Household.	Increased $25 per year	No change
Restrictions on Household Outdoor and Indoor Water Use.	Outdoor use limited to 3 days per week; indoor use reduced 10%	Outdoor use limited to 2 days per week; indoor use reduced 25%
Farmland (acres) in the Everglades Agricultural Area and Western Portions of Palm Beach, Broward and Dade Counties.	Reduce farmland acreage by 100,000 acres or 15% of farmed area	No change in farmland acreage

Survey Results

Responses from the pairwise choice tasks were used to estimate a MAU function for the attributes described in Table 7.1. Statistical results were used to derive marginal willingness to pay values for each attribute[6], which are presented in Figure 7.3. These values are measures of the consumers surplus associated with changes in the level of

[6] Marginal willingness to pay for each attribute was calculated with the formula: $((\beta_i (A_0) - (\beta_i (A_1)))/ \beta^C$ where β_i is the estimated coefficient for an attribute, A_0 and A_1 represent base and restored attribute levels, respectively, and β^C represents the estimated coefficient for the annual cost per household attribute. Due to the nature of the utility function specification, the marginal values are constant (linear) for each attribute with the exception of the water restriction attribute that was decomposed into two separate effects. Because the cost per household attribute is used to transform attribute levels into monetary units, there is no marginal effect associated with the cost attribute. Due to the nature of the household cost attribute (see Table 7.1), these annual willingness to pay values apply over a ten-year period.

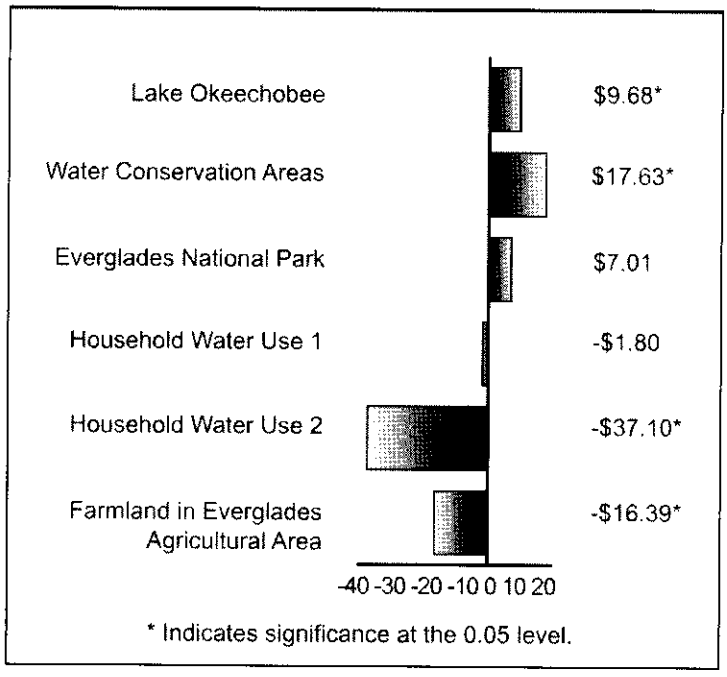

Figure 7.3. Relative marginal values for attributes in the multiattribute model.

each attribute (see Chapter 4). For example, the average respondent would be willing to pay $9.68 annually to change water management so that water levels and timing in Lake Okeechobee were similar to historic, pre-drainage conditions 75 percent of the time instead of the current baseline of 60 percent. (If water levels and timing in Lake Okeechobee were similar to historic, predrainage conditions 90 percent of the time, the marginal willingness to pay for this change would be $19.36 per household per year.) Similarly, respondents would be willing to pay $17.63 to change water management so that water levels and timing in the Water Conservation Areas were similar to historic, predrainage conditions 75 percent of the time instead of the current baseline of 50 percent. The relative difference in willingness to pay for roughly similar changes in the two areas reflects the higher weight given to the Water Conservation Area attribute.

On the other hand, Figure 7.3 also shows that respondents would be willing to pay $37.10 to avoid changes in the water management system that would increase water use restrictions during dry years from allowable outdoor uses three days per week with 10 percent reductions in indoor water use to allowable outdoor uses only one day per week with 40 percent reductions in indoor water use. The magnitude of this value reflects the strong aversion respondents expressed to this type of water use restriction. But, the willingness to pay of $1.80 for a smaller restriction on water use indicates that the marginal loss from this type of restriction would be relatively low.

The marginal values presented in Figure 7.3 show the relative changes in economic value that could result from incremental changes in each attribute. These marginal effects, however, do not constitute measures of economic value for a restoration plan because several attributes would change at one time under any actual restoration plan. Therefore it is necessary to consider how several attribute levels would change under various restoration plan scenarios.

Restoration Plan Rankings

A feature of the multiattribute utility approach is that attribute weights derived from the pairwise choice process can be used to evaluate a range of alternative restoration plans with various configurations of the attributes.[7] To illustrate this application, a set of possible restoration plans was constructed using the attribute levels specified previously in Table 7.1. These plans were intended to reflect the range of alternatives that had been discussed for the Everglades/South Florida restoration plan but were not intended to represent any specific plan.

Table 7.3 presents complete descriptions of the alternative plans along with the attribute levels included under each plan. The plans range from full restoration with no costs to partial restoration plans that impose various levels of costs. Included in Table 7.3 is the percentage of respondents who would vote in favor of each plan based on their MAU score for that alternative[8] and the overall ranking for each of the plans. Table 7.3 also presents estimates of the net willingness to pay for each plan based on the marginal willingness to pay values presented previously in Figure 7.3.

The results in Table 7.3 show that respondents strongly favor full ecosystem restoration, but only when Floridians bear no direct costs through higher taxes, water use restrictions or reductions in farmland.[9] The net willingness to pay for this plan is $58.78 per household per year. Over the ten-year period used for the annual cost attribute (see Table 7.1), this would amount to an aggregate willingness to pay of $588 per household.

When full restoration is matched with low costs ($25 per household per year), reductions in farmland acreage (loss of 100,000 acres) and minor restrictions on water use (outdoor uses restricted to 2 days, 25 percent indoor use reductions), a majority (54.3 percent) would favor such a plan. However, the relative ranking of this plan is only third of the five considered in this analysis. The net willingness to pay for this plan is $15.59 per household per year. If full restoration is matched with high cost and major restrictions on water use, less than a third (31.1 percent) would favor this plan and it is the lowest ranked alternative.

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[7] These plans may differ from the alternatives considered in the pairwise choice process since the 27 attribute combinations used in the interviews were selected to meet specific experimental design criteria.

[8] It is assumed that a respondent would vote in favor of an alternative if the utility score for that alternative was greater than the utility score for a baseline alternative (i.e., all attributes at their lowest, baseline level). Calculations of utility scores can be made using either aggregate or individual-specific weights (Swallow et al. 1994).

[9] From a legal standpoint, a full restoration with no cost plan is not possible since the Water Resources Act of 1996 requires a 50/50 federal and state cost sharing agreement for any Everglades/South Florida ecosystem restoration plan (Vogel 1998).

TABLE 7.3. EVALUATION OF SELECTED RESTORATION PLANS WITH THE EVERGLADES MULTIATTRIBUTE MODEL.

Plan Description	Percent in Favor	Ranking	Net Willingness to Pay
Full Restoration Without Costs Lake Okeechobee = 90% Cost = 0 Water Conservation Areas = 90% Farmland = 0 Everglades National Park = 90% Water Restrictions = 0	71.7%	1	$58.78
Partial Restoration With No Costs, Minor Restrictions Lake Okeechobee = 60% Cost = 0 Water Conservation Areas = 75% Farmland = 100,000 acres Everglades National Park = 75% Water Restrictions = 2 days/25%	54.3%	2	$ 6.42
Full Restoration With Low Cost, Minor Restrictions Lake Okeechobee = 90% Cost = $ 25 Water Conservation Areas = 90% Farmland = 100,000 acres Everglades National Park = 90% Water Restrictions = 2 days/25%	54.3%	3	$15.59
Partial Restoration With Low Cost, Minor Restrictions Lake Okeechobee =75% Cost = $ 25 Water Conservation Areas = 75% Farmland = 100,000 acres Everglades National Park = 75% Water Restrictions = 2 days/25%	44.3%	4	–$ 8.90
Full Restoration With High Cost, Major Restrictions Lake Okeechobee = 90% Cost = $ 50 Water Conservation Areas = 90% Farmland = 200,000 acres Everglades National Park = 90% Water Restrictions = 1 day/40%	31.1%	5	–$61.10

Table 7.3 also indicates that various partial restoration plans would be favored by a majority of respondents, though the results are very sensitive to the costs imposed by the plan. A partial restoration plan that focused on the Water Conservation Areas and Everglades National Park imposed no direct costs on households but minor reductions in farmland (100,000 acres) and minor restrictions on water use, would be favored by a majority (54.3 percent). Net willingness to pay for this plan would be $6.42 per household per year.

A comparable partial restoration plan (that added partial restoration of Lake Okeechobee) in which direct costs increased to $25 per household per year would not

garner a majority (44.3 percent) of respondents. Moreover, the net willingness to pay for this plan would be negative indicating no positive economic benefits. These results suggest that restoration planners should carefully consider the potential loss of public support for any plan that imposes high costs or major water use restrictions on Floridians.

CONCLUSIONS

Ecosystem restoration planning and decision making for the Everglades/South Florida region is complicated by both scientific and social questions. Decisions about what and how much to restore must consider the social tradeoffs inherent in alternative restoration plans. Multiattribute utility analysis provides a flexible tool to frame the decision problem, evaluate public preferences for alternative plans and develop measures of the economic value of alternative plans.

Results from this survey of Floridians about preferences for restoration of the Everglades/South Florida ecosystem demonstrate some of the possible uses of the MAU approach. These survey results suggest that a strong desire by Floridians for restoration of the Everglades/South Florida ecosystem is tempered by the potential consequences of restoration decisions on municipal water users and agricultural interests in South Florida. For example, the net willingness to pay for a full restoration plan with no direct costs to Floridians is $58.78 per household per year (Table 7.3). Extrapolating this value to the population of 5.7 million Florida households (as of 1997) would result in an aggregate net willingness to pay of $335 million per year for this plan.[10] Over a ten-year period, this would amount to $3.35 billion.[11]

Alternatively, a full restoration plan that imposes direct costs on Floridians in the form of a $25 annual cost per household, minor water use restrictions, and a 100,000 acre decrease in farmland would have a net willingness to pay of $15.59 per household per year (Table 7.3). The aggregate net willingness to pay over a ten-year period for this plan would be $889 million. Comparable aggregate values could be constructed in a similar fashion for other plans described in Table 7.3 or for additional plans that could be described by different combinations of the attributes.

Additional analyses of the multiattribute utility survey results could be used to show how these preferences differ across socioeconomic groups and different regions of the state. Estimates of willingness to pay for alternative plans can then be derived for

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[10] The survey was designed to be representative of the population in the five counties described previously and was not intended to be representative of the Florida population. Since the five counties included in the survey account for a large share of the total Florida population south of Orlando (Orange county), the primary differences in preferences and willingness to pay for Everglades restoration would likely occur in North Florida.

[11] Expressed in real 1998 dollars. Growth in the number of households in Florida or changes in preferences over the ten-year period are not considered.

different socioeconomic groups or regions of the state (see Milon et al. 1999, Section 6). This kind of analysis highlights differences in the intensity of preferences that may exist for various groups and their willingness to pay for specific restoration actions. An application of decision making tools such as MAU analysis in ecosystem restoration planning offers the promise of better information for resource managers and the public.

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CHAPTER 8

NATURAL RESOURCE VALUATION OF THE INDIAN RIVER LAGOON

J. Walter Milon

Historically, management actions to protect aquatic ecosystems have often been done in reaction to serious deterioration or on a piecemeal basis; this may be especially so in regions where natural resources are important features of an economy that depends on recreational use of natural resources by residents and large numbers of nonresidents. In the central Florida region of the Indian River Lagoon, concern over environmental degradation and its implications for the economy led to a management plan for restoration and conservation. In order to put the plan into action, it was necessary to develop a firm basis for financial support by residents and visitors. A first step was to determine the economic value associated with various uses of the resources, a value that could not be measured directly but required the use of non-market tools for making such an assessment. The next step was to determine how much residents and visitors were willing to pay to meet the needs of a healthy ecosystem.

THE NEED FOR AN ECONOMIC VALUATION STUDY

The Indian River Lagoon stretches for more than 150 miles along the Atlantic coast of central Florida and is enclosed within the counties of Volusia, Brevard, Indian River, St. Lucie and Martin. The Lagoon is a tidal estuary where fresh water from rivers and creeks along the western shore mix with salt water that enters the Lagoon through inlets in the narrow barrier islands that separate the Lagoon from the Atlantic Ocean. Population and tourism in the region continue to grow. In 1995, there were some 1.25 million residents with about 6 million tourists each year; by 2005, residential and tourism growth is expected to increase by more than 20 percent.

Increasing development around the lagoon has led to greater stress on the ecosystem and deterioration of its natural resources. For example, runoff from upland areas has reduced water quality, leading to declines in the aereal extent of seagrass beds throughout the lagoon; the conversion of wetland areas to other uses has reduced the available habitat for birds and other wildlife. Meanwhile, both commercial and recreational harvests of fish and shellfish have stressed the renewable capacity of these resources.

In an effort to stem further declines and work towards sustainability of natural resources, the Indian River Lagoon National Estuary Program (IRLNEP) was estab-

lished (with funding from the U.S. Environmental Protection Agency) in 1990 to fully define the key problems and to identify possible solutions. One major objective was the development of a Comprehensive Conservation and Management Plan (CCMP) for local and state governments that would provide a blueprint for environmentally sustainable development in the watershed.

If successful, the CCMP could have important economic benefits: it would prevent further degradation of the lagoon ecosystem, and it would enhance the quality and quantity of lagoon resources, thus adding to existing activities while supporting expansion of these activities to accommodate new residents and tourists. Among the actions that could help deliver these economic benefits include effective control of discharges into the lagoon, acquisition of wetland and shoreline areas, and restoration of mangrove and seagrass habitats. Figure 8.1 graphically represents such benefits. Given a baseline economic value for the lagoon's resources, the lower line represents a loss of value in the absence of management actions to prevent further degradation of the ecosystem; the upper line represents an increase in value as CCMP management actions lead to sustainable improvements in the lagoon. The difference in the area between the lower and upper lines is the economic benefit that could accrue to residents and visitors in the region from the CCMP. These benefits may result from changes in both market and non-market values associated with the lagoon.

This discussion of the effects that management decisions have on the economic value of coastal and marine resources indicates the linkages between resource quality and economic value. It does not address specific questions about the economic "worth" of the Indian River Lagoon and whether the benefits of implementing a CCMP for the Lagoon outweigh the costs. To provide more detailed quantitative information that could be used to address these questions, it was necessary to conduct field studies to

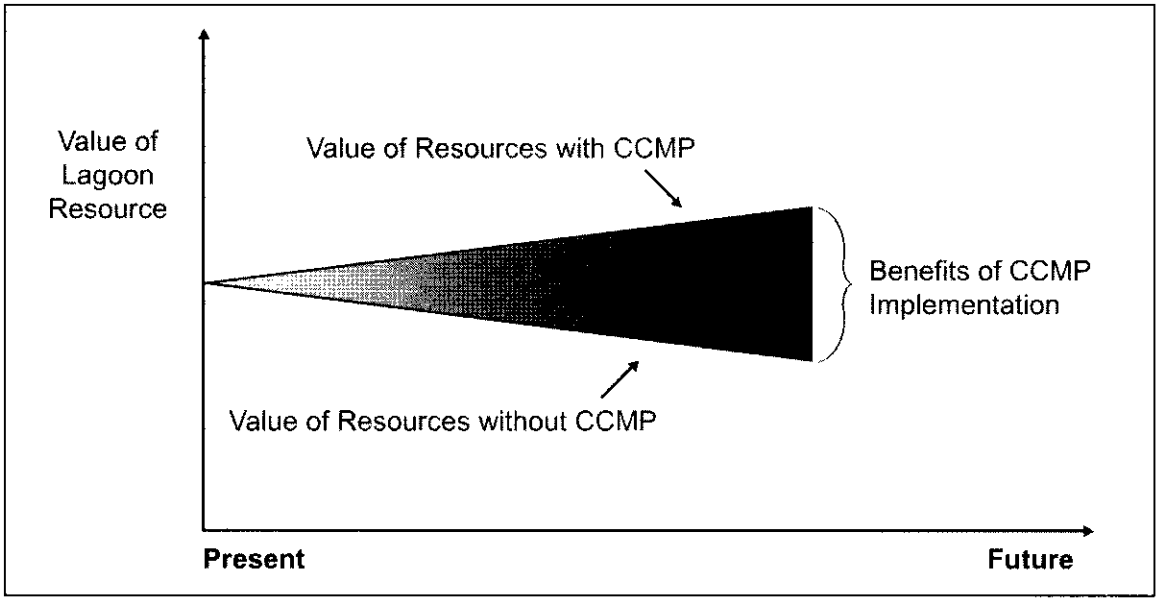

Figure 8.1. Measuring the benefits of CCMP implementation.

identify the activities currently supported by the lagoon and the economic values associated with these activities. This chapter summarizes the procedures and results from a study conducted for the Indian River Lagoon National Estuary Program (Economic Assessment 1996).

RESOURCE EVALUATION AND STUDY PROCEDURES

To evaluate how management actions such as the Comprehensive Conservation and Management Plan might impact the economic value of the Indian River Lagoon, it was necessary to first identify the potential linkages between specific actions and the activities that generate economic value. Figure 8.2 shows how various elements of the CCMP could change the physical resources of the lagoon, thereby leading to changes in economic value. For example, controls to limit freshwater, point source, and marina waste discharges into the lagoon could help to improve water quality and reduce the amount of suspended sediments. These water quality improvements might improve water clarity, which would have direct benefits to recreational boaters, waterfront property owners and other shorefront user groups such as swimmers.

Improvements in water quality could also lead to enhanced growth of seagrasses and other submerged aquatic vegetation (SAV) throughout the lagoon. Although SAV by itself may have little direct value to the economy, enhancements in their coverage and density would likely help to maintain and support increases in fishery stocks and diverse bird and animal populations that prey on these stocks. While the health of fishery and wildlife also depends on other factors, from climatic conditions to resource management policy, the indirect contribution of enhanced SAV growth could lead to direct benefits for commercial and recreational fishers and for those who participate in nature study throughout the lagoon.

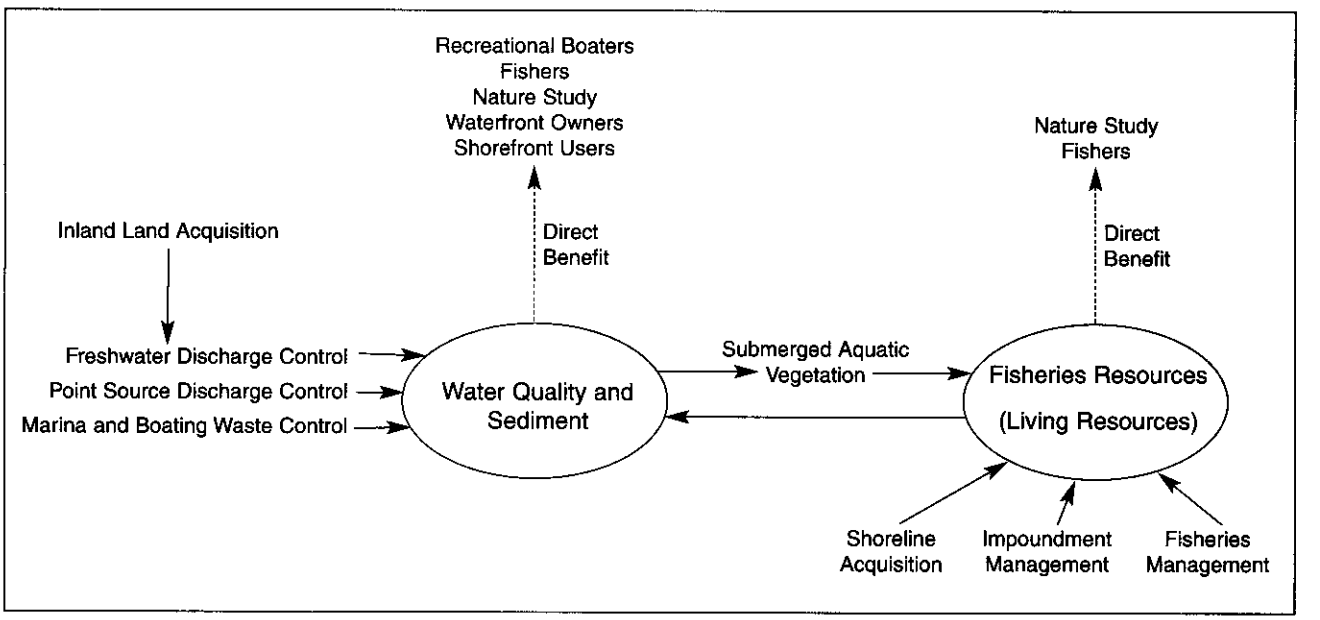

Figure 8.2. Linkages between the CCMP and Lagoon User Group Benefits.

The linkages identified in Figure 8.2 show that the primary beneficiaries of CCMP actions would be recreational users of the lagoon, owners of waterfront property and commercial fishers. The recreational users would be both residents or visitors to the area. Because there was little quantitative information about existing recreational uses of the lagoon and the economic activity associated with these uses, it was necessary to first conduct surveys that would provide the basis for making estimates of economic activity using such tools as contingent valuation analysis and travel cost methods.

Resident and Visitor Surveys

Two surveys were conducted in the five-county region, the first a random sample telephone survey of residents in the five county region and the second, intercept interviews of nonresident visitors. This random telephone survey asked 1,000 residents to identify the type and frequency of participation in different recreational activities in lagoon waters, for example, fishing, swimming, boating, water sports and nature observation. The survey also asked residents to estimate expenditures associated with these activities and to elicit their willingness to pay for various management actions. The nonresident survey asked 500 nonresident visitors to identify their participation in various recreational activities, expenditures and willingness to pay for management actions.

Contingent Valuation Analysis

In addition to participation and expenditure information, the resident and visitor surveys also included contingent valuation questions (see Chapter 4) to elicit respondent's willingness to pay (WTP) for alternative management actions in the lagoon. The contingent valuation questions used a referendum format in which respondents were asked, "If you could vote on (a specific management action) in the next election and it was the only plan you would vote on, would you vote FOR or AGAINST it?" The referendum format is familiar to most Floridians and it is a credible way to elicit preferences for various public programs. This approach differed from a typical public opinion survey in that detailed information was provided about the proposal and a specific payment amount was part of the voting choice. By varying the payment amount across respondents, it was possible to statistically estimate the average respondent's WTP based on their voting response.

For the resident survey, respondents were asked to consider three management action plans:

- *Wetlands Protection* that would enforce and support conservation measures to limit development of privately owned wetlands.

- *Land Acquisition* that would create a public trust fund to buy and maintain wetlands.

- *Stormwater Management* that would limit stormwater runoff and improve water quality.

Each action plan was considered separately using the referendum format with annual payment amounts for each plan varying between $5 and $60. To add credibility to the questions, the payment was described as a tax levied by local governments. After respondents indicated their approval or disapproval for each plan, they were also asked why they voted the way they did; answers provided additional information to managers of the Indian River Lagoon National Estuary Program to better understand public perceptions of the Comprehensive Conservation and Management Plan.

The visitor survey included questions in which all three plans were combined. Respondents were asked if they would be willing to pay an additional lodging and restaurant tax that would be used to fund management plans to maintain and enhance the lagoon. The payment amount was also varied from $2 to $25 across respondents.

Travel Cost Method Analysis

Another important component of the total economic value of the Indian River Lagoon is the non-market value of recreational fishing. While the resident and visitor surveys provided information about recreational fishing participation and expenditures, the telephone survey could not provide sufficient detail to estimate a travel cost demand model (see Chapter 4). Therefore, data from the Marine Recreational Fisheries Statistics Survey (MRFSS), conducted annually by the National Marine Fisheries Service, and an additional add-on survey that had been previously conducted by the University of Florida (Milon and Thunberg 1993) were used in a random utility travel cost model of recreational fishing participation in the lagoon. Figure 8.3 summarizes the choice elements of the model, which was structured to predict if individuals participated in boat or shore modes, the county they fished in, whether they participated in nearshore or offshore fisheries, and the specific species or species group they targeted (three individual species and two species groups were included in the model). This model's construction made it possible to assess the value of access to fishing in each county as well as the value associated with changes in individual species catch rates.

Property Value Analysis

In addition to the various recreational uses of the Indian River Lagoon by residents and nonresidents, owners of land adjacent to the lagoon were likely to benefit from enhanced water quality or from protection against future water quality deterioration. The values that landowners have for the lagoon's amenities are partially capitalized in the prices of residential land located in its proximity: these parcels would be expected to have higher values than those located further away. To identify these values for the purposes of this study, land parcel data from property appraisers offices in the five-county region were collected and evaluated. Based on these data, ratios of waterfront versus non-waterfront property were developed for each county as a measure of the economic value attributable to the lagoon. Ideally, a hedonic pricing analysis (see Chapter 4) could have been used for this analysis. However, property appraiser records in some of the counties did not contain sufficient detail to use this technique.

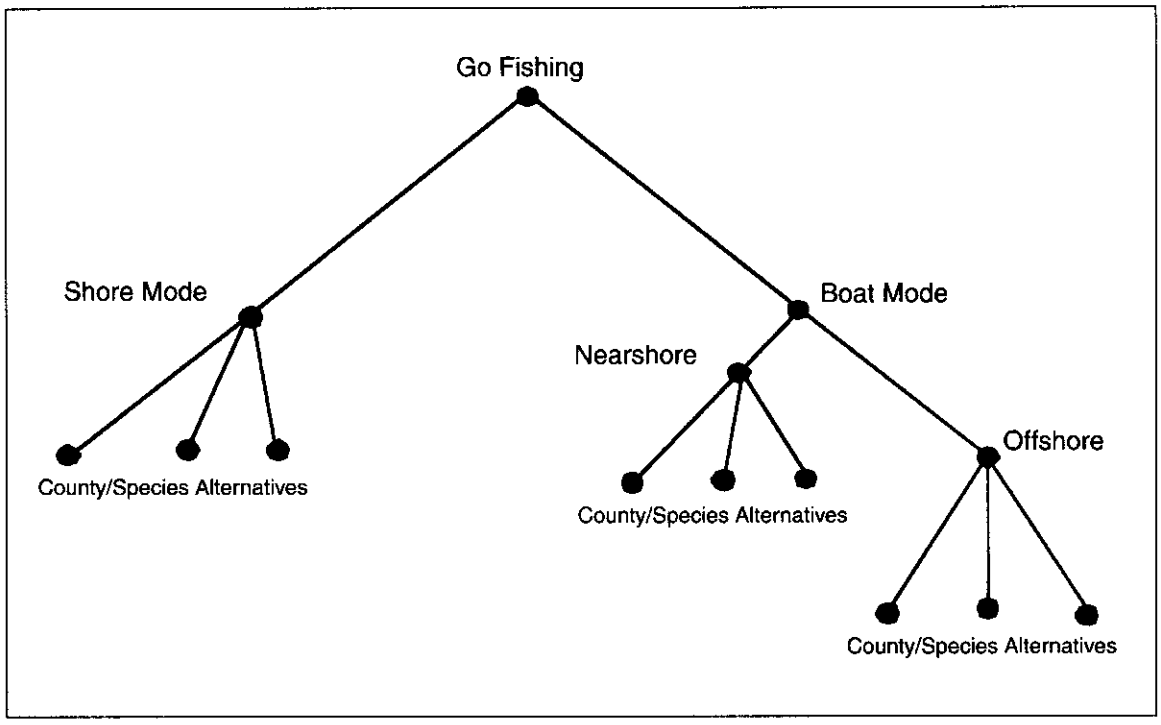

Figure 8.3. Choice structure in the IRLNEP recreational fishing demand model.

Commercial Fishing

One final component of the analysis was the need to account for the economic value of commercial fishing. Over twenty species of shellfish and finfish have traditionally been harvested from the lagoon; their estimated dockside values were tabulated from State of Florida landings records through 1995. These values were not necessarily an indication of future economic values for commercial fishing because a statewide prohibition on gill and entangling nets in Florida waters took effect in 1995 (see Chapter 12). This prohibition would effectively eliminate finfish harvesting in the lagoon; therefore, only the dockside value of shellfish and crustaceans were used in the analysis. In addition, a statistical model was developed to estimate the relationship between submerged aquatic vegetation in the lagoon and shellfish landings based on the marginal productivity theory (see Chapter 5).

RESULTS OF THE ANALYSIS OF ECONOMIC ACTIVITY

The results of individual valuation studies for the Indian River Lagoon are summarized in Table 8.1. Recreational fishing and shellfishing by both residents and visitors in the lagoon constituted a major source of the annual value of the lagoon. The estimated annual value of $338.5 million for recreational fishing was comprised of market related value (expenditures) of $198.5 million for residents and visitors and non-market access values (estimated from the travel cost model) of $140 million. Other recreational activities such as swimming, boating and water sports, and nature observation were also

important and accounted for over $287.3 million in market related value. All recreational uses of the lagoon combined amounted to over $625 million, or more than three-fourths of the annual value of the lagoon.

Willingness to pay estimates from the contingent valuation surveys were used to measure passive use or non-market values (see Chapter 4) for the lagoon. A range of values for both residents and visitors is summarized in Table 8.1, which reflects the difference in estimates when average (mean) and median values from the survey samples are used to represent the population. Statistical analysis determined that the willingness to pay values for residents were only weakly related to current recreational uses of the lagoon; however, a more direct relationship was evident for visitors. This is an important check to ensure that the valuation estimates do not *double count* the various components of total value. The passive use aggregate range of $44.5 - $58.0 million per year indicated that both residents and visitors valued the preservation of environmental quality in the lagoon for the future.

Commercial fishing landing data were evaluated to determine the share of value attributable to shellfish. The value of $12.6 million (Table 8.1) is the contribution that commercial fishing added to the total economic value of the lagoon in 1995. Future changes in water quality and submerged aquatic vegetation could increase or decrease this amount.

The final valuation component reported in Table 8.1 is the value of residential land adjacent to the Indian River Lagoon. The $33 million represents the annual value of proximity to the lagoon that was capitalized in property values across the regions. These values differed by county, reflecting differences in the willingness to pay by property owners for the amenities provided by the lagoon and possibly differences in water quality. The annual value was determined by discounting (to a single year basis)

TABLE 8.1. ESTIMATED TOTAL ANNUAL ECONOMIC VALUE OF HUMAN USES OF THE INDIAN RIVER LAGOON IN 1995 (MILLIONS OF DOLLARS).

Use Category	Value of Resident Use	Value of Visitor Use	Total Economic Value
Recreational Fishing and Shellfishing	$ 295.2	$ 43.3	$ 338.5
Swimming	23.7	112.2	135.9
Boating	49.0	19.5	58.6
Nature Observation	22.2	65.8	88.0
Water Sports	4.8	Included in Boating	4.8
Hunting	1.5	0.1	1.6
Passive Use	14.6 - 25.9	29.9 - 32.1	44.5 - 58.0
Commercial Shellfishing	12.6	Not Applicable	12.6
Riverfront Residential Land	33.0	Not Applicable	33.0
Total Economic Value	$456.6 - $467.9	$260.8 - $263.0	$717.4 -$730.9

the total capitalized market value of riverfront residential property of $825 million in 1995, using a 4 percent real discount rate.

The total estimated economic value of $717.4 - $730.9 million represents the sum of the annual flows of value in 1995 from various sources throughout the Indian River Lagoon region. These estimates can be viewed as baseline values associated with different activities and services that the lagoon supports. Changes in the ecosystem's environmental quality could increase or decrease these values depending on the specific linkage between the change and the related activities and services.

USE OF THE ECONOMIC VALUATION STUDY

As part of an effort to inform the public about the Comprehensive Conservation and Management Plan, staff of the Indian River National Estuary Program prepared a pamphlet that presented the basic results from the natural resource valuation study. It also described how the different components of value contributed to the economy of the five-county Indian River Lagoon region and provided information about implementation costs. However, because management actions under the CCMP could not be linked to predictable changes of the lagoon's environmental quality, and thus corresponding changes in economic value, only baseline economic values were available for comparisons with implementation costs. This limitation meant that it was not possible to perform a reliable cost-benefit analysis.

Despite the lack of a cost-benefit analysis, the results from the valuation study provided valuable information about the economic importance of the lagoon to the region. Newsletters from the IRLNEP to citizens and public officials throughout the region emphasized the relationship between the lagoon's environmental quality and the regional economy. An hour-long public television program, broadcast in November 1995, highlighted the environmental problems facing the lagoon, the role of the CCMP and the diverse economic activities dependent on the quality of health of the ecosystem.

The final approval and signing of the CCMP agreement in November 1997 was attended by local and federal dignitaries, including then EPA Secretary Carol Browner. In her keynote address, Secretary Browner noted the important economic contribution of the Indian River Lagoon to the region and the need to sustain these values for the future. Similarly, the IRLNEP Director remarked on the need to invest in programs to sustain the economic contribution of the lagoon to the economy and the importance of well-documented studies to educate the public about the role of environmental resources in local communities and the regional economy.

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Case Studies of Economic Impact Analysis

CHAPTER 9

Economic Impact of Tourist and Resident Uses of Coastal Resources in the Florida Keys: Survey Methods and Impact Assessment Methodology

Vernon R. (Bob) Leeworthy

This study was designed to develop credible information about the economic contribution of those who use the Florida Keys — its aims were to inform management on how to ensure the health of the Florida Keys ecosystem and to provide the kind of data that public and private investments depend on. The study was unique in that it combined standard economic impact analysis techniques with a community-based approach that had funding support of a wide-ranging partnership of government and non-profit organizations.

INTRODUCTION

There are three basic themes that provided the impetus for the study that ensured the project would develop useful information (i.e., information that would be judged credible and be used to support management activities and public and private investments), and provided the wherewithal to conduct it. The themes are community-based study, partnerships, and scientific methods. The economic techniques employed in this study were in no way innovative and have been used in hundreds of other studies. It was the melding of the scientific methods with a community-based approach and partnerships which set this project apart from most applications of economic impact.

Community-based Study

The project involved multiple objectives; these were decided upon by the funding partners and were based largely on a community meeting held in Key Largo in September 1993. This meeting was organized by Duncan Mathewson of the Center for Shipwreck Research, and Ken Vrana and Ed Mahoney from Michigan State University's Center for Maritime and Underwater Resources Management (CMURM), at the request of Spencer Slate, Chairman of the Keys Association of Dive Operators (KADO). Although the original focus of the meeting was a survey of divers, a consensus called for a study covering all recreation activities in the Florida Keys/Key West. In addition

to determining project objectives, the community, through the Chambers of Commerce, fishing guides, charter boat captains, dive shops, and hotel associations, helped with sample stratification for the Customer Survey. The use of community knowledge improved the scientific basis of the Customer Survey. And the community also organized a sweepstakes/lottery to provide incentives for the mail-back portion of the Auto, Air and Cruise Ship Survey from which visitor expenditures were obtained and for the mail-back for the Resident Survey.

Partnerships

To complement the community-based approach, the project was based on multiple partnerships. First there were the funding partners. They included two Offices within the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS): the Office of Ocean Resources Conservation and Assessment, Strategic Environmental Assessments Division (SEA); and, the Office of Ocean and Coastal Resource Management, Sanctuaries and Reserves Division, Florida Keys National Marine Sanctuary (FKNMS). They also included The Nature Conservancy, Florida Keys Initiative (TNC) and The Monroe County Tourist Development Council (TDC). SEA and FKNMS competed for NOS Partnership Project funding (a national competition) and was one of six projects selected for funding. SEA then formed partnerships with TNC and TDC.

Working partners built upon a 10-year working relationship between the U.S. Forest Service, Outdoor Recreation and Wilderness Assessment Group, the University of Georgia, and the Bicentennial Volunteers. The Forest Service provided economist Don English and the University of Georgia provided the services of economist Warren Kriesel to assist NOAA economists with estimating the economic contribution/impact. The University of Georgia also provided for a survey coordinator and students to enter the survey data into the computer data bases. The Bicentennial Volunteers, Inc., did all the on-site interviewing. The local private campgrounds provided the volunteers with free full-hookup campsites for their stay in the Florida Keys. The TDC provided local coordination, additional incentives to visitors participating in the survey and data collection from local agencies on airline and cruise ship passengers.

ECONOMIC IMPACT/CONTRIBUTION

Economic impact analysis was discussed in the beginning of this book (see Chapter 4). In this project, the community preferred the use of the term "Economic Contribution" to "Economic Impact" when referring to market measures such as spending, output/sales, income, and employment. So we did not impose the economic impact terminology on the community; instead we chose to use the terminology they were more comfortable with. Again, if the information is to be useful, the community must be comfortable with both the information and how it is referenced. Many regional economic analyses eliminate all resident spending based on the notion that all resident spending is derived from "basic" or "export" industries as specified in personal

income by place of work, and counting resident spending would involve double counting. However, this proposition is not generally true, especially in Florida where a large retirement community exists. In Monroe County, personal income not related to work inside the county makes up over 50 percent of total income by place of residence. Thus, a portion of resident spending is based on "basic" or "export" industries (i.e., new money flowing into the county in terms of pensions, dividends, interest, social security, etc.) and would not involve double counting. We identified residents in our survey that comprise the "export" portion of local recreation spending and include this in our economic contribution estimates.

SURVEY METHODOLOGIES/SAMPLES AND OBJECTIVES

A relatively complicated set of sample designs were required to achieve the project's multiple objectives for both the visitor and resident surveys. No one sample of either visitors or residents employing only one survey instrument (questionnaire) could achieve all the project objectives. Figures 9.1 and 9.2 show the visitor and resident survey sample designs and the corresponding objectives achieved with each sample or sub-sample.

Visitor Survey

For the visitors (nonresidents of Monroe County), two separate surveys were used: the Auto, Air and Cruise Ship Survey and the Customer Survey. The Customer Survey was used to estimate travel cost models and non-market economic user values and therefore is not discussed here. The Auto, Air and Cruise Ship Survey was used to obtain visitor expenditures through a mail-back questionnaire. The sample was a stratified random sample of visitors. The on-site portion of the survey was conducted face-to-face in parking lots off U.S. 1 at the northern end of Key Largo (Auto), at the terminals in the two commercial airports (Key West and Marathon), and at the cruise ship docks in Key West (Truman Annex and Mallory Square). An important feature of this sample design is that it allowed us to estimate the number of total visitors so we could extrapolate our sample estimates to the total population estimates. Details of the sample design and estimation methodologies can be found in Leeworthy (1996).

Based on past research and several public meetings, it was determined that samples during two different seasons were required. Visitors during July-August 1995 and during January-April 1996 were surveyed. The July-August 1995 sample was used to estimate all measurements for the June-November 1995 season (summer) and the January-April 1996 sample was used to estimate all measurements for the December 1995-May 1996 season (winter). The two seasons are estimated separately then added together to get annual totals.

Visitors, upon completing the short on-site survey, were asked if they would participate in a follow-up mail-back survey. Visitors were handed a bookmarker brochure that described the sweepstakes/lottery in which they had a chance to win a

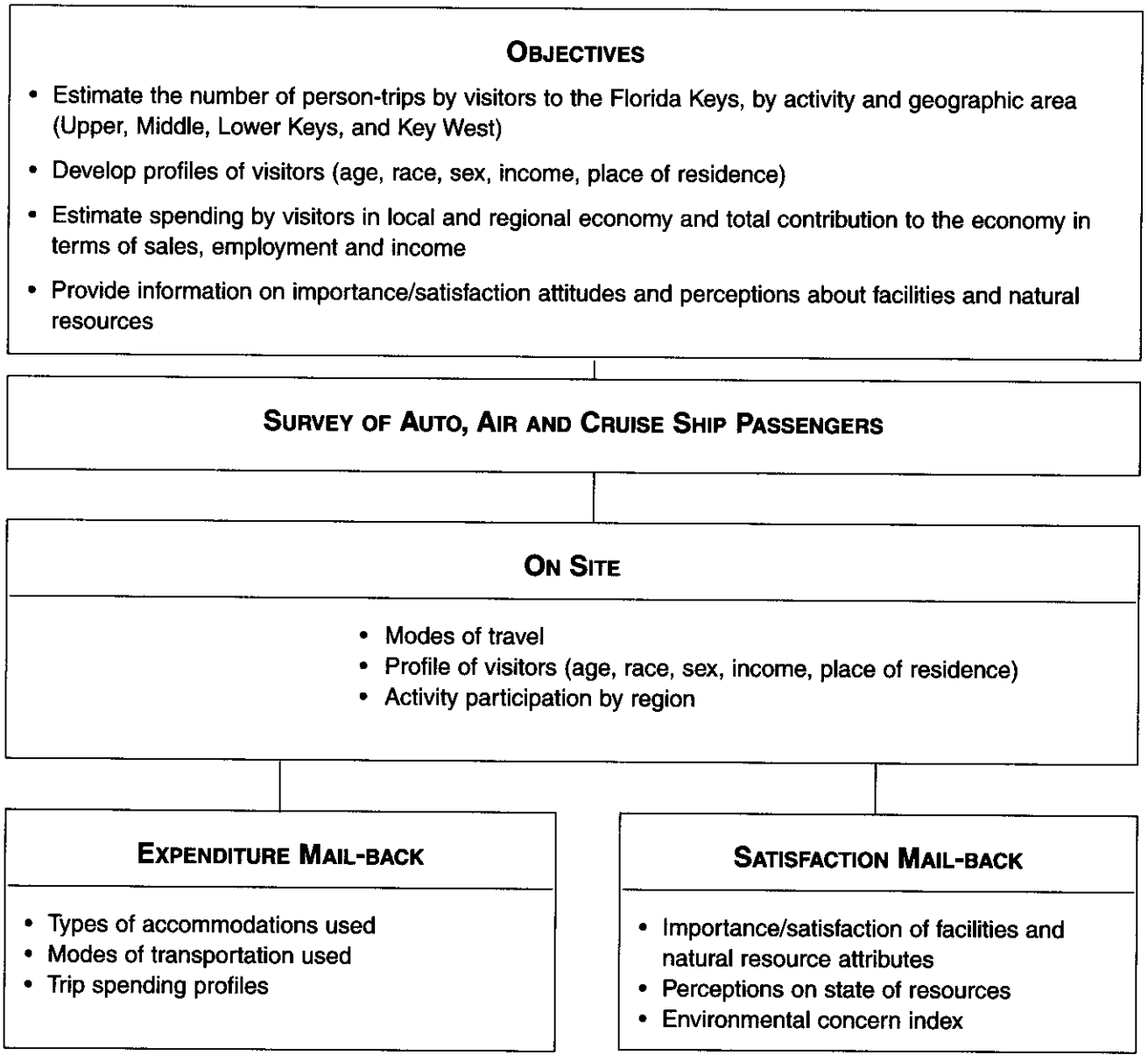

Figure 9.1. Visitor survey sample design and objectives.

paid vacation to the Florida Keys/Key West, if they returned their mail-back survey. A shorter version of the expenditure mail-back questionnaire was designed for cruise ship visitors, since they only stay a few hours in Key West. Response rates varied by season to the mail-back questionnaires. During the summer, the response rate was about 38 percent, while the winter response rate was 46 percent. The sample size was 505 completed returns for the summer and 1,036 for the winter. This allowed us to produce separate estimates of expenditures by mode of travel (e.g., auto, air and cruise ship).

TELEPHONE SURVEY N=2936	MAIL-BACK SURVEY N=632
Population: All Monroe County Households Sample: 2,936 Monroe County Households • Participation in any outdoor recreation activities in either the Florida Keys or Everglades National Park during the past 12 months • Participation in any outdoor recreation activities in Florida Keys during the past 12 months • Participation in any activities in the Florida Bay portion of Everglades National Park during the past 12 months • Profile of residents (age, race/ethnicity, sex, household income, zip code of residence, employment status, education level, household size, years lived in Monroe County, work outside Monroe County, access to waterfront property, own a boat) • Ratings of quality of life in Monroe County • Primary reason for locating in Monroe County	Population: All Monroe County Residents that participated in any outdoor recreation activities in the Florida Keys during the past 12 months Sample: 632 Monroe County Residents that participated in outdoor recreation activities in the Florida Keys during the past 12 months and returned the mail-back survey • Participation in 66 activities in four regions of the Florida Keys • Intensity of use (days of activity) for 37 activities in four regions of the Florida Keys • Expenditure on outdoor recreation in Monroe County • Importance and satisfaction ratings of facilities and natural resources attributes in Florida Keys • Environmental Concern Index

Figure 9.2. Monroe County resident survey sample design and objectives.

Resident Survey

For the residents of Monroe County, a telephone/mail-back sample design was used (Figure 9.2). Expenditures were obtained from the mail-back portion of the survey. The telephone sample was selected using the random digit dialing method. Over 2,900 Monroe County households were included in the survey. About 82 percent of the households contacted participated in outdoor recreation and were thus eligible for receiving the mail-back survey. About 83 percent of the eligible households agreed to receive the mail-back surveys and 29 percent of the eligible households returned complete questionnaires for a total of 587 useable expenditure mail-backs.

Sample Weighting

Both the visitor and resident surveys required sample weighting. Extensive analysis was done to assess the possibilities of non-response bias. Some potential for

non-response was found in both the visitor and resident surveys, however, in both cases it proved to be minor. Sample weighting was thought to adjust for non-response bias (See Leeworthy 1996, and Leeworthy and Wiley 1997b).

MONROE COUNTY IMPACT/CONTRIBUTION

Use of Census Ratios

The simplified approach for Monroe County used several types of ratios on economic measurements for the Monroe County economy from the U.S. Department of Commerce, Census Bureau and the Bureau of Economic Analysis, Regional Economic Information System. Wages-to-sales and wages-to-employment ratios by standard industrial classification (SIC) were used. Also, the total income to wages and salaries ratio and the proprietor's income to proprietor's employment ratio were used. These ratios are fundamental to estimating the direct income and employment impacts for both visitors and the export portion of resident spending.

Direct Spending, Output/Sales, Income, and Employment

The first step in estimating economic contribution is to estimate total expenditures or sales. For visitors, we multiply the estimated average expenditure per person-trip made in Monroe County (for each detailed expenditure item) by the total number of person-trips. This was done separately for the summer and winter seasons. For the summer season, average expenditures per person-trip were $422.53 and the number of person-trips was 1,172,004 yielding a total expenditures estimate of about $495.2 million. For the winter season, average expenditures per person-trip were $508.31 and the number of person-trips were 1,368,484 yielding a total expenditure estimate of over $695.6 million. The total annual visitor expenditure was then about $1.19 billion. To obtain an estimate of direct output/sales impact, total spending is multiplied by the percent of inputs that are purchased locally (.70). This percentage adjusts for labor and other inputs that are purchased from outside the county. The yield estimates are about $346.645 million for the summer season and about $486.930 million for the winter season, and thus a total annual direct impact on output/sales of about $833.575 million.

Direct Wages and Salaries and Direct Income

To estimate direct income requires two steps. In the first step, direct wages and salaries are estimated; then estimates of proprietor's income are made to arrive at estimates of the total direct income. The first step was to match expenditure categories to the SIC classifications for which we have wages-to-sales ratios for Monroe County. Direct wages and salaries are derived by multiplying an expenditure estimate for a particular item by the appropriate wages-to-sales ratio. Wages and salaries are then summed across expenditure items. To show how this is done, we use lodging as an example. Lodging expenditures for the summer season were estimated to be approximately $176.246 million. The wages-to-sales ratio for SIC 70 (hotels and motels) for Monroe County was .2418. So for the summer season our estimate of the direct wages

and salaries impact from lodging expenditures was approximately $42.616 million ($176.246 million x .2418). This step is repeated for each expenditure item, by season, and then summed across expenditure items and seasons to arrive at the total direct wages and salaries impact. The details of these calculations can be found in Leeworthy (1996). The total direct wages and salaries impact for Monroe County was $258.761 million.

The next step was to take the direct wages and salaries impact and add the component of income to proprietor's. In Monroe County, proprietor's income is a higher share of total income than in Florida or the U.S. This is due to the many small businesses involved in the tourist economy. From the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System, we were able to get the ratio of Total Income-to-Wages and Salaries. That is total income by place of work to wages and salaries by place of work. This ratio was estimated at 1.2222. So multiplying this ratio by our direct wages and salaries estimate yields an estimate of $316.258 million in direct income.

Direct Employment

As with direct income, we first had to estimate the direct employment associated with direct wages and salaries and then derive the number of proprietors employed to get an estimate of the total direct employment impact/contribution. The first step here was to divide our estimate of direct wages and salaries for each spending category by the wages-to-employment ratio for each spending category. Continuing with the lodging example, we divide our estimate of $42.616 million by $14,874 per employee to get an estimate of 2,865 direct wages and salaries employees as a result of the summer season spending on lodging. Again, this procedure is repeated for each spending category for both seasons and summed across spending categories by season. However, unlike income, number of employees are not summed across seasons. When estimating total annual employment, it is better to average the summer and winter estimates. For estimating relative employment contribution, we do it by season. We estimated a total wages and salaries direct employment of 8,350 for the summer and 11,848 for the winter.

The next step was to estimate the direct proprietor's employment. To do this we first estimated proprietor's direct income which is equal to (Wages and Salaries x 1.222) – Wages and Salaries. For the summer season the estimate was $23.730 million and for the winter season the estimate was $33.766 million. Dividing these estimates by the Proprietor's Income-to-Employment ratio of $18,690 yields estimates of total direct proprietor's employment. For the summer, the estimate is 1,270 and for the winter, 1,807. Adding these to our estimates of employees from direct wages and salaries yields estimates for total direct employment of 9,620 for the summer and 13,655 for the winter.

Multiplier Impacts

Once we derived estimates of the total direct impacts for output/sales, income and employment, the next step was to use a regional multiplier to estimate total impacts. We chose a multiplier derived by Bell (1991) for Monroe County; although he derived

his multiplier using the economic base theory approach, we treated his multiplier as a Type III multiplier. That is, we multiplied his estimated multiplier of 1.6 times the direct output/sales, income and employment estimates. The net Type I multiplier implied by this method for output/sales is only 1.12 for Monroe County. Using the 1.6 multiplier yields estimates of total output/sales impact of $1.33 billion and a total income impact of $506.01 million. Total employment estimates were 15,392 for the summer and 21,848 for the winter.

Total Impacts/Contributions

The same methods used for the visitors for estimating impacts/contribution were used for the "export" portion of the resident spending on outdoor recreation activities in the Florida Keys. Residents had a total spending in the Florida Keys of over $400 million. However, we estimate that only about $94 million came from the "export" sector of residents. Figure 9.3 summarizes the estimates for the "export" sector of Monroe County residents. The resident spending led to a total output/sales impact of $105.63 million and a total income impact of $30.87 million and generated 2,414 jobs.

It is important to put these estimates into perspective. Table 9.1 shows our estimates for total output, income and employment relative to the totals for the entire

TABLE 9.1. ESTIMATED ECONOMIC CONTRIBUTION OF VISITOR AND RESIDENT RECREATIONAL ACTIVITIES IN MONROE COUNTY.

		Official Reported[1,2]	Estimated Contribution	
		Direct	Total	Percent of Economy
Visitor				
Output	$ –	$833,574,666	$1,333,719,466	60.53
Income	$ –	$ 16,257,815	$506,012,504	45.03
Employment	–	13,655	21,848	46.49
Resident				
Output	$ –	$ 66,020,640	$ 105,633,024	4.79
Income	$ –	$ 19,291,709	$ 30,866,774	2.75
Employment	–	1,509	2,414	5.14
Total				
Output	$2,203,305,357	$899,595,306	$1,439,352,490	65.33
Income	$1,123,685,732	$335,549,524	$ 536,879,238	47.78
Employment	47,000	15,164	24,262	51.62

[1] Source (Output): Florida Department of Revenue.

[2] Source (Income and Employment): Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce.

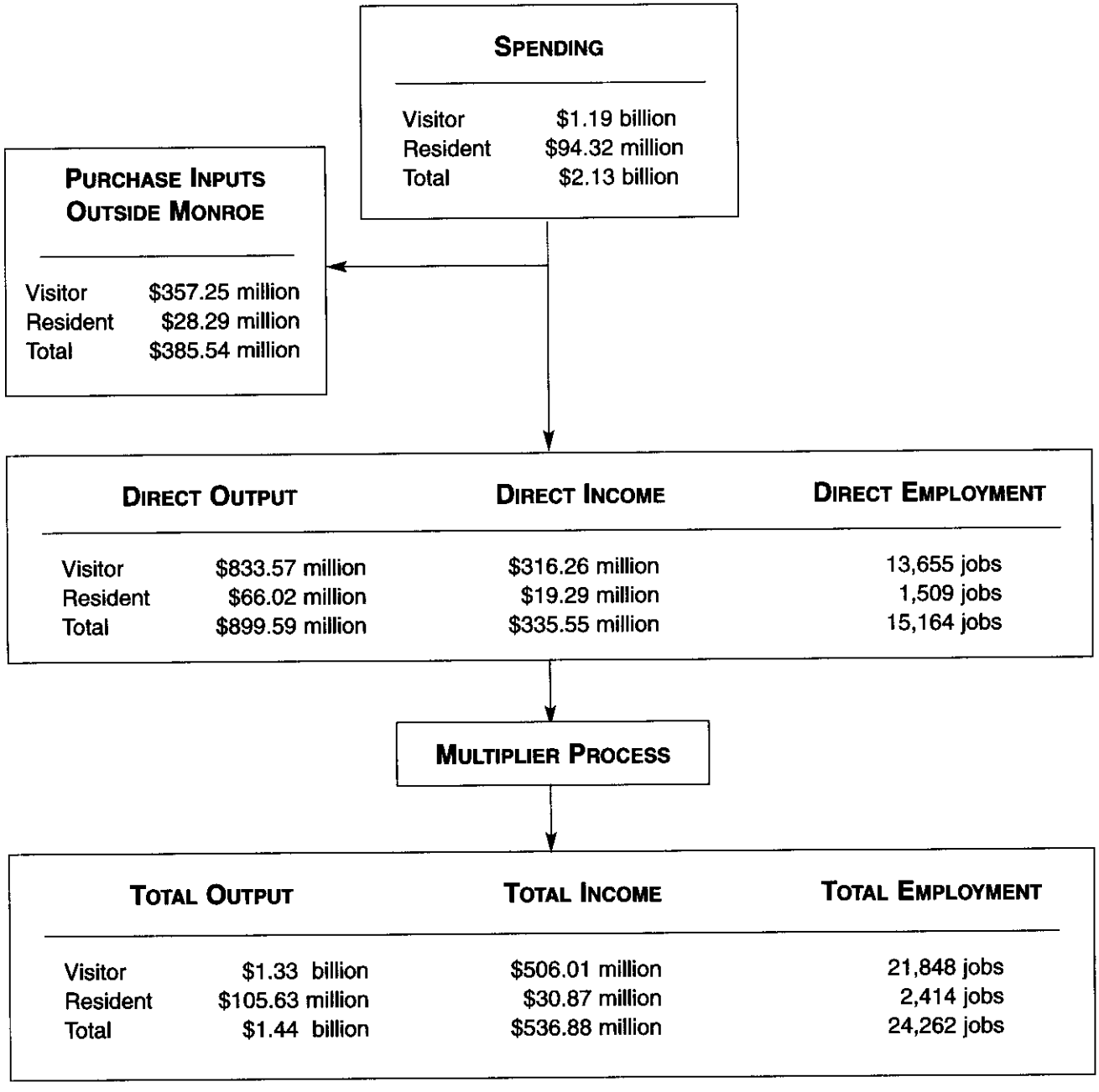

Figure 9.3. Impact process due to visitor and resident spending in Monroe County, June 1995-May 1996.

Monroe County economy. Visitors accounted for over 60 percent of output/sales, 45 percent of income and over 46 percent of employment. Resident "export" sector spending accounted for an additional 4.79 percent of output/sales, 2.75 percent of income and 5.14 percent of employment. So in total the recreational uses of coastal and ocean resources in the Florida Keys accounted for over 65 percent of the total output/sales, almost 48 percent of total income and almost 52 percent of employment in the Monroe County economy.

SOUTH FLORIDA IMPACT/CONTRIBUTION

As discussed above, we were able to estimate the economic impact of visitor spending on the three county area of Broward, Dade and Monroe Counties using the Micro Computer IMPLAN input-output model. With this model, we were able to estimate not only the direct and total impacts, but indirect and induced impacts separately. In addition, the IMPLAN model also allows for the separate estimation of value added.

Figure 9.4 summarizes the IMPLAN model estimates for South Florida from visitor spending related to trips to the Florida Keys. First, we estimated that visitors spent $1.67 billion in the three county area. About $400 million of this spending went to purchase inputs used in producing final goods and services to visitors from firms outside the three county area. This results in estimates of direct output of $1.27 billion. This generated direct value added of $866.3 million, direct income of $753.28 million and direct employment of 14,493 jobs. Jobs here are defined differently than estimates for Monroe County: for Monroe County, jobs were defined as the number of full and part time employees; the IMPLAN model estimates the number of full-time equivalent employees.

Figure 9.4 also shows that the multiplier process leads to estimation of indirect, induced and total impacts. We estimated a total output impact of $2.94 billion, a total value added impact of $1.92 billion, a total income impact of $1.69 billion and a total employment impact of 27,822 full-time equivalent jobs. Using our estimates for visitors impacts to Monroe County only, we derive that Broward and Dade counties received $1.61 billion in output/sales and $1.37 billion in income from visitors to the Florida Keys. This is the result of both direct spending by visitors on their way to the Florida Keys plus the many interactions between the economies of the three county area.

CONCLUSIONS

The results of this study were employed in a number of applications to management and policy issues. They were used in the Socioeconomic Impact Assessment for the Final Management Plan for the Florida Keys National Marine Sanctuary; they were incorporated into the Socioeconomic Monitoring Program for the Florida Keys National Marine Sanctuary and the results updated for years 1996-97 and 1997-98. They were also used by the Florida Keys National Marine Sanctuary to estimate the potential economic impact of an ecological reserve (no take zone) in the Tortugas area of the Florida Keys National Marine Sanctuary.

The Key West Chamber of Commerce is currently building an econometric model of Monroe County. The tourist sector, as we have shown, is the most important part of the economy. The results of this study are being incorporated into this model. Further, the model is extending the work to include the capability to estimate tax revenues received as a result of tourist spending. One policy issue is whether any of the funds received from the special "bed tax" distributed to the Monroe County Tourist Development Council should be diverted away from attracting additional tourists and

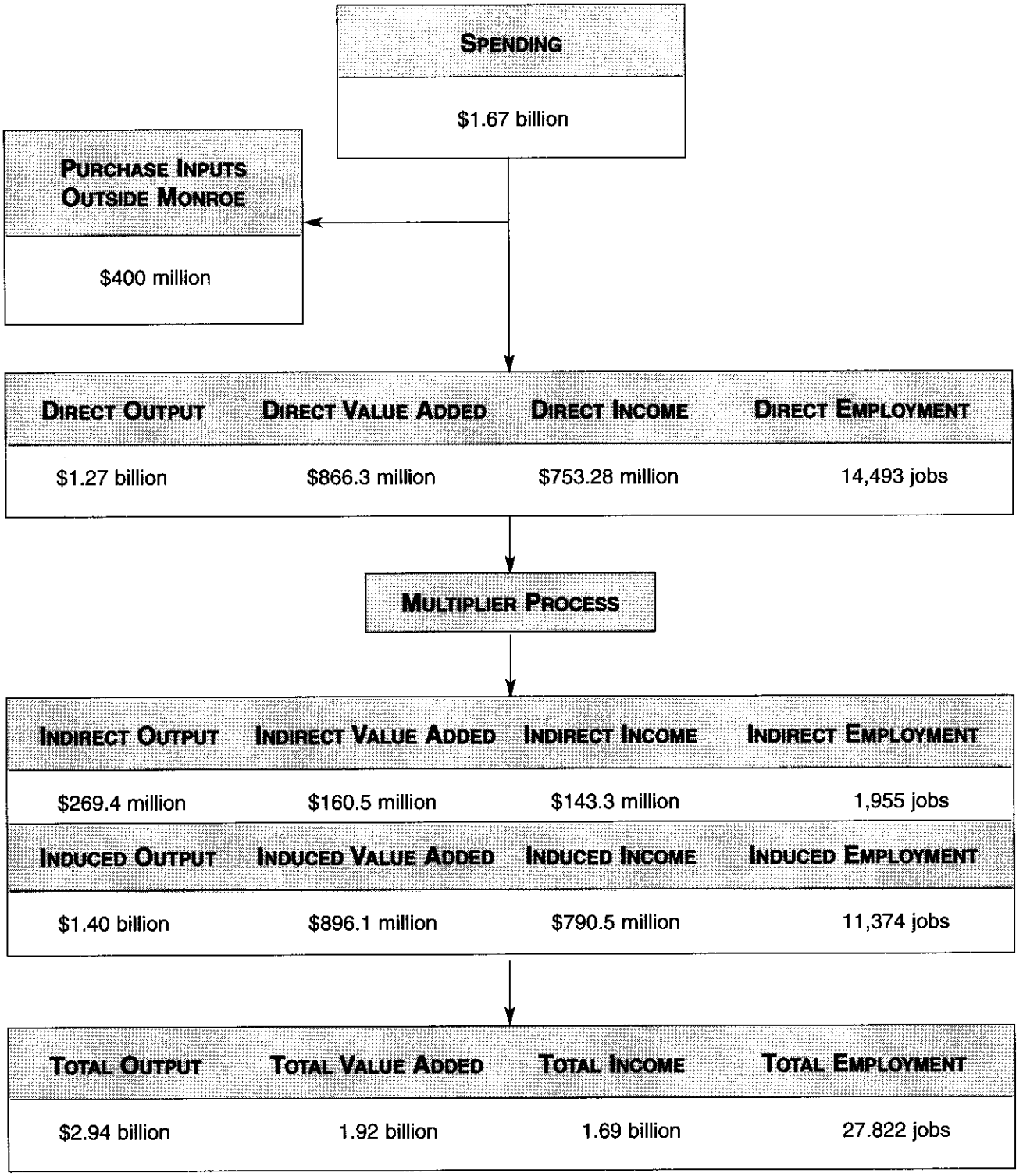

Figure 9.4. Impact process due to visitor spending in South Florida.

allocated to other efforts such as water quality protection. The results of the economic impact or contribution analysis can be used to assess the wider array of tax revenues generated by tourist spending rather than just focusing on the bed tax.

As the above discussion indicates, there is local concern about the negative impacts that tourist visitation can have on the local environment. The economic impact or contribution analysis shows how the spending associated with this visitation also generates funds that can be used to address the environmental impacts which would support management and policy changes that in turn support achieving the goals and objectives of sustainable development.

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CHAPTER 10

Dairy Rule and Buyout Program in the Lake Okeechobee Watershed: Economic Impact of Non-Point Source Pollution Controls

Grace Johns

Stormwater runoff from dairy and cattle farms in the Lake Okeechobee watershed was identified as a major source of water quality declines in the lake. A key contributor to those declines was found to be pollution from non-point sources, particularly runoff from dairy and cattle farms. To stem that deterioration and protect Lake Okeechobee's natural resources, the State of Florida implemented a number of non-point source water quality control programs in the watershed from 1988 through 1993. An ex-post facto economic impact analysis quantified how these specific programs, implemented by the South Florida Water Management District, affected participants and the local and regional economies.

ENVIRONMENTAL RESOURCE CONCERNS AND MANAGEMENT PROGRAMS

Lake Okeechobee is the second largest freshwater lake within the conterminous United States, covering about 730 square miles with an average depth of nine feet. Popular as a sport fishing destination, it is also a major water source for the surrounding communities. Storm water runoff from cattle and dairy operations north of Lake Okeechobee had been carrying high concentrations of phosphorus into the lake. This source of phosphorus was considered to be a significant contributor to the lake's eutrophic conditions and was considered a potential for contributing to hypereutrophic conditions in the future. Eutrophication is a process in which overenrichment of nutrients in lakes and inshore waters can lead to severe oxygen depletion with consequent impacts on wildlife productivity and drinking water quality.

Regulating Nutrient Runoff

In the late 1980s, the State of Florida implemented a comprehensive set of land management programs to reduce phosphorus loads from cattle and dairy operations north of the lake. These programs and related regulations required dairy and cattle operations to make certain investments in controlling non-point runoff. Known as the Dairy Rule, the Dairy Buyout Program and the Okeechobee Works of the District Rule, these programs can be summarized as follows:

Dairy Rule The Florida Department of Environmental Protection (FDEP) imposed technology standards requiring dairies to have an approved collection and treatment system for wastewater and runoff from milking parlors and intensive use areas before discharging into state water bodies. Implementation began in 1987. The basic system includes a high intensity runoff area control system to capture the wastewater and storm water from the dairy barn, one or more lagoons to store this water and an irrigation field onto which the water is applied via a center pivot system. The capital cost of these systems was shared by the dairy owners and the State of Florida.

Dairy Buyout Program. This voluntary program was financed by the District and the Florida Department of Agriculture and Consumer Services as an alternative to Dairy Rule compliance. During the period 1989 to 1992, owners of dairy cows in the Okeechobee drainage basin were offered a one-time payment of $602 per cow in exchange for moving operations out of the basin and accepting restrictions on future use of the lands on which the dairies had been located (easement).

Okeechobee Works of the District (WOD) Rule. Formulated by the District under the Interim Lake Okeechobee Surface Water Improvement and Management (SWIM) Plan and implemented in 1989, this rule established a phosphorus concentration standard for drainage water originating from acreage under regulated land uses which ultimately discharge into a Works of the District.

Public Concerns over Negative Economic Impact

During development of these Water Quality Programs (WQPs), economic impact studies were conducted to assess potential negative economic impacts from implementing the programs. The studies found that the costs of the dairy rule modifications were significant and no offsetting revenue increases or cost reductions from these modifications were identified. These results and concerns by dairy owners led the District to recommend state cost-sharing of dairy modifications and the addition of the buyout program (Hazen and Sawyer 1995).

In the early 1990s as implementation approached 100 percent compliance, the local community of Okeechobee County, the heart of the dairy industry affected by these programs, expressed deep concern regarding negative effects on the local economy. In public forums, community leaders described an apparent and significant drop in local employment and a rise in business failures throughout all sectors of the economy after program implementation began.

In response to these concerns and to determine if the area could finance any additional storm water regulations that might be required to protect Lake Okeechobee, the District agreed to conduct a "post implementation" economic impact study. Included as an action item in the District's Lake Okeechobee SWIM Plan published in 1993, the "post implementation" economic impact study began in 1994 and was completed in October 1995 (Hazen and Sawyer 1995). This chapter summarizes the methods and results of this study.

MEASURES OF ECONOMIC IMPACT

The boundary of the Lake Okeechobee Watershed is depicted in Figure 10.1. The study evaluated the following types of economic impacts: (1) actual program implementation costs; (2) changes in firm/farm location, farm size, land use and land use intensity; (3) changes in total direct, indirect and induced sales, employment, and income in the local and regional economic impact areas; (4) differential impacts to relatively small businesses and farms; (5) changes in tax revenues to local governments; and, (6) impacts of the Buy-Out Program on the dairy industry statewide. From the beginning, economists consulted with regulatory agency representatives, local dairy operators, local dairy suppliers and service providers, University of Florida Cooperative Extension Service faculty, local government leaders, local property appraisers and local school officials.

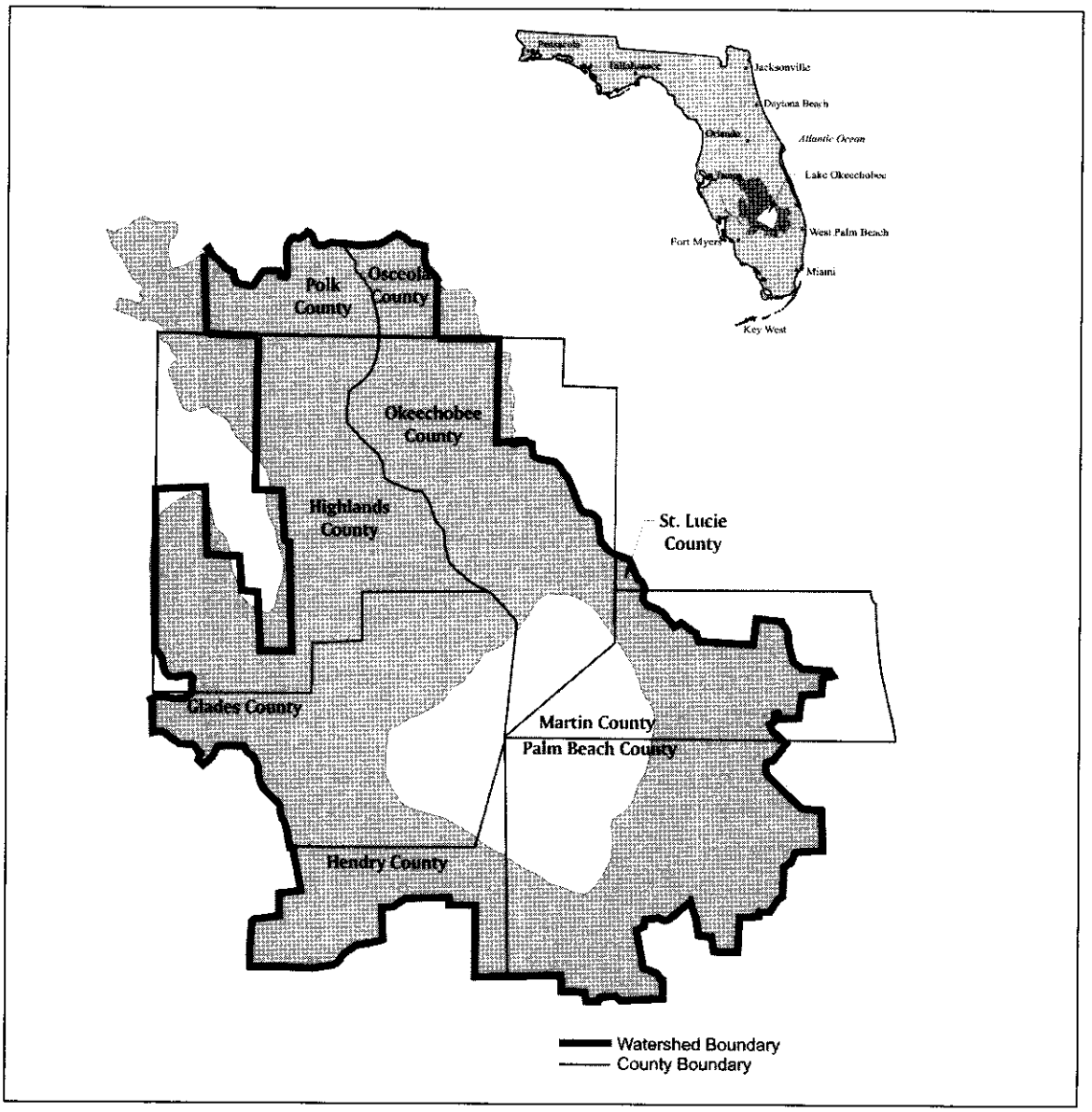

Figure 10.1. Boundaries of the Lake Okeechobee watershed.

Data Sources

The data used to evaluate economic impacts were derived from publicly available sources and from surveys of businesses. The businesses surveyed included dairies that participated in the Dairy Buyout Program, the dairies that complied with the Dairy Rule and the Works of the District (WOD) permittees. Other businesses surveyed included local agricultural supply industries, the Florida Dairy Farmers Association, local retailers and local bankers. Hazen and Sawyer (1995) conducted these surveys.

The survey of Dairy Rule participants solicited information on the types and timing of modifications made, and the costs and the herd size before and after the Dairy Rule investment. The survey of dairy owners who participated in the buyout program included questions regarding the number of cows moved, age of barns, barn relocation, reasons for choosing the buyout program and the net cost to move or dispose of the herd. Dairy owners were also asked if they would have complied with the Dairy Rule if the buyout program were not offered. Works of the District permittees were asked questions regarding the impact of the WOD Rule in their operations. All other businesses were asked their perceptions of the impact of these programs on farmers and the local economy.

Definition of the Study Areas

Based on the information from the surveys of dairies, permittees and other local businesses, economists defined three study areas: (1) the local economic impact area (LEIA), (2) the regional economic impact area (REIA) and (3) the milk production study area (MPSA). The criteria for choosing the LEIA were that a very large portion of the impacts were felt in this area and the dairy industry is an important part of the economy. All survey responses indicated that the LEIA is Okeechobee County. The REIA is defined such that the local economic impact area provides important contributions to the economy of the larger regional area. The survey responses indicated that the REIA is Okeechobee, Highlands, Martin and St. Lucie Counties. The MPSA was defined as the area of milk production that contributes to the economy of the LEIA and includes Okeechobee, Highlands and Martin Counties.

DAIRY RULE IMPLEMENTATION

Construction to comply with the Dairy Rule took place from 1987 to 1993. The heaviest construction activity occurred in 1990 and 1991. About 42 percent of dairies began construction in 1990 and modifications were completed on a cumulative 67 percent of the barns by the end of 1991. All except one barn were modified by the end of 1992.

All of the barns surveyed built spray fields, effluent retention ponds and high intensity area runoff control systems, as required by the Dairy Rule. While the rule did not specifically require feed barns, these barns improved the operation of the wastewater management system: they helped concentrate the animals into small areas while

the concrete flooring provided an impervious surface. Feed barns were constructed to accommodate 13 dairy barns. The next most common modification was the installation of fencing for seven barns. Three dairies converted to total confinement systems in an attempt to increase milk productivity while controlling wastewater runoff. Based on the design drawings that each dairy farm submitted, the State reimbursed dairies for 75 percent of the estimated costs of the high intensity area (HIA) runoff control system, the effluent retention ponds, the spray field and the concrete flooring of the feed barns.

During construction of the required modifications, dairies also made additional modifications, which were primarily the rebuilding or replacement of milking parlors, barns, showers and shade structures that had reached the end of their economic lives. These investments, which likely would have been made without the Dairy Rule, were not cost-shared by the State.

CHARACTERISTICS OF THE ECONOMY DURING THE STUDY PERIOD

Four major factors influenced the economy of Okeechobee County during the study period. First, the local and regional areas were experiencing a nationwide recession. Second, 16 dairies closed their operations under the Dairy Buyout Program, reducing the milk production capacity of the area and the sales, income and employment that it generated. Third, 18 dairies were constructing modifications to comply with the Dairy Rule and the Works of the District (WOD) permittees were implementing measures to comply with the WOD Rule, both of which increased economic activity in the area during the study period. Fourth, the cost of complying with the Dairy Rule reduced the desirability of milk production in the Basin and constrained the growth in Basin milk production. These simultaneous shocks to normal economic growth directly influenced the methodologies that economists chose to estimate the economic impacts of the Water Quality Programs.

METHODOLOGY TO ESTIMATE IMPACT OF WATER QUALITY PROGRAMS ON MILK PRODUCTION AND VALUE

Statewide production of milk is not great enough to support Florida milk consumption. Consequently, milk must be imported into the state each year. Because fluid milk is available just outside of Florida's border, small to short-term moderate reductions in Florida milk production can be replaced by imports with relatively small changes in price. Most fluid milk imports are in bulk form. After 1987, significant quantities of prepackaged milk entered the state; by 1993, prepackaged milk accounted for about seven percent of total Florida milk consumption.

The proportion of total Florida milk consumption which was supplied from Florida producers outside the milk production study area (MPSA) increased from 51 percent in 1988 to 59 percent in 1993. The share from imports fell from 23 percent to 18 percent during the same period, while the share from the MPSA fell from 26 percent to 23 percent.

ECONOMETRIC MODEL

To measure the impact of the water quality programs on milk production in the MPSA, economists estimated an econometric model of milk production using time series data from 1973 to 1987. The econometric model includes three equations: (1) a milk demand equation that predicts the average annual price received by the Florida Dairy Farmers Association (FDFA) for milk supplied by its members, including the dairies (MPSA) and from imports; (2) an equation predicting annual MPSA milk production; and (3) an equation predicting annual milk production in the rest of Florida plus imports. The sum of MPSA milk production, milk production in the rest of Florida and imports is equal to Florida milk consumption. This econometric model accounts for the impact of milk demand, milk price, weather, imports, Florida milk production outside the MPSA, and cost of production on the annual amount of milk produced in the MPSA during the 1973 to 1987 time period.[1]

The independent variables of the equations and the functional form of the equations were chosen to best represent the behavior of the three dependent variables, (1) milk price, (2) milk production study area production and (3) milk production in the rest of Florida plus imports, in mathematical form. The parameters associated with the independent variables were then estimated using ordinary least squares regression correcting for first order serial correlation of the error variable. Ordinary least squares regression is appropriate here because the milk price variable used in the model is lagged one year to reflect the fact that dairies' best information regarding the price they will receive for their milk is the price received during the previous year.

The estimated econometric model is presented in Equations (1) and (2). The equations are multiplicative so the natural logarithm (Ln) of both sides of the equation provides a linear functional form. The estimated model explained over 95 percent of the deviation in milk production, imports and price during the 1973 to 1987 period. The estimated parameters had the expected signs and were statistically significant. The estimated model was then used to forecast MPSA milk production from 1988 to 1993. This forecast was subtracted from actual milk production in the MPSA to obtain an unadjusted estimate of the change in milk production resulting from implementation of water quality programs.

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[1] Originally, an econometric model describing the number of cows and milk production per cow in the MPSA and Florida was estimated. However, it was found that the time series was too short to meaningfully isolate the impact of economic variables between these two components of milk production.

Estimated Equations of the Econometric Model

Note that the natural log (Ln) of each side of the equation linearizes the parameters so that linear regression analysis can be performed. The t-statistic for the estimated parameter is in parentheses below the parameter estimate. Price is real dollars (1982) per cwt. Supply is in pounds of milk. Unemployment rate is in percent. Proportion of Florida Population Less than 19 Years Old is a proportion. Interest rate is a percent. Rain is in inches. Temperature is in degrees Fahrenheit. All other variables are qualitative.

Equation 1. Florida milk demand equation.

$$\begin{aligned} Ln(Price_t) = \; & \underset{(4.39)}{10.57} \; \underset{(-2.23)}{-0.28} \times Ln(\text{Fla Milk Production}_t + \text{Milk Imports}_t) \\ & \underset{(-2.40)}{-0.12} \times Ln(\text{Fla's Unemployment Rate}_t) \\ & \underset{(3.57)}{+1.11} \times Ln(\text{Proportion of Fla Population less than 19 years old}_t) \end{aligned}$$

Time Period:	1973 to 1987
Adjusted R-squared:	0.98
Durbin Watson Statistic:	1.89

Equation 2. Supply of milk from Florida outside MPSA plus milk imports.

$$\begin{aligned} Ln(\text{Supply outside MPSA}_t) = \; & \underset{(882)}{21.12} \; \underset{(3.52)}{+0.085} \times \text{Milk Diversion Program}_t \\ & \underset{(3.75)}{+0.112} \times \text{Dairy Termination Program}_t \\ & \underset{(5.22)}{+0.017} \times \text{Trend}_t \end{aligned}$$

Time Period:	1973 to 1987
Adjusted R-squared:	0.99
Durbin Watson Statistic:	1.75

Equation 3. Supply of milk from MPSA.

$$\begin{aligned}
\text{Ln(Supply from MPSA}_t) = \; & \underset{(11.5)}{41.30} - \underset{(-8.09)}{0.276} \times \text{Milk Diversion Program}_t \\
& - \underset{(3.09)}{0.26} \times \text{Dairy Termination Program}_t \\
& + \underset{(4.16)}{0.809} \times \text{Ln(Price}_{t-1}) - \underset{(-4.97)}{0.208} \times \text{Ln(Rain}_t) - \underset{(-6.26)}{5.12} \times \text{Ln(Temperature}_t) \\
& - \underset{(-2.16)}{0.174} \times \text{Ln(Interest Rate}_t) + \underset{(7.42)}{0.093} \times \text{Trend}_t
\end{aligned}$$

Time Period:	1973 to 1987
Adjusted R-squared:	0.99
Durbin Watson Statistic:	2.33

Economists made an adjusted estimate of the change in milk production caused by the water quality programs because the econometric model was unable to predict the observed constant total Florida milk consumption from 1989 to 1993. The forecast trended upward during this time period, overestimating actual Florida consumption by as much as nine percent by 1993. Because of the relative ease of acquiring milk from the rest of Florida and from imports with little or no change in price, it is expected that Florida milk consumption should not have been impacted by the water quality programs.

It is evident that something other than the water quality programs and the variables included in the econometric model impacted Florida milk consumption from 1989 to 1993. National milk consumption exhibited a similar flat trend after 1987. The flat milk consumption trend may be part of a trend in tastes and preferences away from fluid milk as was observed by the United States Department of Agriculture during this time. As this economic impact study was being conducted, the United States milk cooperatives had increased milk advertisements in television and magazines (USDA/ERS 1995).

The estimated equation for milk supplied from *outside* the milk production study area (MPSA) predicted that, without the water quality programs, milk supplied from outside the MPSA would have been lower than actually occurred. This prediction suggests that the increased milk supply from outside the MPSA made up for the drop in MPSA milk production.

An adjusted estimate of the impact of the water quality programs on MPSA milk production was made under the assumption that the MPSA milk production equation overpredicts milk production from 1989 to 1993 in the absence of the water quality programs (WQPs). However, it was evident that had these programs not existed, the MPSA would have produced the extra amount of milk that came from outside the

MPSA. Thus, the adjusted estimate of the impact of the WQPs on MPSA milk production is the difference between actual and predicted milk supply from outside the MPSA.

The unadjusted and adjusted estimates of milk production and value in the milk study production area during the study period with and without the water quality programs are summarized in Table 10.1.

TABLE 10.1. IMPACT OF WATER QUALITY PROGRAMS ON MILK PRODUCTION IN MPSA, IN MILLION POUNDS.

Year	Milk Production, MPSA			Change in Pounds of Milk Produced due to WQPs	
	Predicted, without WQPs		Actual, with WQPs	Unadjusted	Adjusted
	Unadjusted	Adjusted			
	(1)	(2)	(3)	(4)	(5)
1988	862	872	781	(81)	(91)
1989	828	916	800	(28)	(116)
1990	933	909	753	(180)	(156)
1991	1,049	907	656	(393)	(251)
1992	1,043	887	749	(294)	(138)
1993	1,089	797	713	(376)	(84)

Trend Model — Milk Production Study Area Milk Shares

To further refine the estimates of milk production that would have been realized in the MPSA without the water quality programs (WQP), a trend model of MPSA milk shares from 1975 to 1987 was estimated. This model is an equation where the dependent variable is the proportion of Florida milk consumption that the MSA supplied each year. The independent variables are qualitative variables representing the Federal milk diversion program (MDP), the dairy termination program (DTP) and a trend variable (TREND) which takes the value of 3 in 1975 and increases by 1 each successive year. The estimated parameters are statistically different from zero and have the expected signs. The equation explains 90 percent of the deviation in milk shares. The estimated Equation (4) is as follows:

Equation 4. MPSA estimated milk shares, 1973-1987.

$$\text{Proportion of Florida Milk Consumption Produced in MPSA}_t = 0.21 + \underset{(8.07)}{0.0048} \times \text{Trend}_t$$

$$- \underset{(-7.44)}{0.0361} \times \text{Federal Milk Diversion Program}_t - \underset{(-4.55)}{0.260} \times \text{Federal Dairy Termination Program}_t$$

Time Period: 1973 to 1987
Adjusted R Squared: 0.90

Comparison of MPSA Milk Production Estimates

The predicted proportions, or shares, of Florida milk consumption supplied from the milk production study areas without the water quality programs were taken from the unadjusted and adjusted econometric model and from the trend model. Table 10.2 provides comparison of the three predictions. The estimates of MPSA milk production without the water quality programs were taken from the adjusted econometric model for the years 1988 through 1992 and from the milk shares model in 1993. The direct sales impact from the water quality programs is equal to the change in milk production due to these programs multiplied by the real price (1991 dollars) received each year by the Florida Dairy Farmers Association, the milk marketing cooperative of dairies in the MPSA.

Trend Model — Herd Size Growth and Milk Productivity per Cow

Milk production capacity can be increased by increasing milking herd size and by increasing the amount of milk produced per cow per year. To evaluate whether there

TABLE 10.2. COMPARISON OF FORECASTED MPSA MILK SHARES WITHOUT THE WATER QUALITY PROGRAMS USING UNADJUSTED AND ADJUSTED ECONOMETRIC MODEL AND MILK SHARES TREND MODEL[1].

Year	Unadjusted Econometric Model (Percent)	Adjusted Econometric Model (Percent)	Milk Shares Trend Model (Percent)
1988	29	29	26
1989	27	30	26
1990	30	29	27
1991	32	27	27
1992	31	27	28
1993	32	23	28

[1]Numbers are percent of Florida milk consumption supplied by the MPSA if the WQPs did not exist.

was a statistically significant change in the growth rate of the number of milk cows and milk production per cow in the milk production study area and in the rest of Florida, a trend regression analysis was performed. The study examined the trend in milking herd size and milk production per cow for covered geographic regions between 1974 and 1993. The statistical equations are not meant to be used for forecasting; they were estimated to determine if the time series of data suggests that there was a change in the growth in herd size and milk production per cow in the milk production study area before and after the water quality programs were implemented.

The results further supported the idea that milk production in the rest of Florida compensated for the reduced production in the MPSA. In addition, milk production per cow increased significantly in the MPSA during the water quality programs relative to the rest of Florida. The study found a 13.5 percent increase in milk production per cow in the MPSA during implementation of the water quality programs.

Methodology to Estimate Direct, Indirect and Induced Economic Impacts

Implementing the three water quality programs caused an overall reduction in total sales, employment and income in the local and regional economic impact areas during the 1988 to 1993 study period. Implementing the WQPs affected the local and regional economies as follows.

- The total value of milk produced in the MPSA, which includes Okeechobee, Highlands, Martin and Glades counties, was lower due to the Dairy Rule and the Dairy Buyout Program.

- Although not a specific requirement of the Works of the District Rule, some cow/calf permittees reduced the number of beef cattle grazed per acre in an attempt to reduce the concentration of phosphorus in their drainage water.

- Construction activity in the Okeechobee Basin increased as permittees modified their facilities in response to the Dairy Rule and the Works of the District Rule.

- New dairy barn construction did not occur due to the water quality programs. Therefore, sales, income and employment tied to this type of construction was not generated during the study period.

- Some new employment was generated in Okeechobee County as the District implemented and enforced the Works of the District Rule from their Okeechobee Field Office.

The economic impact evaluations focused on the impacts associated with these changes in agricultural production, construction and implementation activities. Economists applied input-output multipliers representing the local and regional economic impact

areas (LEIA and REIA) to the estimated changes in the total value of milk produced in the milk production study area (MPSA) due to the water quality programs. For example, a LEIA income multiplier of 0.5 means that for every dollar of raw milk value (sales) produced in the MPSA, $0.50 in total direct, indirect and induced income is generated within the MPSA. Appropriate multipliers for Dairy Rule and Works of the District Rule investments, and barn construction were also applied. Direct, indirect and induced economic impacts can be defined as follows:

- Direct Impact: Sales, employment and income generated by the target industry, such as milk production.

- Indirect Impact: Sales, employment and income generated by industries that support the target industry.

- Induced Impact: Sales, employment and income generated by other industries due to purchases made by households who are employed by the target industry and the indirect industries.

The input-output multipliers were obtained from the IMPLAN database and software obtained from the Minnesota IMPLAN Group, Inc. Two sets of input-output multipliers were used. One set represents the direct, indirect and induced changes in sales, income and employment within the LEIA; the other set represents changes in these same economic variables for the REIA.

Table 10.3 summarizes the changes in total income in the LEIA due to the water quality programs. The positive economic impact of the investments made to comply with the Dairy Rule, the Buyout Program and the Works of the District Rule offset 14 percent of the negative economic impacts from the drop in milk production and barn construction during the period 1988 to 1992.

RESULTS OF THE ECONOMIC IMPACT ANALYSIS

A summary of the results of this economic evaluation follows. The estimated economic impacts are net of the drop in sales, income and employment due to the national recession which affected all Florida counties, including Okeechobee County.

Total Costs to Implement the Water Quality Programs

The total cost to implement the water quality programs by government agencies, dairies and Works of the District permittees from 1987 to 1993 was estimated at $51.2 million. The costs incurred to administer and comply with these programs in 1994 were estimated at $1.8 million.

TABLE 10.3. ECONOMIC IMPACT OF THE WATER QUALITY PROGRAMS IN OKEECHOBEE COUNTY BY TYPE OF IMPACT[1].

Year	Change in Direct, Indirect and Induced Income[2] from:					
	Change in Milk Production	Change in Barn Construction	Dairy Rule Investments	WOD Rule Compliance[3]	Estimated Total Change in Income	Percent Change in Income
	(1)	(2)	(3)	(4)	(5)	(6)
1988	($11,621,152)	($1,310,034)	$2,464,998	$28,395	($10,437,794)	-3
1989	($15,015,920)	($1,310,034)	$1,232,499	$113,795	($14,979,660)	-4
1990	($20,216,411)	($1,310,034)	$4,108,329	$246,068	($17,172,047)	-4
1991	($29,288,173)	($1,310,034)	$1,643,332	$453,841	($28,501,034)	-7
1992	($16,698,187)	($1,310,034)	$410,833	$82,745	($17,514,643)	-4
1993	($19,203,155)	$0	$0	$103,777	($19,099,378)	-4

[1] All dollar values are in 1991 dollars. Values in parentheses represent negative numbers. For example, when the change in income is negative, then the Water Quality Programs reduced income in the area from what they would have been had the WQPs not existed.

[2] Income includes wage and salary, proprietor's income, profits and rents. All income is in 1991 dollars.

[3] Includes net impact of permittees' initial compliance measures, cow/calf gross revenue reductions and District SWIM employees.

Farm Location, Land Use, Land Use Intensity

No new dairies opened in the Lake Okeechobee Basin during the study period. New dairies have avoided the Okeechobee Basin and instead opened barns in Lafayette, Gilchrist and Suwannee Counties. New dairies have perceived the water quality programs to be expensive and have chosen these counties because of the relatively low price of land and the relatively high milk prices received from the Florida Dairy Farmers Association, which is also the milk cooperative of the milk production study area.

Operators of the surveyed dairies said that the feed barns they installed as part of the Dairy Rule modifications seemed to increase milk productivity per cow. The economic impact study found that in 1993, after the Dairy Rule modifications were completed, milk production per cow in the milk production study area was 13 percent higher than it would have been had the water quality programs not existed. This increase is net of the annual increases in milk productivity that would be expected from breeding and other types of improvements.

Total Direct, Indirect and Induced Economic Impacts

The estimated net impacts of the water quality programs on sales, income and employment in the local economic impact area, which is Okeechobee County, from 1988 through 1993 are summarized in Table 10.4. These net losses include the impact of reductions in milk sales from the milk production study area, reductions in barn construction activity, reductions in cow/calf herd size per acre; and the increased economic activity tied to construction of modifications and compliance monitoring under the Dairy Rule and the Works of the District Rule.

As a result of the water quality programs, Okeechobee County experienced annual losses in total sales ranging from $21 million in 1988 to $61 million in 1991. That is, had the programs not existed, Okeechobee County sales would have been $21 million larger in 1988 and $61 million larger in 1991. Income was also lower during the study period due to the water quality programs. Income losses ranged from $10.5 million in 1988 to $28.5 million in 1991. Income losses as a percent of total county income ranged from three percent in 1988 to seven percent in 1991. Full-time and part-time employment was lower than it would have been during the study period due to the water quality programs. Employment losses ranged from a loss of 281 jobs in 1988 to a loss of 785 jobs in 1991. Employment losses as a percent of total county employment ranged from three percent in 1988 to six percent in 1991.

TABLE 10.4. SUMMARY OF ESTIMATED ECONOMIC IMPACTS OF THE WATER QUALITY PROGRAMS, DIRECT, INDIRECT AND INDUCED CHANGES IN OKEECHOBEE COUNTY (LEIA)[1].

Year	Estimated Total Change in Sales	Estimated Total Change in Income[2]	Percent Change in Income	Estimated Total Change Employment[3]	Percent Change in Employment
	(1)	(2)	(5)	(7)	(10)
1988	($21,407,581)	($10,437,794)	-3	(281)	-3
1989	(32,006,506)	(14,979,660)	-4	(414)	-4
1990	(35,010,869)	(17,172,047)	-4	(446)	-3
1991	(60,888,832)	(28,501,034)	-7	(785)	-6
1992	(38,252,498)	(17,514,643)	-4	(498)	-4
1993	(41,490,216)	(19,099,378)	-4	(527)	-4

[1] All dollar values are in 1991 dollars. Values in parentheses represent negative numbers. For example, when the change in sales is negative then the Water Quality Programs (WQPs) reduced total sales in the area from what they would have been had the WQPs not existed.

[2] Income includes wage and salary, proprietor's income, profits and rents.

[3] Employment is the number of full-time and part-time jobs and includes wage and salary employment and self-employed. A negative employment number of, say (500), means that 500 fewer jobs existed in the economy because of the water quality programs.

The economic impacts to the regional economic impact area (REIA) were about three percent greater than those reported in Table 10.4. The economic activity generated from milk production in the milk production study area is concentrated in Okeechobee County. Dairies in the MPSA rely on Okeechobee County and out-of state resources to a greater extent than on resources in nearby counties. For example, about 50 percent of dairy production cost is for feed, which is purchased from suppliers outside Florida.

Differential Impacts to Relatively Small Businesses

Barns participating in the Dairy Buyout Program tended to have smaller than average milk cow herd sizes. The loss of these barns increased average barn size by 155 cows. For the required Dairy Rule modifications, including permanent shade structures, the total cost per cow was higher for large barns than for small barns. After State reimbursement, dairies with small barns paid, on average, $478 per cow for the required modifications while dairies with large barns paid $606 per cow. The total capital cost of all investments made and paid for by dairies (after cost-sharing) when making the Dairy Rule investments was $486 per cow for dairies with small barns and $1,249 for dairies with large barns.

Changes in Tax Revenues of Local Governments

The water quality programs reduced ad valorem tax collections by about $37,755 which was a tiny fraction of the $17 million in ad valorem tax collected by Okeechobee County in 1992. Tangibles tax collections fell by $13,500 in 1993. The water quality programs changed Okeechobee County retail tax collections by about three percent in all years except 1991 when sales tax collections were five percent lower than what they would have been had the water quality programs not existed.

Impacts of the Water Quality Programs on the Florida Dairy Industry in the Rest of Florida

Most of the reduced milk production in the milk study production area was offset by increases in milk production in the rest of Florida. The rest came from imports. The Florida Dairy Farmers Association, the marketing cooperative for dairies in the Basin, stated that the members of the association absorbed any cost increases. Therefore, there were no increases in wholesale or retail milk prices due to the water quality programs.

USES OF THE ECONOMIC IMPACT ANALYSIS

The final report with technical appendix was submitted to the District and was presented to District staff and Okeechobee county residents and businesses in October 1995. In March 1996, the results of the study were presented to the District's Governing Board during a public workshop. The study and the presentations were well received by the Board and the Okeechobee community. The results demonstrated that significant costs and local economic impacts occurred due to the WQPs. The information con-

tained in the report was used to evaluate additional water quality programs and to assess the economic and financial feasibility of best management practices in the Okeechobee Basin.

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CHAPTER 11

THE EVERGLADES FOREVER ACT IN THE EVERGLADES AGRICULTURAL AREA: ECONOMIC IMPACTS OF NON-POINT SOURCE POLLUTION CONTROLS

Grace Johns

The Everglades Forever Act enacted in 1994 was designed to curb environmental degradation in Florida's Everglades ecosystem. In designing regulations for restricting stormwater runoff and implementing best management practices, concern was raised over the long-term economic implications. Consequently, the state undertook an economic impact analysis to identify and quantify those implications on agricultural and other development interests in the regional and state economies. The study was unique in that it examined alternative stormwater management programs over a 20-year period, from 1994 through 2013. Hazen and Sawyer (1993) provide a detailed description of the methods and results of this economic impact study.

RESOURCE MANAGEMENT ISSUE

For decades, the Everglades watershed south of Lake Okeechobee has been under intense agricultural and suburban development. Growers immediately south of the lake in the Everglades Agricultural Area (EAA) produce sugar cane, vegetables and sod. In 1991, some 522,000 acres were in agricultural production — the predominant use is the production and milling of sugarcane into raw sugar. The EAA provides about 25 percent of the sugar consumed in the United States; vegetable production includes celery, lettuce and sweet corn, while a relatively small amount of land is in rice production.

The EAA generated about $1.5 billion in sales in 1990. Agriculture, sugarcane milling, retail trade, wholesale trade and services were the primary economic activities. The area supported about 15,600 jobs in 1990.[1] Over 17,000 households comprised of

[1] Does not include the cane cutters (employees under H-2A program) and seasonal harvest labor. In 1991, 7,878 people entered the United States from other countries to cut cane for the 1991- 92 harvest season. An additional 6,000 seasonal farm workers harvested vegetables, rices and sod during the harvest season.

51,400 people lived in the EAA in 1990; one in every three households had lived in the EAA for more than ten years.

To grow sugarcane, vegetables and sod in the Everglades Agricultural Area, water table levels are managed throughout the year. During periods of excessive rainfall, water is drained into farm canals and ultimately enters the South Florida Water Management District's canal system flowing south into the water conservation areas and the Everglades National Park. The District and the Environmental Protection Agency were concerned about high phosphorus concentrations in the drainage water because of potential harm to native flora and fauna in the wetlands. Concern was also growing about protecting water supplies, nurturing valuable commercial finfish and shellfish populations, providing unique recreation opportunities and attracting tourists. Throughout the years, preserves as well as a national park were established and significant state regulations were adopted to enhance and protect the rare Everglades ecosystem.

In 1991, the Governing Board of the South Florida Water Management District sought an understanding of the economic impacts that proposed stormwater control programs in the EAA would have on the regional and state economies. Public concern had been raised in Okeechobee County over apparent contraction of the regional economy from the dairy wastewater managemnt programs north of Lake Okeechobee. Concurrently, the District Governing Board recognized the potential for negative economic impacts from new regulations.

In 1992 and 1993, a regional and statewide economic impact analysis was prepared to estimate the "ex-ante" changes in sales, income and employment that could be expected from alternative stormwater management programs in the EAA. The study's forecast period was 1994 through 2013, a period of twenty years. The specific stormwater management programs evaluated were the following:

- Conversion of 35,000 acres of land from agricultural production to Stormwater Treatment Areas (STAs) and construction and operation of the STAs.

- Implementation of best management practices (BMPs) by all growers in the Everglades Agricultural Area (EAA) to reduce phosphorus in the drainage water.

- Landowner payment of one of three levels of annual per acre assessments on land in the EAA, $10, $25 and $100, to finance the Stormwater Treatment Areas.

In 1994, the State of Florida enacted the Everglades Forever Act after years of litigation and mediation. Focusing on the control and treatment of stormwater runoff from the EAA, the Act resulted from the settlement agreement between the United States and the South Florida Water Management District after intensive and lengthy mediation among the U.S., the State of Florida, growers in the EAA and environmentalists. The Everglades Forever Act replaced the Marjory Stoneman Douglas Everglades Restoration Act, which was less specific regarding the details of the stormwater regulation process.

Under the new Act, growers in the Everglades Agricultural Area are required to obtain a permit to discharge water into the "Works-of-the-District." These works are the canals that drain water from the EAA. To obtain a permit, applicants must present the District with a farm management plan designed to reduce the amount of phosphorus in the drainage water.

The settlement agreement requires the District to purchase 34,700 acres of land in the EAA to be used for filtering phosphorus from the drainage water prior to it entering the water conservation areas and the Everglades. The agreement called on the District to develop a method to finance the purchase of land and the construction of the "Stormwater Treatment Areas" (STAs). Currently, about 40,000 acres of STAs are being designed and built in the Everglades Agricultural Area.

ECONOMIC IMPACT OF THE WATER QUALITY PROGRAMS IN THE EVERGLADES AGRICULTURAL AREA

The study evaluated the total economic impact of proposed stormwater management regulations and programs in the Everglades Agricultural Area (EAA) over the twenty-year forecast period. Total economic impacts are the *direct, indirect and induced changes* in sales, earnings and employment to all industries in the study area that are likely to result from a change in sales of the target industry in the study area such as sugar, vegetables or sod production. The changes in sales of a target industry will affect earnings and employment in that target industry (direct impacts). These changes lower the sales, earnings and employment of the industries that provide goods and services to the target industries (indirect impacts). As these employees reduce their spending, the industries that provide them with goods and services also experience reduced sales, earnings and employment (induced impacts).

The region under study included the regulated area just south of Lake Okeechobee in Palm Beach and Hendry counties. About 90 percent of this regulated land area is located in Palm Beach County and ten percent is located in Hendry County. Economic impacts to the State of Florida were also assessed (Figure 11.1).

Data Sources

Technical, economic and financial data for the study were collected from various sources including the United States Department of Agriculture — Economic Research Service (USDA); the Institute of Food and Agricultural Sciences — University of Florida (IFAS); and the Palm Beach County and Hendry County Property Appraiser's offices. Other sources included Donnelley Marketing Information Services; Dun and Bradstreet, Inc.; and the Florida Sugarcane League.

Revenue and cost of production data were obtained from USDA, not from the financial records of growers and raw sugar mills; the revenue and cost data for sugarcane production and milling from USDA are based on the financial records of growers and raw sugar mills in the EAA. Data describing the cost of producing vegetables in the EAA were obtained from IFAS and were based on EAA grower surveys. Both data

sources publish cost data representing annual costs over the past ten to fifteen years. While costs of producing sod in the EAA were not available from public information sources, a large sod grower in the area provided the data necessary for the evaluation.

Numerous meetings with regional growers and mill operators were held to obtain information regarding operations and perceived impacts. Although little financial information was obtained, the meetings were useful in obtaining information on farm and mill operations and issues affecting their ability to afford the best management practices and the assessments. The Florida Sugar Cane League sponsored a tour of one of the raw sugar mills and a helicopter tour of the fields. The information they provided to the project team was very valuable to this study.

Impact Estimation Methods

Two types of impacts were modeled: the first is due to the construction of STAs on 34,700 acres of productive agricultural land; the second is due to the increased costs to growers in the EAA as a result of implementing BMPs and paying annual assessments.

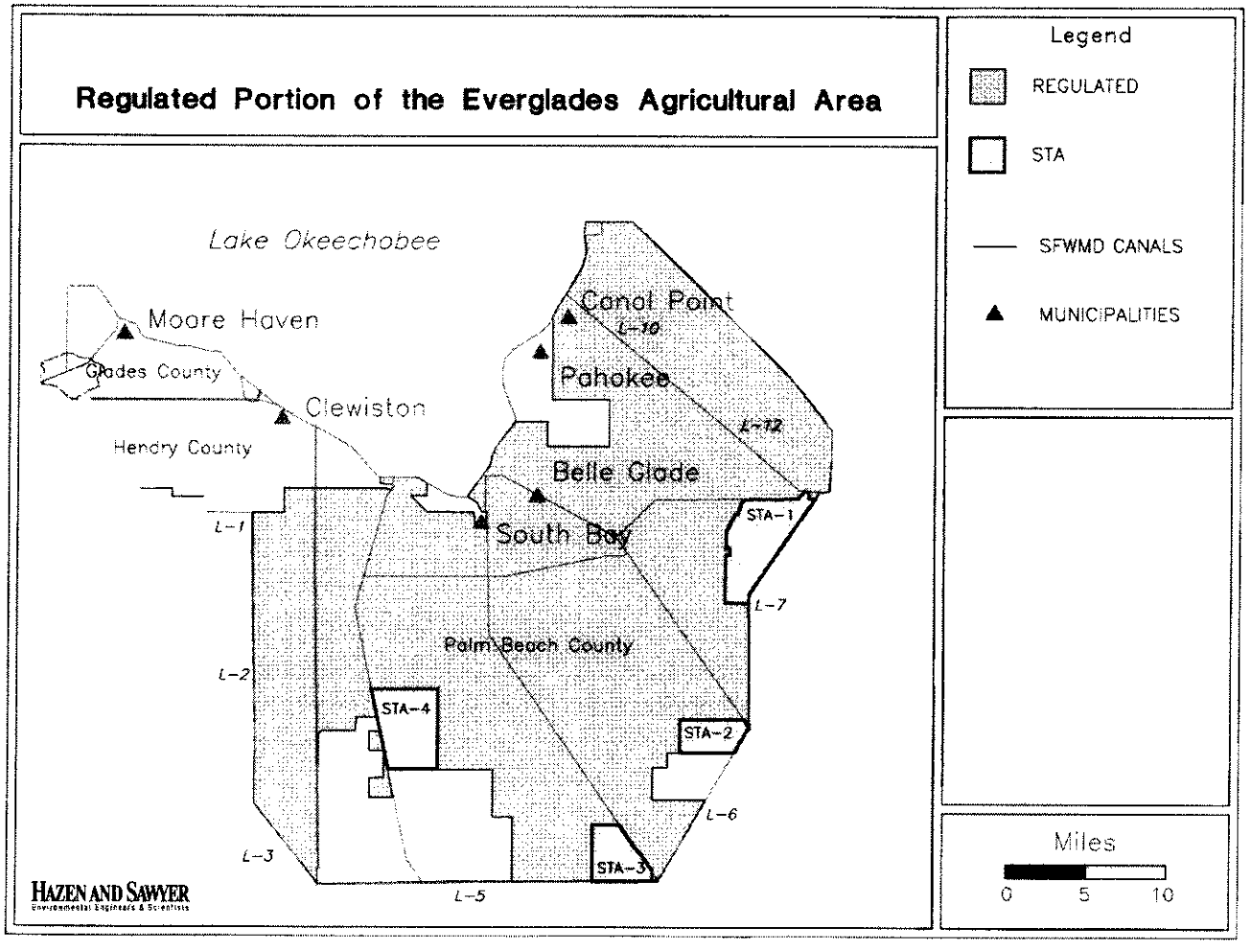

Figure 11.1. Regulated portion of the Everglades agricultural area.

These cost increases may reduce net farm income to the point where land would cease production, thus resulting in a loss in sales. The methods used to estimate both types of economic impacts are summarized below.

Impacts from Stormwater Treatment Area Construction and Operation. The land acquisition and construction of the STAs generates three types of economic impacts:

1. Loss of sales, earnings and employment from the removal of land from agricultural production.

2. Lost earnings from lower raw sugar production at three of the raw sugar mills in the EAA.

3. Additional sales, earnings and employment that will be generated from the construction and operation of the STAs.

The proposed land area of the stormwater treatment areas produced sugarcane, vegetables and sod. Removing this land from production will lower sales, earnings and employment unless the production is shifted to idle land within or outside the EAA. The study found that this shift would not likely occur because of increased production costs and/or the lack of available and suitable land. While sugarcane production was expanding to lands outside the EAA, this expansion would occur with or without the proposed regulations.

Impacts from the STAs were estimated using estimates of agricultural sales losses and economic input-output multipliers. The economic multipliers are from the U.S. Department of Commerce RIMS II model and were estimates of the total changes in sales, income and employment in the regional and State economies from a $1 million change in sugar, sod and vegetable sales.

In addition to the lost sales, earnings and employment from converting agricultural land to STAs, reductions in the amount of sugarcane entering the raw sugar mills were expected to increase the cost per ton of sugarcane milling and lower the net returns to raw sugar production. The maximum price that a mill can pay sugarcane growers for their sugarcane is reduced. While the corresponding reduction in prices paid to growers by the mills would not be significant, it could affect the sugarcane grower's financial ability to stay in production under the proposed per acre annual assessments. Therefore, the study considered this change in the maximum price and its impact on per acre returns to sugarcane production.

Construction of the four stormwater treatment areas involves four components: (1) land acquisition; (2) engineering and design; (3) construction and; (4) hydroperiod restoration. The District estimated the total cost of these components to be $359 million. Components (2), (3) and (4) will increase sales, earnings and employment in the regional and State economies to the extent that labor and goods are supplied from

industries within these areas. The increased sales, earnings and employment from STA construction were estimated using the itemized component costs and the timing of these expenditures; the proportion of labor and goods purchased from within the respective economies; and the RIMS II economic input-output multipliers. The multipliers represented changes in total sales, earnings and employment within the regional and state economies from each $1 million increase in the construction of new conservation and development facilities.

The District estimated that the annual operations and maintenance of the STAs would cost about $5 million per year. The increased sales, earnings and employment from STA operation and maintenance were estimated using the itemized operations and maintenance costs; the proportion of labor and goods purchased from within the regional and state economies; and the RIMS II economic input-output multipliers representing new conservation and development facilities operation within the economies.

Impacts from BMPs and Annual Assessments. The stormwater treatment areas, the best management practices and the annual assessments will increase the costs to produce sugar, vegetables and sod. This study developed twenty-year economic projections of residual returns to land and risk from agricultural production in the EAA under five alternative District actions and under baseline (no action) conditions. Residual returns are revenues minus the sum of cash costs and depreciation and interest on owned and borrowed capital. These economic projections are defined as follows.

PROJECTION	DEFINITION
1. Baseline Economic Projection	District takes no action (no plan)
2. STA Economic Projection	STAs built only — no other District action.
3. STA / BMP Economic Projection	STAs built, BMPs required.
4. STA / BMP / $10 Assessment Economic Projection	STAs built, BMPs required, $10 per acre annual assessment on land.
5. STA / BMP / $25 Assessment Economic Projection	STAs built, BMPs required, $25 per acre annual assessment.
6. STA / BMP / $100 Assessment Economic Projection	STAs built, BMPs implemented, $100 per acre annual assessment.

Agricultural land in the Everglades Agricultural Area was stratified based on crops grown, farm size, and geographic location of the land. These factors will determine the extent to which one farm would be affected differently from another farm by the stormwater management programs. Land-use records from the Palm Beach County and Hendry County Property Appraiser's offices and data from the Florida Agricul-

tural Statistics Service were used to group farm acreage by farm size, location and crops grown. Eleven model farms were developed and revenues and costs of these farms were evaluated over a twenty-year period from 1994 through 2013. The model farms represented sugarcane, celery, lettuce, sweet corn and sod production.

The baseline economic projections for sugarcane, vegetable and sod production represent the revenues and costs of production expected over the next twenty years if the stormwater management programs are not implemented. Baseline economic projections were developed for each crop and represent a range of economic, political and technological factors that are likely to occur over the next twenty years. These factors included future United States' raw sugar policies and trade agreements that affect the price received for raw sugar; the rate of soil subsidence, production efficiencies, product prices and costs. These factors were consolidated into optimistic and pessimistic scenarios that reflect alternative farm profitability levels. Next, economic projections of revenues and costs were developed using the same assumptions as the baseline economic projections but adding the alternative District actions.

Crop production becomes uneconomical when residual returns to land and risk fall below zero as a result of cost increases and/or revenue reductions. When crop production becomes uneconomical, the land leaves production and reduces direct, indirect and induced sales, earnings and employment. The economic impact was evaluated by determining if the land supporting the model farms could remain in production during the forecast period under each of the projections. When revenue from the product cannot at least cover the cash costs from producing the product, then production of the product immediately ceases on the land associated with the model farm. In addition, if the revenue cannot cover all cash, depreciation and interest costs, then production on the model farm ceases in year ten of the projection period (the capital is used until it needs replacement).

When a small model farm cannot economically support crop production, the large model farm within the same geographic area and growing the same crop will buy out the small farm and keep the land in production if it is profitable to do so. When the land use on the large model farm can no longer economically continue in agricultural production, all land on farms with characteristics similar to the model farm also cease production.

Best Management Practices. Entities that discharge water into the canals owned by the District in the regulated portion of the Everglades Agricultural Area would be required to obtain a "Works-of-the-District" permit under which best management practices (BMPs) would be implemented to reduce the amount of phosphorus in the drainage water. Practices include minimizing water table fluctuations in vegetable and sugarcane fields; retention of drainage water; production of an aquatic cover crop, such as rice; and fallow rotation of sugarcane. Permittees must also have an independent laboratory monitoring the flow and water quality of drainage water during each drainage event. These types of practices increase the cost of producing crops in the area.

Best management practices costs were applied to the model farms in the EAA. The "typical" costs of BMP implementation and monitoring were estimated using available public information sources. The BMP cost estimates reported in the District's draft report, Evaluation of On-Farm BMPs (1993), were also incorporated into the analysis. Table 11.1 summarizes the BMP costs for each crop in each scenario.

TABLE 11.1. ANNUAL BMP COSTS PER ACRE USED IN THE EVALUATION.

Scenario	Sugarcane	Vegetables	Sod
Optimistic	$23	$16	$11
Pessimistic	$23	$73	$37

Under either scenario, the BMPs and monitoring requirements appeared to be affordable and did not seem to pose a significant threat to the economy of the EAA. Grower costs for BMPs represent income and employment to those who will implement the BMPs on behalf of the growers. Employment was expected to increase by about 172 full-time-equivalent employees as a result of BMP implementation.

Crop Acreage Forecasts. Crop acreage was forecast each year for each type of projection. The difference in production acreage between the "District action" projection and the baseline projection is the impact of the District action. The steps can be summarized as follows:

1. The impact of the STAs was equal to the acreage in production under the STA Projection minus the acreage in production under the Baseline Projection.

2. The impact of adding the BMP requirements was equal to the acreage in production under the STA/BMP Projection minus the acreage under the STA Projection.

3. The impact of adding the assessment to the BMPs and the STAs is equal to the acreage in production under the STA/BMP/Assessment Projection minus the acreage in production under the STA/BMP Projection.

4. The change in acreage associated with each District action (STAs, BMPs, or Assessment) was converted to an estimate of the change in direct sales using the product of the change in acreage, the yield per acre, and the estimated sales price of the product.

5. The direct, indirect and induced changes in sales, earnings and employment were then estimated by multiplying the change in direct sales of each crop by the appropriate RIMS II multipliers for each type of crop.

Baseline Projection

The baseline projections of acreage by crop type were estimated using the available data. The primary determinants of these projections were the effect of soil subsidence in the Everglades Agricultural Area and forecasts of residual returns to land and risk.

Effect of Soil Subsidence on Baseline Projection. The soil throughout the EAA contains large concentrations of organic deposits. When the land is drained, the organic deposits oxidize, phosphorus is released and the depth of the organic soil falls. The underlying material throughout most of the EAA is limestone. As the organic soil oxidizes, the distance between the top of the soil and the limestone decreases. According to the Institute of Food and Agricultural Sciences — University of Florida (IFAS), the soil layer will eventually become very thin unless the soil is continuously flooded. While technologies exist to grow many crops under almost any type of condition, the cost of growing crops on an organic soil layer less than six inches or on limestone is probably not economical. Thus, the future profitability of sugarcane, vegetable and sod production in the EAA is tied to the existence of sufficient organic soil.

Under baseline economic projections, forecasts of organic soil depths show that some land in the EAA will leave production before the end of the forecast period. Rice, pasture, and cow/calf operations were considered as potentially profitable alternatives in the EAA. Under all scenarios, land ceases production when the organic soil thickness reaches six inches.

Estimates of the numbers of acres of each crop expected to leave production during the twenty-year period, due exclusively to insufficient organic soil are provided in Table 11.2. By 2013, land withdrawn from production due to insufficient organic soil was estimated to reduce employment by about twenty percent from its current level.

TABLE 11.2. BASELINE PROJECTION OF ACREAGE LEAVING PRODUCTION DUE TO INSUFFICIENT ORGANIC SOIL.

Crop	Acres Leaving Production due to Insufficient Organic Soil			
	1994-2001	2002-2008	2008-2013	Total
Sugarcane	0	55,000	0	55,000
Vegetables	0	0	16,600	16,600
Sod	0	9,000	0	9,000
Total	0	64,000	16,600	80,600

Returns to Land and Risk under the Baseline Projection. Under the optimistic scenario, future profits to agriculture on the remaining land in the Everglades Agricultural Area, under baseline conditions, were similar to historic profits over the past ten years. Under the pessimistic scenario, on the remaining land, land use throughout the forecast

period was expected to be the same as under the optimistic scenario, except that residual returns to land and risk would be lower. Under the pessimistic scenario by 2013, residual returns to land and risk were expected to be less than $50 per acre in at least half of the regulated EAA. These farms would be vulnerable to any additional regulations that increase the cost of production or reduce revenues.

Results of the Economic Impact Analysis

The alternative projections of production acreage and economic impacts may be summarized as four plans that represent combinations of District actions:

Plan 1: STAs, BMPs and no assessment.

Plan 2: STAs, BMPs and a $10 assessment.

Plan 3: STAs, BMPs and a $25 assessment.

Plan 4: STAs, BMPs and a $100 assessment.

The economic impacts were evaluated over the twenty-year period from 1994 through 2013. Stormwater Treatment Area construction took place from 1994 through 1996. BMP implementation and the assessment began in 1994.

Overall Employment Impacts. Table 11.3 summarizes the impact of each plan on the number of jobs in Palm Beach and Hendry Counties. Ranges of job impacts are presented from 1994 through 2013. These ranges reflect the economic impacts under the optimistic scenario (first number) and the pessimistic scenario (second number). If there is no range, then the optimistic and pessimistic scenarios provided similar results. Actual economic impacts are expected to lie within the range. All impacts are the employment with each plan, minus employment under the baseline projection.

- 1994 to 1996. The number of jobs in Palm Beach and Hendry Counties was expected to be about 800 full-time equivalents higher under all plans than under the baseline projection. This increase is due to the jobs generated from implementing the BMPs; and the effect of STA construction activity net of job losses from reduced agricultural production. The per-acre assessments do not impact employment during this period.

- 1997 to 2003. The number of jobs in Palm Beach and Hendry counties was expected to be about 490 full-time equivalents lower under all plans than under the baseline economic projection. This reduction is the net effect of the jobs lost due to reduced agricultural production in the STA areas and the jobs generated from the operation of the STAs and BMPs. The per-acre assessments do not impact employment during this period.

TABLE 11.3. IMPACT OF EAA STORMWATER REGULATIONS AND PROGRAMS ON REGIONAL EMPLOYMENT: NUMBER OF JOBS EACH YEAR WITH THE PLAN MINUS NUMBER OF JOBS EACH YEAR UNDER BASELINE PROJECTION.[1]

Plan	Action	1994 to 1998[2]	1997 to 2003	2004 to 2008	2009 to 2013
Number of Jobs Under Baseline Projection[3]		17,700	17,700	15,900	13,900
		Change in Number of FTE Jobs Relative to Baseline Projection[4]			
	STAs	626	(660)	(215)	(215)
1	STAs, BMPs[5]	798	(488)	(43)	(43)
2	STAs, BMPs, and $10 Assessment	798	(488)	(43)	(43)
3	STAs, BMPs and $25 Assessment	798	(488)	(43)	(43) to (1,100)
4	STAs, BMPs and $100 Assessment	798	(488)	(43) to (4,200)	(43) to (7,400)

[1] Direct, indirect and induced impacts. Numbers in parentheses mean that the Plan is responsible for a decrease in jobs during the period. Numbers not in parentheses mean that the Plan is responsible for an increase in jobs during the period. Employment is in full-time-equivalent units (FTEs).

[2] Reduction in the number of jobs in agriculture is offset by the increase in jobs during construction of the STAs.

[3] The number of jobs in the baseline projection falls during the period because land is being abandoned due to critically thin organic soil thickness.

[4] This table reports the maximum annual employment impacts during the period. Employment impacts fall over time because land leaving production in previous periods due to the Plan later leave production under the baseline projections due to insufficient organic soil or other reasons.

[5] BMPs are expected to create about 170 jobs.

- 2004 to 2008. The number of jobs in Palm Beach and Hendry Counties is expected to be about 43 full-time equivalents lower under plans 1, 2 and 3 than under the baseline economic projections. This reduction is the net effect of jobs lost due to lost agricultural production in the STA areas that are not critically affected by soil subsidence in the baseline and the jobs generated from the operation of the STAs and BMPs. Assessments of $10 and $25 per acre per year do not impact employment during this period. Plan 4, which includes the $100 assessment, is expected to result in 43 to 4,200 fewer jobs than under the baseline.

TABLE 11.4. IMPACT OF EAA STORMWATER PROGRAMS ON REGIONAL EARNINGS: EARNINGS EACH YEAR WITH THE PLAN MINUS EARNINGS EACH YEAR UNDER BASELINE PROJECTION.[1]

Plan	Action	1994 to 1998[2]	1997 to 2003	2004 to 2008	2009 to 2013
	STAs	$8,500,000	($16,029,000)	($7,399,000)	($7,510,000)
1	STAs, BMPs	$12,811,000	($11,729,000)	($3,099,000)	($3,210,000)
2	STAs, BMPs, and $10 Assessment	$12,811,000	($11,729,000)	($3,099,000)	($3,210,000)
3	STAs, BMPs and $25 Assessment	$12,811,000	($11,729,000)	($3,099,000)	($3,210,000) to ($23,219,000)
4	STAs, BMPs and $100 Assessment	$12,811,000	($11,729,000)	($3,099,000) to ($76,523,000)	($3,210,000) to ($136,524,000)

[1] Direct, indirect and induced impacts. Numbers in parentheses mean that the Plan is responsible for a decrease in earnings during the period. Numbers not in parentheses mean that the Plan is responsible for an increase in earnings during the period. The tables report the maximum annual earnings impacts during the period. Impacts fall over time because land leaving production in previous periods due to the Plan later leave production under the baseline projections due to insufficient organic soil or other reasons.

[2] Reduction in agricultural earnings is offset by the increase in earnings during construction of the STAs.

- 2009 to 2013. The number of jobs in Palm Beach and Hendry Counties is expected to be about 43 full-time equivalents lower under plans 1 and 2 than under the baseline economic projections. Plan 3, which includes the $25 assessment, is expected to result in 43 to 1,100 fewer jobs than under the baseline. Plan 4, which includes the $100 assessment, is expected to result in 43 to 7,400 fewer jobs than under the baseline. Table 11.4 summarizes the impact of the four plans on earnings; it follows the same format as Table 11.3.

Overall, the regional economy was expected to increase by about seven percent from 1994 to 1996 due to construction of the Stormwater Treatment Areas. Beginning in 1997, the regional economy would shrink by about four percent relative to baseline projections because construction of the STAs would be completed and the job losses associated with the lost agricultural production on the STAs would be felt.

When the best management practices and the $10 per acre assessment are added, the incremental impact under the pessimistic scenario would be less than one percent additional contraction of the economy. When the $10 assessment is replaced by the $25 assessment, the BMPs and the $25 assessment will change the economy very little until 2009 when expected impacts could range from very little impact to a contraction of as much as 7.5 percent. Under the $100 assessment, the potential economic impacts range from very small to a 25 percent reduction in regional economic activity beginning in 2004 and increasing to about 50 percent by 2009.

USE OF THE ECONOMIC IMPACT ANALYSIS RESULTS

The study findings regarding economic impacts from the stormwater treatment areas and the best management practices provided assurance to the District that impacts would not be severe. The results regarding the annual assessments were used to justify, in part, the financial feasibility of the $25 per acre annual assessment. While the large sugar and vegetable growers disputed the findings of this study during Governing Board meetings, they never provided information that would change the study's results. In 1993, the Everglades Forever Act was enacted by the Florida Legislature. This Act gives authority to the District to create stormwater treatment areas; requires the Everglades Agricultural Area growers to implement best management practices; and requires EAA landowners to pay about $25 per acre annually to finance the STAs. In the years since the Everglades Forever Act became law, the EAA is still a productive agricultural area with sugar production the predominant land use.

Over the years the economic impact study report has been used as a reference document for the U.S. Army Corps of Engineers in developing their Central and Southern Florida Comprehensive Review Study. It has also been used as a reference document by the U.S. Environmental Protection Agency and environmental organizations.

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CHAPTER 12

Economic Importance of the San Carlos Island Shrimp Processing Industry to the Lee County Economy

Chuck Adams, David Mulkey and Alan Hodges

A conflict in Lee County between the commercial shrimp processing/packing industry and opposing interests over expansion of anchorage facilities led the West Coast Inland Navigation District to support a study on the industry's economic contribution to the county's economy. The processors/packers have argued that a decision not to expand would have economic consequences because commercial shrimp fishermen would go to other ports in Florida to offload harvests. The study was designed to estimate the economic contribution of the commercial shrimp industry and, given several scenarios, the potential economic cost, which can be seen as loss, if anchorage facilities were not expanded and fishing vessels chose to go elsewhere with shrimp harvests.

INTRODUCTION

Most of the shrimp offloading, grading, packing and processing in Lee County, Florida, occurs on San Carlos Island, in the Matanzas Pass anchorage basin. Shrimp-laden vessels returning from extended trips navigate the federal channel into the basin for docking and unloading at one of the processing facilities. Shrimp are offloaded and the vessels then move to an adjacent moorage location to refuel, make repairs and prepare for the next trip. Most of the revenues earned on a trip are spent within the Lee County economy.

During seasons when shrimp landings are relatively high, the limited commercial dock space can become overcrowded; some vessels are then diverted to Key West or Tampa Bay. If expanded dock space were available, additional commercial vessels could then tie-up, which would eliminate the need to divert them. However, the Matanzas Pass anchorage basin also serves as an important anchorage location for numbers of recreational craft. Proposals by San Carlos Island processors to expand moorage space and attract additional commercial vessels have been met with considerable resistance by representatives of Ft. Myers Beach, which lies directly across the Matanzas Pass basin (Ft. Myers News-Press 1997a; 1997b; 1998). To better contribute quantitative economic information to the debate, the West Coast Inland Navigation District undertook a study to assess the economic activity of the commercial shrimp

processing industry (and the lost economic activity of each diverted shrimp vessel) to the local economy. The specific study objectives were to:

1. Describe how shrimp processing activities on San Carlos Island are linked to other businesses within Lee County.

2. Estimate the economic impact (i.e., expenditures, economic output, incomes, and jobs) of the San Carlos Island shrimp processing/packing industry to the Lee County economy.

3. Estimate the change in economic activity when a typical shrimp vessel is diverted from off-loading at the shrimp processing facilities on San Carlos Island.

SAN CARLOS ISLAND SHRIMP PROCESSING ECONOMY

The commercial fisheries industry of Lee County represents an important component of the Florida commercial seafood industry. During 1997, approximately 8.7 million pounds of finfish and shellfish were landed in Lee County (Florida Department of Environmental Protection 1998). In Florida, only Monroe, Pinellas and Brevard Counties produce greater volumes of commercial fisheries products. While vessels with home ports on Pine Island and San Carlos Island target many varieties of finfish and shellfish, the most important commercial species in Lee County is shrimp.

Shrimp are not typically harvested in the waters immediately adjacent to the county, but rather are harvested from Florida Bay and the Dry Tortugas regions. Within the south Florida region, the shrimp are off-loaded primarily in Key West, Tampa Bay and San Carlos Island. Of the three ports, San Carlos Island has become the most important for off-loading; in 1997, for example, 2.703 million pounds (heads-off) had a dockside value of $13.399 million (National Marine Fisheries Service 1998). Its importance is because of the proximity to fishing grounds, the presence of several processing/packing firms, the availability of a wide range of repair and maintenance services, the availability of fuel and ice, and significant, albeit limited, room for off-loading and moorage.

Off-loading of raw shrimp at processing/packing facilities on San Carlos Island sets in motion economic activity that leads to the sale of shrimp outside of Lee County. These activities include spending and respending of dollars, which create incomes and jobs in several associated industries and markets.

The price per pound of shrimp that a vessel receives is determined by the size and product form (heads-on or heads-off). From the total received, the vessel operator pays the crew and makes purchases necessary for the next trip, purchases that are made in Lee County — they include fuel, ice, supplies, net repairs, deck equipment and hull maintenance, electrical services, groceries for the next trip and other goods and services. In addition, the vessel crew spends money in the local economy for lodging, transportation, food, entertainment and other activities.

Prior to being sold at the next market level, the off-loaded shrimp are headed (if necessary) at the processing plant, sorted by size, boxed and iced for shipment. A

"value-added" margin is created as expenditures are incurred (e.g., labor, storage, refrigeration, packing materials) and the shrimp are processed and packed for shipment. The resulting wholesale price then includes the original dockside price plus the processing margin. The wholesaler ships the shrimp out of the Lee County area for further processing elsewhere or sells to distributors, food service buyers, grocery markets or retail customers within the county. If sold to buyers outside of Lee County or visitors to the county, the transaction will bring "new" revenue into the local economy. In contrast, sales within Lee County do not inject new revenue but redistribute existing dollars.

The amount of economic activity associated with the San Carlos Island shrimp processing/packing industry is directly related to the volume of shrimp off-loaded into the dockside processing facilities. The volume harvested is determined by a number of factors such as stock abundance and shrimping effort, which are in turn affected by environmental conditions in Florida Bay and the Tortugas, short-term weather conditions, and the general market for shrimp.

San Carlos Island commercial landings of shrimp, which make up approximately 92 percent of the shrimp landed within Lee County, have varied considerably since 1981. For example, landings peaked at 3.1 million pounds (heads-off) in 1985, then fell to an average of 1.5 million pounds between 1987 and 1992 (National Marine Fisheries Service 1998). Landings steadily increased to 4.2 million pounds in 1996, then declined to 2.7 million pounds the next year. In addition, the landings of shrimp, especially pink shrimp, are seasonal in nature. Approximately 90 percent of the landings occur between November and June of each fishing year. This is because of the seasonal abundance of pink shrimp on the Florida Bay/Tortugas fishing grounds and the relaxing of the Texas Closure (an annual closed season off Texas, implemented to produce larger shrimp). Shrimp vessels throughout the southeast U.S. region converge on Texas waters in July of each year to take advantage of the season opening and larger shrimp available off the Texas coast. During this period, the number of off-loading events and, thus, landings at San Carlos Island decline dramatically as vessels move to Texas waters.

METHODOLOGY OF ECONOMIC ANALYSIS

Data

To better understand the linkages among related sectors of the shrimp processing and packing industry, in-depth interviews were conducted with managers and owners of the four facilities on San Carlos Island. These interviews provided detailed financial and operational information on the following: disposition of initial payment to off-loading shrimp vessels, vessel revenue/expense categories and amounts, expenditures associated with processing the shrimp (i.e., sorting, washing, thawing, heading, packaging, storing, and shipping), related industries in the immediate area and the greater Ft. Myers area, prices for shrimp by size class and form (i.e., heads-on and heads-off), estimates of percentage processed shrimp exported from the Lee County, numbers of ves-

sels off-loading during a typical season, number of off-loading events per vessel per season, estimates of the number of off-loading events that are diverted to other ports, and other related information. Also interviewed were representatives of other types of local businesses, such as marine repair facilities, seafood distributors, and marine electrical suppliers.

The National Marine Fisheries Service (NMFS) port agent for the Ft. Myers region provided annual and monthly landings and dockside value data and the number of offloading events (1993-97) for the four processing/packing facilities on San Carlos Island. The NMFS agent provided additional information on the seasonal nature of the shrimp fishery, described interactions between the shrimp industry and related industries in the region, and provided advice on interpreting the NMFS current price and landings data in terms of the study objectives. The information from these various sources helped to create a schematic illustration of the flow of shrimp, dollars, and associated goods and services among the industry sectors linked within the San Carlos Island and Lee County shrimp markets (Figure 12.1).

Estimating Economic Impact

Data from the interviews made it possible to estimate economic activities in the Lee County economy associated with the San Carlos Island shrimp processing/packing industry. These economic activities take the form of initial expenditures, economic output, value added, wages and salaries, and employment. The IMPLAN model, a computer software and database package designed for regional economic impact analysis in the United States at the county level (Minnesota Implan Group, Inc. 1997), estimates each of the values. The analytical framework for IMPLAN is the "input-output" economic modeling approach originally described by Liontief (1959). The model employs databases consisting of a set of social/economic accounts which describe the structure of the U.S. economy in terms of transactions between households, governments and over 500 standardized industry sectors that are classified on the basis of the primary commodity or service produced.

Regional models may be constructed in IMPLAN for any county, group of counties, or state or territory in the United States. Economic impacts and activities for a given region are specified in IMPLAN as a change in final demand, output or employment for a particular industry sector or social institution (e.g., households, government). The aggregate economic impact of these changes is calculated by a mathematical procedure that develops economic multipliers, which reflect the direct, indirect and induced impacts. Direct, indirect and induced impacts are set in motion within Lee County by changes in the sales of raw shrimp, which in turn affects the sales of goods and services associated with producing raw shrimp.

The commercial shrimp industry on San Carlos Island represents a "basic" industry in that it produces a product for sale outside the county. Dollars generated through these out-of-county sales (or consumption locally by non-residents), when respent in

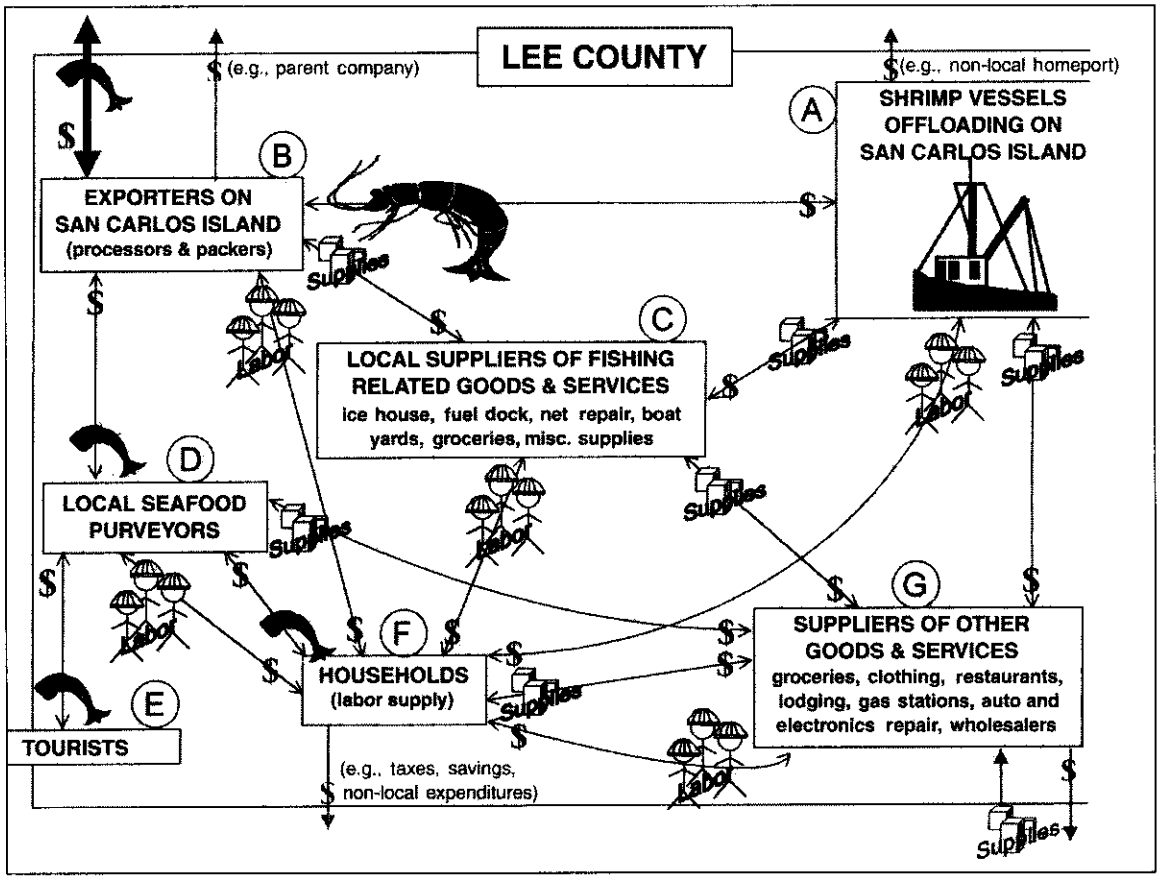

Figure 12.1. Schematic of economic linkages between the San Carlos Island shrimp industry and the Lee County economy.

the county, produce additional county-wide economic impacts. For the commercial shrimp industry in Lee County, direct activity would include sales, jobs and earnings generated in commercial shrimping and other activities related to the preparation of the raw shrimp for shipping to market. These direct activities produce additional indirect effects in the local economy as dollars earned through the sale of shrimp are respent locally. Indirect effects represent purchases of local products by shrimp vessels, such as ice, fuel, gear, net repair and groceries. All the indirect effects are additional economic activity in the county and are indicative of additional jobs and income generated by the sale of shrimp outside Lee County.

Direct and indirect activities associated with commercial shrimping and the sale of shrimp outside Lee County then produce additional (induced) local impacts. These impacts are associated with the spending of income earned in the direct and indirect activities. This spending translates into local retail sales, local bank deposits and the purchase of a diverse mix of consumer goods. An assessment of the total economic impact of a basic industry, such as commercial shrimping on San Carlos Island, must consider the sum of the direct, indirect and induced activities. In essence, the sale of

San Carlos Island shrimp outside the county triggers a chain of local spending, which generates income and leads to additional spending. This process, however, is not infinite in nature. At each round of spending, for example, some dollars are lost (leaked) from the local economy. Leakages are in the form of savings in non-local institutions, taxes/fees paid to the state and federal governments, and payments for goods and services used in the preparation of raw shrimp for market which are initially purchased outside the local area. Thus, the true economic impact from non-local sales of San Carlos Island-landed shrimp is represented by the new dollars remaining after accounting for the various leaks in the "economic hull" of the Lee County economy and the San Carlos Island shrimp processing/packing industry.

Total economic activities and impacts to the Lee County economy that are associated with off-loading shrimp on San Carlos Island are estimated. The direct, indirect and induced affects, in terms of economic output (sales of shrimp), personal incomes, total value added (wholesale margin) and employment, are estimated using the IMPLAN model. The estimates are measured for several different scenarios which embody several sets of assumptions related to shrimp landings, dockside price, wholesale markup and share of product exported from Lee County.

Vessel Diversion Impacts

The economic activities associated with an individual shrimp off-loading event on San Carlos Island are also analyzed. This is a pertinent issue given the constraints that may exist for moorage space during periods of relatively high volumes of pink shrimp landings. Over the course of a fishing year, the volume of shrimp eventually off-loaded on San Carlos Island is the total of a large number of individual off-loading events; each event is associated with a specific trip for a vessel. When a vessel is unable to off-load at San Carlos Island in a timely manner because of overcrowding at the docks, it may go to an alternate port, such as Tampa or Stock Island. If this occurs, the economic activity associated with the out-of-county sales from that specific load of shrimp will be lost to the Lee County economy.

This loss represents an opportunity cost of the moorage constraint which purportedly exists on San Carlos Island. Because the actual number of vessels that are forced to off-load elsewhere is unknown, the analysis was designed to estimate the economic activities associated with an "average" off-loading event. An average off-loading event is determined by the number of trips and the total volume of shrimp off-loaded for a given year, as reported by the National Marine Fisheries Service port agent office in Ft. Myers. Thus, the average off-loading event is defined as the average weight per trip.

RESULTS OF THE ECONOMIC ANALYSIS

Linkages between the San Carlos Island Industry and Lee County Economy

The economic linkages between the San Carlos Island shrimp processing and packing industry and other sectors of the Lee County economy are summarized in Figure 12.1. These linkages were determined in part through individual interviews and consultations with members of the local business community on San Carlos Island and Ft. Myers Beach. Further insight came from a review of annual cost data for 15 commercial shrimp vessels that use the San Carlos Island anchorage as their homeport.

During the 1997 season, shrimp vessels incurred an average of $199,610 in total expenses, including overhead (Table 12.1). The largest single expense was crew share (30.1%); also notable were costs for fuel (20.3%), maintenance and repair (17.0%) and supplies (11.1%) costs. Other costs included nets and gear, groceries, insurance and loan interest. Crew share (shrimp vessels typically have up to three crew members) represents incomes spent within the local economy, particularly if the crew members reside in households within Lee County. Crew members from non-local vessels also spend a large portion of their crew share within the local economy for goods and services such as lodging, food, entertainment and transportation while waiting for their vessel to make the next trip.

As Figure 12.1 indicates, economic activities associated with the San Carlos shrimp industry are set in motion by the landing of shrimp (A). Raw shrimp flows to the processors/packers (B) as dockside revenues flow to the vessels where shrimp are then processed (i.e., headed, graded, boxed, iced). To accomplish this task, however, supplies are purchased from local suppliers of goods and services (C), while labor is "purchased" from local households (F).

Though some shrimp is sold to local seafood distributors and retailers (D), the majority is sold to wholesale firms out of the region. The revenue generated by these "export" sales represents new dollars in the Lee County economy that are then spent again and again within the local economy as earnings by local households (F) are used to purchase goods and services from other local businesses (G) and shrimp from local seafood dealers (D). In addition, dockside revenues initially paid to shrimp vessels (A) are used by crew members to purchase goods and services from both fishing-related suppliers (C) and other local businesses (G). Some dockside revenues are used to purchase labor from local households (F) as shrimp vessel crew members. Some dockside revenues may also be retained in the local economy by vessel owners who reside within Lee County households (F). Finally, some of this revenue is used to re-initiate the process by purchasing the next harvest of shrimp that arrives at the dock.

Economic Impacts Associated with the San Carlos Island Shrimp Industry

The study used IMPLAN to estimate the economic impacts associated with the shrimp industry on San Carlos Island. Three scenarios were examined, each with a dif-

TABLE 12.1. ANNUAL AVERAGE EXPENSES FOR SAN CARLOS ISLAND-BASED COMMERCIAL PINK SHRIMP VESSELS, 1997.

Expenses Category	Annual Average per Vessel	Percent of Annual Total (%)
OPERATING EXPENSES		
Crew Share	$ 60,149	30.1
Groceries	$ 9,290	4.7
Taxi	$ 125	0.1
Packing	$ 3,053	1.5
Vessel Maintenance/Repair	$ 33,866	17.0
Electronics Maintenance/Repair	$ 2,770	1.4
Ice	$ 2,286	1.1
Fuel	$ 40,582	20.3
Lube/Oil	$ 467	0.2
Nets/Gear	$ 10,770	5.4
Supplies	$ 22,174	11.1
Dues / Licenses	$ 1,260	0.6
Transportation	$ 78	0.1
Total Operating Expenses	$186,870	93.6
OVERHEAD EXPENSES		
Contract labor	$ 1,359	0.7
Insurance	$ 6,078	3.0
Interest	$ 3,220	1.6
Legal / Accounting	$ 1,808	0.9
Taxes	$ 99	0.1
Miscellaneous	$ 116	0.1
Depreciation	—	—
Medical	$ 60	0.1
Total Overhead Expense	$ 12,740	6.4
TOTAL EXPENSES	$199,610	100.0

Source: Data obtained from informal consultations and interviews with industry representatives. Data reflect costs associated with trips originating from Florida and Texas ports.

ferent set of underlying assumptions regarding shrimp landings, dockside price, wholesale markup and other factors (Table 12.2). The impacts resulting from base, high and low cases provide a range of impact estimates, which captures the highly volatile nature of the resource and market; this is because the estimates for only one set of assumptions for a given year or set of resource/market conditions could be obsolete the following year. A range of estimates provides insight into the sensitivity of associated economic impact measures to changes in key factors that influence the shrimp industry and the local economy. The underlying assumptions of each are discussed below.

TABLE 12.2. SCENARIOS ANALYZED IN THE IMPLAN ECONOMIC IMPACT ANALYSIS.

Assumption	Scenario		
	Base Case	High Case	Low Case
Shrimp Landings[1]	2.18	4.18	2.18
Average Dockside Price[2]	$ 6.30	$ 7.00	$ 5.00
Dockside Value[3]	$ 13.734	$ 29.272	$10.900
Wholesale Markup Per Pound[2]	$ 1.25	$ 1.50	$ 1.00
Wholesale Value of Shrimp Sales[3]	$ 16.459	$ 35.545	$13.080
Share of Product Domestically Exported[4]	75%	90%	60%
Domestic Export Sales[3]	$ 12.344	$ 31.990	$ 7.848

[1]Heads-off, million pounds. [2]Per pound heads-off. [3]Million dollars. [4]Percent of wholesale value of shrimp sales.

Assumptions Underlying the IMPLAN Economic Impact Analysis Scenarios

Base Case. This scenario uses an average for the heads-off shrimp landings (2.18 million pounds) during the period from 1981 to 1997 (NMFS data). The average dockside price, however, was derived from interviews with managers or owners of the four shrimp processing/packing facilities on San Carlos Island. The price of $6.30/lb represents an anecdotal estimate of the per pound average price, weighted by predominant size class and species, for heads-off shrimp off-loaded at the local facilities during the last 2 to 3 years. The estimated dockside value is the product of landings and price. The wholesale markup per pound is defined as the increase in the dockside price per pound that is added by the processor/packer to cover all costs of processing and packing (e.g., off-loading, washing, sorting, grading, packaging, storage) prior to sale to the next market level. This markup also includes a profit margin added by the processor/packer. The markup of $1.25/lb. was based on interviews with each of the shrimp processing/packing facility managers on San Carlos Island. The wholesale value of shrimp sales is derived by multiplying the wholesale markup per pound and the total volume of heads-off shrimp landings; this value is then added to the dockside value. The share of product domestically exported represents the percent of the total volume of wholesale shrimp sales that are sold to buyers outside of Lee County. The 75 percent value, which was also derived from interviews with managers or owners of the San Carlos Island shrimp processing/packing facilities, is then applied to the wholesale value of shrimp sales to yield the estimate for domestic export sales. IMPLAN is then used to estimate the economic activities associated with the Base Case scenario.

High Case. This scenario attempts to duplicate conditions that might exist in a "best" case situation, where landings, dockside price, wholesale markup and export

share are assumed to be extremely favorable relative to the Base Case scenario. Shrimp landings are held at the 1996 level of 4.18 million pounds (heads-off) as reported by NMFS. Landings during that year were well above the average experienced during the 1981 to 1997 period (2.18 million pounds). Average dockside price is assumed to be $7.00/lb. heads-off. While this price is approximately 10 percent higher than the Base Case assumption, processing/packing facility managers and owners who were interviewed suggested that it was reasonable. The wholesale markup is assumed to be $1.50, or a 20 percent increase over the Base Case assumption. This markup percentage was within the upper range estimated from the interviews. Finally, the export share was increased to 90 percent, which is 33 percent over the Base Case. This percentage may be a reasonable assumption during years when landings are higher than average, thereby creating an excess supply that cannot be absorbed by the local markets. Such conditions may necessitate exporting a greater percentage of shrimp to out-of-county wholesalers. However, these assumptions do not account for possible market price responses to above-average supply conditions.

Low Case. This scenario attempts to duplicate conditions that might prevail in a "worst" case situation, when landings, dockside price, wholesale markup, and export share are assumed to be less than favorable relative to the Base Case scenario. Shrimp landings are assumed to be 2.18 million pounds, the 1981 to 1987 average; it is almost 50 percent and 19 percent lower than for 1996 and 1997 landings, respectively (NMFS data). During the 17-year period, reported landings exceeded the assumed average value only six times. Average dockside price is assumed to be $5.00/lb, while the wholesale markup is assumed to be $1.00/lb. These values are within the lower range of possible estimates provided by those interviewed on San Carlos Island during the course of the study. Finally, the export share is assumed to be only 60 percent. A lower percentage may be reasonable during years when landings are low and a relatively larger share of the total production is allocated to the local market. In addition, a lower export percentage may illustrate market conditions characterized by high levels of imported shrimp or reduced consumer/retail buyer demand. Higher levels of imported shrimp serve as competition for domestically produced shrimp in the overall market for green, raw, headless shrimp to be further processed into peeled, deveined, cooked, breaded or other valued-added products.

Findings of the IMPLAN Economic Impact Analysis

As should be expected, the results of the IMPLAN analysis varied with each set of assumptions. The largest economic impact estimates were associated with the High Case scenario, whereas the lowest impact estimates resulted from the conservative Low Case assumptions (Table 12.3). Findings from the High Case scenario suggest that the direct, indirect, and induced impacts total $55 million of economic output. Personal incomes were estimated to be $22.24 million, while total value added (export sales) and

TABLE 12.3. TOTAL ECONOMIC IMPACT ESTIMATES ASSOCIATED WITH VARIOUS IMPLAN SCENARIOS.

Scenario	Impact Type	Value in Million Dollars (1998) or *Number of Jobs*			
		Direct	Indirect	Induced	Total
(1) Base Case	Output	$12.55	$ 3.33	$ 5.33	$21.21
	Personal Income	$ 5.38	$ 1.22	$ 1.98	$ 8.58
	Value Added	$ 8.34	$ 1.68	$ 3.49	$13.50
	Employment	*481*	*44*	*75*	*600*
(2) High Case	Output	$32.51	$ 8.63	$13.81	$54.96
	Personal Income	$13.94	$ 3.17	$ 5.13	$22.24
	Value Added	$21.61	$ 4.35	$ 9.04	$35.00
	Employment	*1,247*	*113*	*195*	*1,555*
(3) Low Case	Output	$ 7.98	$ 2.12	$ 3.39	$13.48
	Personal Income	$ 3.42	$ 0.78	$ 1.26	$ 5.46
	Value Added	$ 5.30	$ 1.07	$ 2.22	$ 8.59
	Employment	*306*	*28*	*48*	*382*

Note: The economic impact estimates are additive across impact components (i.e., direct, indirect, and induced), but not across type of impact measure (i.e., output, income, value added, and jobs).

employment totaled $35 million and 1,555 jobs, respectively. Findings associated with the Base Case scenario suggested that total economic output would be $21.2 million. Personal incomes and value added were estimated to be $8.6 million and $13.5 million, respectively. The number of jobs associated with the Base Case scenario was estimated to be 600. The lowest estimates were associated with the conservative assumptions, which defined the Low Case scenario. Total economic output impacts were estimated to be $13.5 million, while incomes, total value added and jobs totaled to $5.5 million, $8.6 million and 382, respectively.

The magnitude of the estimated economic impacts is directly related to the volume of landings, dockside price, wholesale markup and the export percentage. Thus, the actual economic impacts associated with the San Carlos Island shrimp industry will vary from year to year. As landings increase, the economic impacts will increase, assuming all other factors remain proportionally constant. Similarly, as landings or market price for shrimp decrease, the economic impacts will also likely fall. The range of estimates summarized in Table 12.3 provides insight into the fallacy of assigning a given economic value to an industry influenced so strongly by fluctuating environmental and general economic conditions.

ECONOMIC CONSEQUENCES OF OFF-LOADING EVENT DIVERSION

Given the reported constraints on moorage space, which confront the shrimp processing/packing activities on San Carlos Island, the activities associated with an "average" off-loading event are of important economic interest. Vessels returning from a trip will moor in a parallel fashion at the dock in front of one of the facilities where the shrimp are off-loaded by hand or mechanically. This time consuming work requires the labor of both deckhands and workers from the processing facility. Once emptied, the vessel will move out of the way to make room for the next one to be off-loaded and moor at an adjacent location for servicing (i.e., maintenance, refueling, repair) for the next trip. Numbers of vessels may be moored three and four abreast for several days as they await servicing for the next trip. Accomodating additional shrimp-laden vessels for off-loading becomes a problem when there is insufficient room at the docks to moor empty ones. If such a situation occurs, incoming vessels may then need to off-load at another location such as Tampa Bay. Thus, the economic activity associated with those shrimp that would have been off-loaded on San Carlos Island is lost to the local economy.

The economic activity associated with an average off-loading event was estimated simply as the quotient of the individual total economic impact values (Table 12.3) and the average number of trips (i.e., off-loading events) taken during the 1992-1996 period. The number of off-loading events (trips) that occurred on San Carlos Island during the 1992-1996 period ranged from 976 (1992) to 1,436 (1996) (National Marine Fisheries Service 1998). The average number of trips during this period was 1,126. The average weight of shrimp off-loaded per event during the same period was 2,318 pounds heads-off. The economic impacts associated with an average off-loading event were derived for the same three scenarios as discussed for the total economic impact analysis.

The relative magnitude of the economic impact estimates for an average off-loading event across the three scenarios mirror that found for the total economic impact estimates (Table 12.4). The impact associated with the Base Case scenario suggests the total economic output (i.e., summed across the direct, indirect and induced impact components) associated with an average off-loading event is $18,830. The total personal income impact is estimated to be $7,620, while the total value added impact is $11,990. The number of jobs associated with an off-loading event are estimated to be 0.53. The highest impact estimates are associated with the High Case scenario. In that scenario, almost one and one-half full-time equivalent jobs are associated with an average off-loading event.

These values provide an estimate of the economic impact that is lost to the local economy if a shrimp vessel is turned away from San Carlos Island and off-loaded in an alternative port facility out of Lee County. This impact can be referred to as an "opportunity" cost of allowing the moorage constraints that reportedly characterize the San Carlos Island docks to continue to exist.

TABLE 12.4. ECONOMIC IMPACT ESTIMATES ASSOCIATED WITH DIVERTING A SHRIMP OFF-LOADING EVENT FROM THE SAN CARLOS ISLAND PORT FACILITY.

Scenario	Impact Type	Value in Thousand Dollars (1998) or *Number of Jobs*			
		Direct	Indirect	Induced	Total
(1) Base Case	Output	$11.14	$ 2.96	$ 4.73	$18.83
	Personal Income	$ 4.78	$ 1.09	$ 1.76	$ 7.62
	Value Added	$ 7.40	$ 1.49	$ 3.10	$11.99
	Employment	*0.43*	*0.04*	*0.07*	*0.53*
(2) High Case	Output	$28.87	$ 7.66	$12.26	$48.79
	Personal Income	$12.38	$ 2.82	$ 4.56	$19.75
	Value Added	$19.19	$ 3.86	$ 8.02	$31.07
	Employment	*1.11*	*0.10*	*0.04*	*1.38*
(3) Low Case	Output	$ 7.08	$ 1.88	$ 3.01	$11.97
	Personal Income	$ 3.04	$ 0.69	$ 1.12	$ 4.84
	Value Added	$ 4.71	$ 0.95	$ 1.97	$ 7.62
	Employment	*0.27*	*0.02*	*0.04*	*0.34*

Note: The economic impact estimates are additive across impact components (i.e., direct, indirect and induced), but not across type of impact measure (i.e., output, income, value added and jobs).

The total number of diverted off-loading events during a typical year is difficult to estimate. However, the economic impact associated with the total number of diverted off-loadings can be estimated by simply multiplying the reported number of diverted off-loadings by the values in Table 12.4. For example, if it is assumed that during 1996 a total of 12 vessels were diverted to Tampa Bay due to moorage constraints, then the Base Case loss in economic impact to the Lee County economy would have been $225,960 in economic output, $91,440 in personal incomes, $143,880 in value added impacts and 6.36 jobs. Further, it is possible that a vessel diverted to an alternative port facility may continue to off-load at that alternative location for the entire fishing season, rather than for just the single off-loading event. If so, the economic activity associated with those off-loading events (1-2 trips per month during the pink shrimp season) would be lost to the Lee County economy. Note that market factors and fishery production will affect the likelihood of off-loading event diversion due to congestion of shrimp vessels at San Carlos Island.

CONCLUSIONS

The shrimp processing and packing industry on San Carlos Island represents an important component of the Lee County economy. Activities associated with harvesting, offloading, processing, packing and shipping shrimp from the San Carlos Island facilities have been shown to be intrinsically linked with several sectors of the local economy. These activities create positive economic impacts for the local economy as shrimp products are sold to buyers located outside of Lee County and shrimp is purchased locally by nonresidents. The sale of shrimp to both local and non-local buyers results in the purchase of inputs from a variety of service and supply firms, and the distribution of incomes to local employees. These expenditures are circulated within the Lee County economy as these dollars are spent and re-spent. The total economic impact of the San Carlos Island shrimp industry depends on the amount of shrimp landings and the general economic conditions that exist at any given time. Thus, the actual impact values will vary from year to year.

Similarly, the economic impacts associated with an average off-loading event can vary. Under favorable conditions with landings at the volumes reported during 1996 and a strong market for shrimp prevailing, the total economic output associated with a single off-loading event may approach $49,000. In addition, $20,000 in personal incomes, $31,000 in value added impacts, and almost 1-1/2 jobs may result. These values can also be viewed as the losses associated with an off-loading event that may be diverted from Lee County if moorage space on San Carlos Island is unavailable.

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CHAPTER 13

Bioeconomic Models and the Florida Spiny Lobster Trap Certificate Program

Sherry L. Larkin, J. Walter Milon and Nelson Ehrhardt

Florida's spiny lobster fishery grew rapidly between 1970 and the early 1990s as evidenced by the rapid increase of lobster traps: from less than 100,000 between 1960 and 1970 to more than 900,000 by the early 1990s. Despite the expansion in effort, commercial landings did not increase proportionally. Concern was raised statewide over the inefficiency of harvesting and the consequences on the potential deterioration of the fishery and environment. The state instituted a regulatory system that was designed to limit the number of traps and to bring a new level of efficiency to the fishery that would optimize harvests and minimize costs. This chapter summarizes a study designed to examine whether the regulatory system of trap certificates was maximizing benefits.

THE MANAGEMENT PROBLEM

Florida's spiny lobster (*Panulirus argus*) fishery is one of the state's most important fisheries, with ex-vessel prices valued at nearly $30 million in 1998. Between 1960 and the early 1990s, commercial fishing effort expanded from less than 100,000 traps (the dominant gear type) to more than 900,000 (Hunt 1994). Despite the significant increase in effort, total commercial landings varied little, fluctuating between five and eight million pounds per year since 1970. Even though the significant increase in effort did not have an effect on landings that would cause concern for the health of the stock, it did raise several other concerns. In 1991, for example, the Florida Legislature observed that "Due to rapid growth, the spiny lobster fishery is experiencing increased congestion and conflict on the water, excessive mortality of undersized lobsters, a declining yield per trap, and public concern over petroleum and debris pollution from existing traps" (Florida Statute 370.142(1)).

The number of traps was eventually regulated in 1992 when the Florida Legislature implemented the Trap Certificate Program (TCP). Its mandated goal was "to stabilize the fishery by reducing the total number of traps, which should increase the yield per trap and therefore maintain or increase overall catch levels" (Florida Statute 370.142(1)). The TCP ended an era of open-access management of the spiny lobster fishery in Florida by establishing a cap on total effort. The program is one of the first individual transferable effort programs in the United States. Under the TCP, qualified commercial fishers own certificates that entitle them to fish a specified number of traps (each certifi-

cate allows the use of one trap). All traps are identical since trap size and design are regulated. Each year, fishers pay an annual certificate fee ($1.00 beginning in 1998-99) and, in return, receive a tag for each certificate owned. The tags are attached to the traps and indicate the trap is legal for that season (tags are color-coded each season and stamped with a certificate number that can be used to identify the owner). Certificates are transferable, all or in part, among fishers.

The total number of certificates, which is considered a proxy for the total level of effort allowed in the fishery, has been periodically reduced in accordance with the stated goal of the program (Florida Statute 370.142(1)). The Statute that established the program did not, however, specify the total number of traps to eliminate from the fishery. Since 1992, periodic reductions in the total number of certificates have eliminated approximately 35 percent of the commercial traps. It is not clear, however, whether these reductions have been too much or too little relative to an optimal (e.g., profit maximizing) number of traps in the fishery.

The purpose of this study was to determine the total number of traps that would maximize the net economic benefits in the commercial fishery and, thus, test the hypothesis that previous regulatory actions have achieved an economically optimal and sustainable number of traps in the fishery. Following a brief description of the bioeconomic modeling approach and its applicability for representing the spiny lobster trap fishery in Florida, the individual biological production and cost model results are presented. The integrated results include estimates of the economically optimal and sustainable number of traps in the fishery. These optimal effort levels and corresponding trap values are then compared with the current effort level and trap certificate prices, which have been observed since certificate reductions and transfers began during the 1993-94 season. The concluding discussion identifies the potential profits per trap if the economically optimal number of traps were established as the target effort reduction goal. Several related management issues, including factors that may prevent further reductions, are also discussed in the summary.

BIOECONOMIC MODELS AND THE FLORIDA SPINY LOBSTER FISHERY

Bioeconomic theory for a commercial fishery posits that the socially optimal level of effort and corresponding harvest is determined by both the biological dynamics of the stock and the economics of the industry, i.e., harvesting costs and market prices (Hartwick and Olewiler 1998). This relationship occurs because society is interested in stock conservation and the profitability of the industry. Without entry or effort restrictions, harvest continues to the breakeven point — an effort level where total revenues just cover total costs (TR = TC) — which is known as the open-access equilibrium (OAE). Using a Schaefer (logistic) yield-effort curve, and assuming constant costs and prices, the OAE solution is shown in Figure 13.1. The OAE (unregulated) equilibrium is socially inefficient (sub-optimal) because the same total revenue can be achieved at a lower cost (at a relatively low level of effort). At the OAE solution, the additional effort

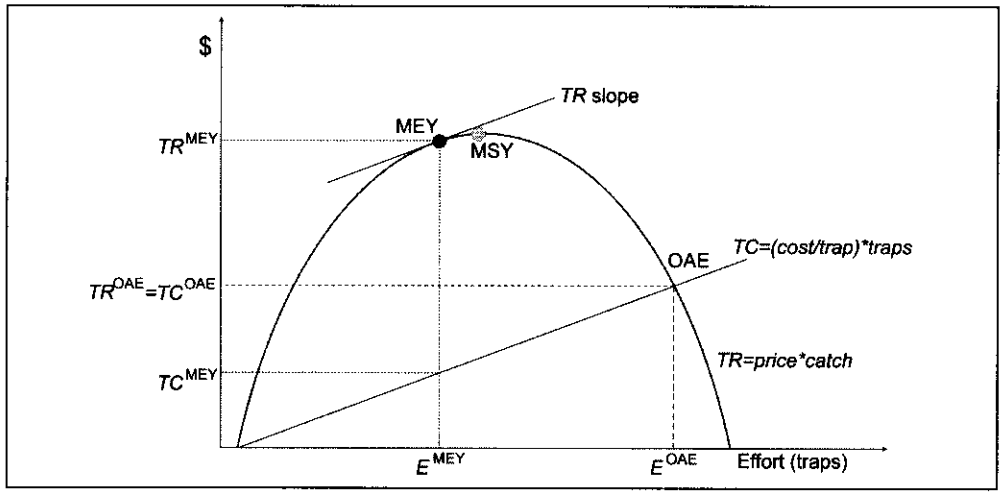

Figure 13.1. MEY, MSY, and OAE solutions with a logistic production function.

incurs additional costs, which completely offset total revenues (profits are zero). In addition, the level of catch at OAE is less than at the maximum sustainable yield (MSY), which occurs at the height of the total revenue (TR) curve. The relative catch levels can be identified using the TR curve since the TR curve retains the same shape as the underlying sustainable yield (catch-effort) curve when price is constant. The MSY catch level represents the largest quantity that can be harvested on a sustainable basis (i.e., without compromising the stock); it is the harvestable surplus.

From society's point of view, the maximum economic yield (MEY) is the optimal solution since industry effort is increased only to the point where additional revenues are offset by harvesting costs (Gordon 1954). This solution is identified by equating the slopes of the total revenue and total cost curves (i.e., where marginal revenue equals marginal cost). TR^{MEY} minus TC^{MEY} represents the maximum profit per unit effort in the fishery.[1] In the traditional example shown in Figure 13.1, the MEY effort is less than needed to take the MSY.

To estimate an MEY solution for the Florida commercial spiny lobster fishery, we must first estimate a sustainable yield curve. The sustainable yield curve, also known as the surplus production function, describes the aggregate effects of natural mortality, growth and recruitment in a single compensatory function. According to Menzies and Kerrigan (1980), surplus production models can be used when the relationship between the local stock size and future recruitment is weak or unknown (as with spiny lobster in Florida) (Ehrhardt 1994). In addition, these models have relatively modest data

[1] This solution would also provide the maximum rents to the fishery if costs included the opportunity cost of capital and labor (i.e., the market value of alternative uses for the resources). Since opportunity costs are often difficult to measure in fisheries, most empirical studies attempt to measure only profit changes (Hartwick and Olewiler 1998).

requirements and are particularly useful as first approximations (Clarke et al. 1992). The shape of this curve depends on assumptions regarding the growth rate of the stock. For example, the traditional logistic model in Figure 13.1 assumes a density-dependent growth pattern whereby the sustainable annual harvest is dependent on the size of the local population in previous years. This specification is characterized by the potential for complete depletion of the stock since catch can be driven to zero at excessive levels of effort.

Recent studies have concluded that spiny lobster recruitment in Florida is dependent, at least in part, on the size of the spawning stock in waters adjacent to Florida (Ehrhardt 1994). In addition, the Florida fishery prohibits harvest (1) during spawning season, (2) of egg-bearing females and (3) of juvenile (undersize) individuals. According to Clarke et al. (1992), if recruitment into a fishery is exogenous or local regulations are sufficient to maintain recruitment, a logarithmic production function is most appropriate. A logarithmic production function (Figure 13.2) assumes the sustainable yield is not entirely dependent on stock size so increasing effort eventually has no effect on total catch (total revenues).

As illustrated in Figure 13.2, a logarithmic or flat-top sustainable yield curve has a wide range of effort levels that produce the MSY solution. Effort at the open-access equilibrium (E^{OAE}) is greater than effort that maximizes economic yield (E^{MEY}). Since total revenues are the same at either E^{MEY} or E^{OAE}, society is not making the best use of its resources by increasing effort from E^{MEY} to E^{OAE}. The additional effort at the OAE solution dissipates profits that would be earned at E^{MEY} since costs are higher. Thus, even if the biological relationship indicates that additional effort will not threaten sustainability, the bioeconomic framework shows that it is necessary for management to restrict effort in the fishery to achieve an economically efficient allocation of resources.

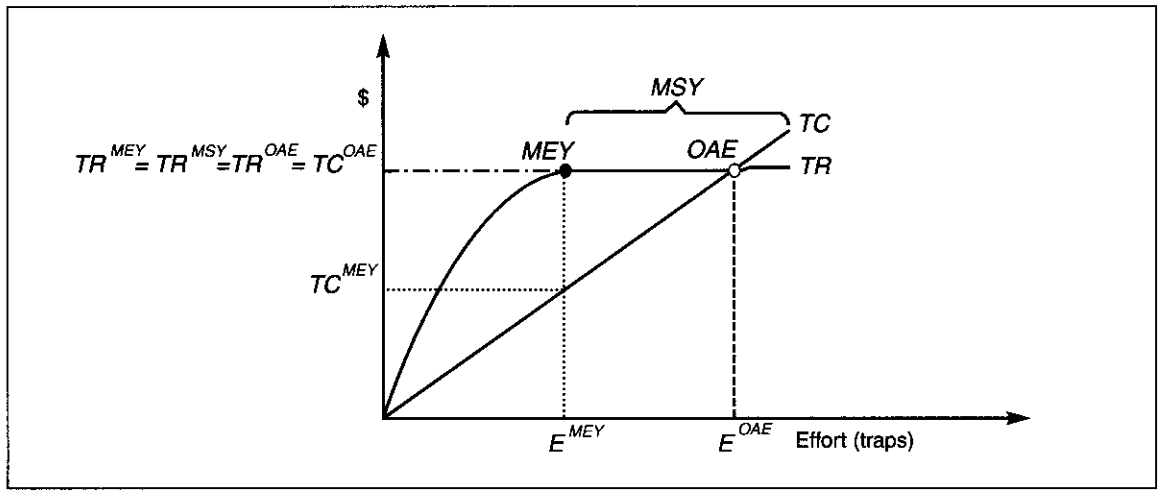

Figure 13.2. MEY, MSY and OAE with a logarithmic production function.

ANALYTICAL METHODS

Collection of Data

Catch and effort data, as well as records of certificate transactions since the inception of the TCP, were obtained from the State of Florida. The catch and effort data, consisting of annual landings and trap use, cover the 1960-61 through 1997-98 seasons (Figure 13.3).[2] Landings are the quantity purchased (total pounds whole weight) by licensed wholesale dealers and are assumed to equal total commercial catch (C). These landings exclude harvests by the recreational sector.[3] Fishing effort (E) is the total number of traps operated by commercial fishermen. It is implicitly assumed that fishing practices have not changed over time and do not differ among fishers. These are valid assumptions given that trap size and construction are regulated. In addition, fishing technology changes may have increased the rate of harvest — which is accounted for in

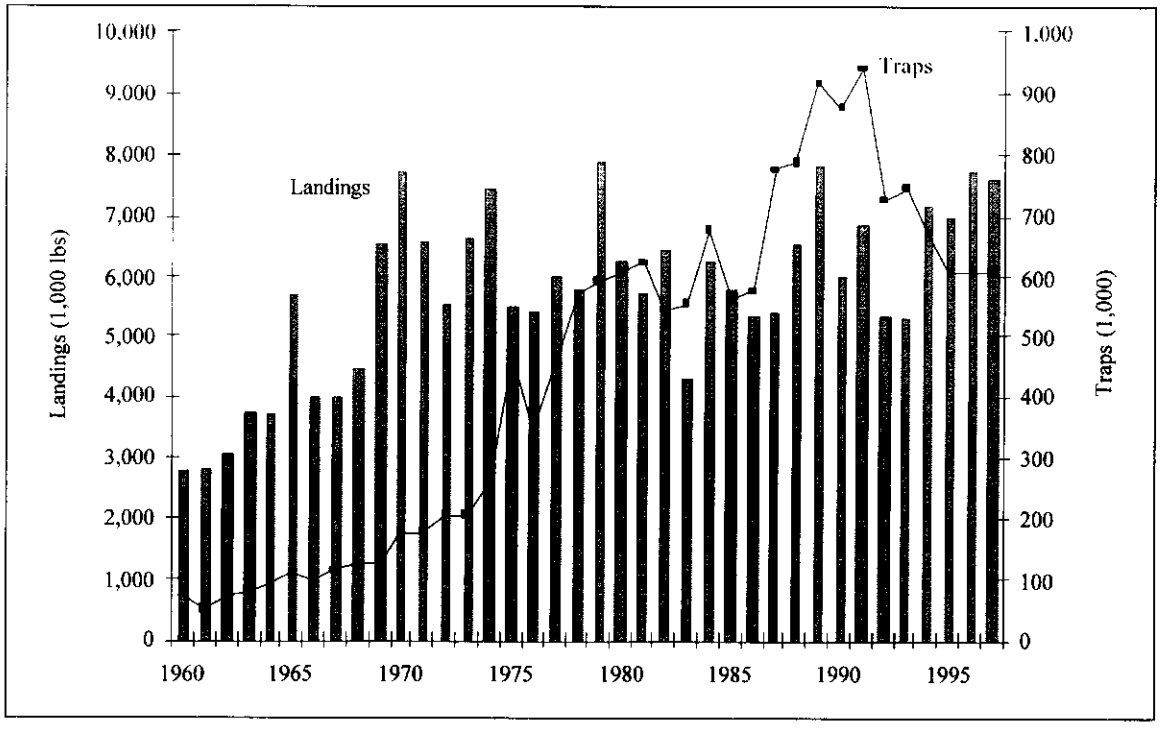

Figure 13.3. Total spinal lobster landings and traps in Florida, 1960-1997.

[2] Data reported on the East Coast from 1964 to 1975 were adjusted to remove landings and traps associated with fishing in the Bahamas. Correction details are available in Milon, Larkin, and Ehrhardt (1999).

[3] Excluding recreational landings was necessary since (1) statistics are not available for the entire period and (2) effort is measured differently than in the commercial sector. Omitting the recreational landings will not affect the shape of the production function at recent effort levels since these landings have remained a relatively constant share of total landings since data collection began in 1991 (Hunt et al. 1998).

the cost information and biological coefficients — but would not have affected resource availability and, therefore, estimation of the long-run surplus production function. As shown in Figure 13.3, annual landings in Florida averaged approximately 3 million pounds in the early 1960s. Since 1975, however, landings have ranged from 4.3 to 7.8 million pounds, with no apparent trend. Total effort increased significantly between 1960 and 1992, from less than 100,000 to nearly one million traps. The dramatic increase in traps with relatively stable landings caused the CPUE for the commercial trap fishery to decline approximately 75 percent from 1970 to 1990. Since 1992, when the TCP was implemented, the number of traps has been reduced to approximately 544,000.

Cost data needed to estimate the marginal cost per trap were obtained during interviews conducted with a stratified sample of lobster fishers in the Florida Keys (Milon et al. 1999). Variable costs included trip costs (fuel, bait, groceries, ice, supplies, and labor payments), equipment leasing and repair, and maintenance expenses incurred during 1996. These costs averaged $16,366 annually, exclusive of labor. Labor payments equaled $12,950 assuming captain and crew were paid the minimum wage ($5.15 per hour). The minimum wage was a necessary assumption since preliminary surveys indicated that a variety of compensation methods were used and this information was a sensitive issue that many did not wish to discuss. Basing labor costs on the minimum wage provides an estimate of the minimum opportunity cost associated with work hours expended in this fishery. Fixed costs averaged $21,238 annually and included interest payments, docking fees, depreciation (vessels and gear), and licensing.

Biological Production Models

Two flat-top production models were estimated for this fishery. The empirical models and corresponding catch-effort curves are shown in Figure 13.4. The first, dubbed the Effort-Corrected Schaefer model, incorporated the effects of trap density into a traditional Schaefer production model. In particular, this model specified the catch rate as

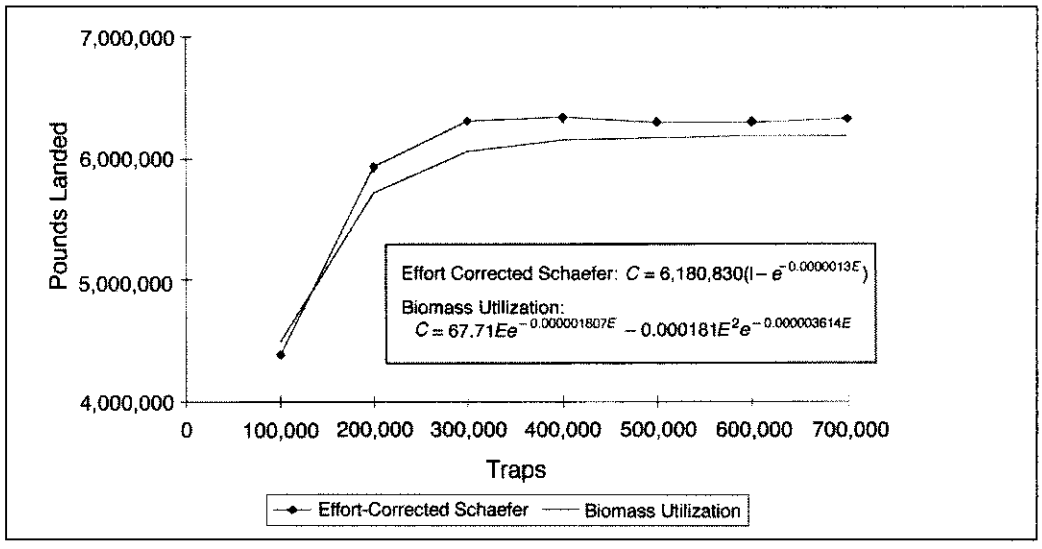

Figure 13.4. Estimated biological production functions: C = f(E)

an inverse function of effort (i.e., the catch rate declined at higher trap densities). In addition, a relative trap efficiency parameter was estimated and used to standardize effort over time. Both parameters in the Effort-Corrected (E-C) Schaefer model were statistically significant at the one percent level and the estimated model was highly significant overall ($F_{1,34}$= 69.9). The second flat-top production model, referred to as the Biomass Utilization (BU) model, assumed that catch is a function of the maximum catch possible and the catch rate. As with the E-C Schaefer model, the catch rate incorporated the dynamics of trap density on yield. Catch was estimated as the difference between the asymptotic (maximum) catch minus the catch that survived fishing effort. This model is unique in that catch is a function of the available catchable biomass without taking population regeneration into consideration. Using the nominal data, the estimated BU model was statistically significant at the one percent level ($F_{1,34}$ = 71.1). See Milon et al. (1999) for further detail.

Figure 13.4 shows the relationship between the total number of traps and sustainable landings predicted by each model. Both models predict landings would increase at a decreasing rate until approximately 400,000 traps. Landings would then remain constant at approximately six million pounds as effort increases. The corresponding marginal productivity curves shown in Figure 13.5 reflect the slope of the biological production functions and, therefore, represent the change in total industry catch from adding an additional trap to the fishery when all other inputs are held constant.

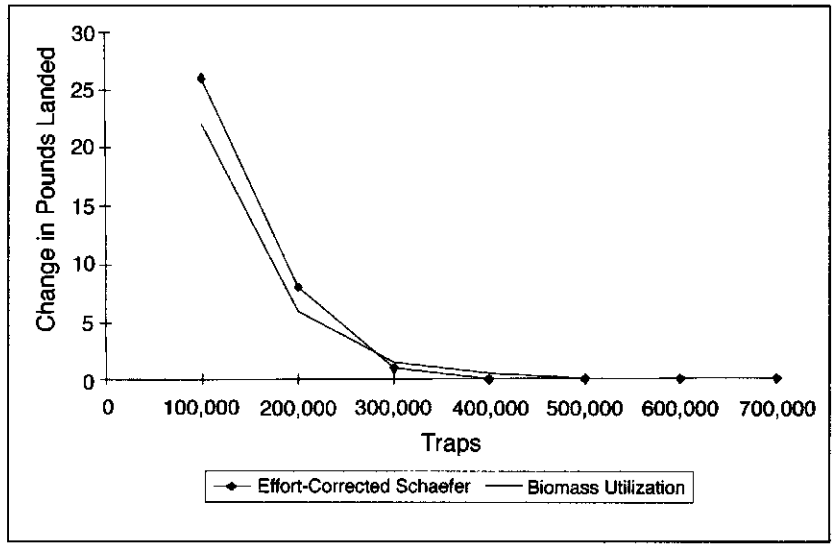

Figure 13.5. Estimated biological marginal productivity functions: $\partial C/\partial E$.

Cost of Production Models

Two cost models were estimated for this study. The first followed an earlier study by Prochaska and Cato (1980) in which the total annual cost of lobster fishing for each vessel (TC_i) was regressed against the number of traps the firm operated (E_i): $TC_i = A + \beta E_i$. This equation provides an estimate of the annual fixed cost for each vessel (A) and the corresponding marginal cost per trap (β). The costs estimated from this specification represent the short-run costs of fishing. The second model assumed all costs were dependent on effort: $TC_i = E_i$. This equation specifies

that the total cost is variable since it depends on the number of traps fished, which is a variable input. This is the appropriate specification for a long-run analysis. It implies that extra effort is from new traps, not increased effort from existing traps.

The two cost models were estimated using a least squares technique on 1996-97 survey data (n=53 vessels). Results are presented in Figure 13.6 (standard errors are reported in parentheses). Both marginal cost estimates were statistically significant at the one-percent level. The short-run cost curve estimated annual fixed costs at approximately $14,900 and marginal cost at nearly $30 per trap ($R^2$=0.50). The long-run cost curve estimated marginal cost at nearly $39 per trap ($R^2$=0.87), approximately 30 percent above the short-run cost.

INTEGRATED BIOECONOMIC ANALYSIS

Four maximum economic yield (MEY) solutions were determined by equating the two marginal revenue curves (MR) with the two marginal cost estimates (MC). The marginal revenue curves were derived by multiplying the estimated marginal productivity curves (Figure 13.5) by the average price per pound in 1996 ($3.79, NMFS 1997). These solutions are identified in Figure 13.6. The profit-maximizing number of traps in the fishery ranged from approximately 160,000 to 200,000.[4] The four MEY solutions would generate industry profits from $12.7 million to $14.3 million at 1996 prices. Using the long-run cost curve resulted in fewer traps and lower landings but higher

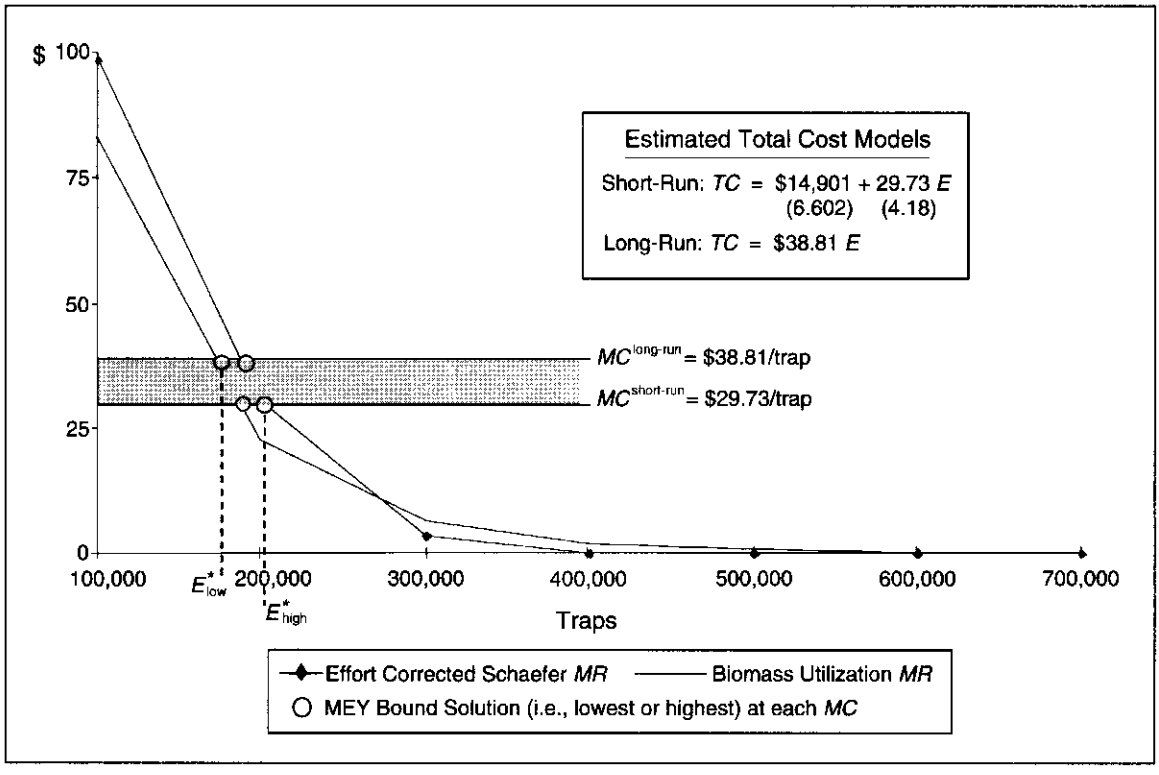

Figure 13.6. Range of bioeconomic optima (i.e., MEY solutions) if labor paid the minimum wage.

landings per trap. Total landings and effort were highest with the E-C Schaefer production model, however, total profits and profits per trap were highest with the biomass utilization (BU) specification. The four MEY solutions are summarized in Table 13.1.

The optimums identified and described in Figure 13.6 and Table 13.1 encompass differences in the specification of the production and cost curves (i.e., uncertainty as to the most appropriate specifications). The sensitivity of the solutions to the assumed market price is also important. An increase in the average lobster price would shift the marginal revenue curves upwards and increase the optimal number of traps. For example, if the dockside lobster price equaled $5 per pound instead of $3.79 (a 32 percent increase), the economically optimal number of traps would increase from 10 to 14 percent depending on the revenue and cost curve specification. Also note that the estimated profits per trap presented in Table 13.1 were based on a marginal cost estimate that assumed crew members and the captain (if different than the owner) were paid the

TABLE 13.1. RANGE OF MAXIMUM ECONOMIC YIELD (MEY) SOLUTIONS.

	Total Revenue Specifications	
Cost Specification	Biomass Utilization	E-C Schaefer[1]
Short-run Cost:[2]		
Effort (E^*)	179,159 traps	198,523 traps
Catch (C^*)	5,576,306 pounds	5,909,496 pounds
	(31 pounds per trap)	(30 pounds per trap)
Profit	$13,720,529	$14,182,009
	($76.58 per trap)	($71.44 per trap)
Long-run Cost:		
Effort (E^*)	158,619 traps	178,655 traps
Catch (C^*)	5,391,621 pounds	5,730,632 pounds
	(34 pounds per trap)	(32 pounds per trap)
Profit	$14,278,428	$12,704,075
	($90.02 per trap)	($71.11 per trap)

[1] Where q = 0.000001807

[2] Assuming each vessel owned 1,279 traps (the sample average) in order to calculate total fixed costs.

[4] These profit calculations are based solely on the estimated (minimum) marginal costs per trap. Since the cost estimates do not include externalities or an opportunity cost for capital invested in the firm, these profits should be interpreted as upper bound estimates of accounting profits rather than rents or economic profits.

national minimum wage. If the actual labor payment or opportunity costs of labor were higher, the estimated profits per trap and optimal number of traps would be overestimated.

The total profits estimated from each MEY solution can be used to estimate the optimal certificate price under the assumption that the price of a certificate should equal the profits derived from its use. This price is the profit per trap when the total number of traps are at the optimum. Using the model that produced the most conservative optimal effort level and highest profits (Table 13.1, short-run bioutilization model), the upper-bound estimate of the optimal certificate price for a one-year time period would equal approximately $90.

From the bioeconomic analysis, we know the value of each certificate (trap) if the total number of traps were optimal (i.e., from approximately 160,000 to 200,000). If the transfer market for trap certificates is working properly (e.g., buyers and sellers can exchange easily) and buyers anticipate the increased profits predicted by the bioeconomic models, observed certificate transfer prices should closely match the estimated optimal certificate values. Differences between reported certificate prices and estimated optimal certificate values could be used as a rough approximation of the gains from certificate reductions, that is, the gains from moving toward the maximum economic yield solution.

During the 1996-97 season, 604,920 certificates were available — approximately three times the optimal number of traps — and reported certificate prices averaged from $4.47 to $15.52 depending on the certificate type and calculation method (Milon et al. 1998). Although lower than the price that would be expected if the number of traps were near optimal (i.e., $70-$90, Table 13.1), these prices are near the value expected with the current number of traps (544,000 in 1998-99). For example, given an average annual yield of 12.8 pounds per trap and average price of $3.79 per pound, gross returns are approximately $48.50 per trap. Net returns would range from $9.69 to $18.77 using the estimated long- and short-run marginal costs, respectively. For comparison, the annual profit per trap from the BU model would equal $13.30 at the 1998-99 certificate level. Consequently, the trap values from the estimated bioeconomic models are similar to the average transfer prices reported to date, indicating that current certificate prices do not reflect potential future profits in the fishery.

CONCLUSIONS

Effort reductions under the Florida spiny lobster TCP have made progress toward the goal for the program established by the Florida Legislature. From the 1991-92 to 1998-99 seasons, the total number of traps declined approximately 35 percent and the average yield per trap increased 42 percent (Milon et al. 1998). As a result, the average reported transfer price has increased each year. The bioeconomic analysis revealed that if reductions were to continue until the economically efficient number of traps is reached (i.e., approximately 60 percent of current trap numbers), economic efficiency in the fishery would reach a maximum. Certificate values would increase from less than

$20 to $70-$90 per certificate (the reported and optimal prices, respectively), consequently, industry profits would increase approximately four-fold. Resource managers could redistribute, if desired, a portion of the increased returns to the citizens of Florida in the form of an equitable rent per trap (Florida Statute 370.142(2)). However, given the current reduction schedule (10 percent reductions every two years), 10 additional reductions are required to reach the optimum (i.e., 20 years at best). This relatively slow adjustment period delays potential economic benefits to the industry. In addition, reductions are imposed in the form of percentages against each individual's total certificate holdings. This continual down-sizing is an inefficient means of removing effort since it requires each participant to repeatedly purchase certificates to return to their previous size; it does not allow participants to remain at their optimal size and may disproportionately impact small firms.

The bioeconomic analysis indicates that future effort reductions in the commercial spiny lobster fishery could significantly increase the profit per trap and the value of certificates. The estimated optimal number of traps, however, could imply a significant reduction in the total number of vessels in the fishery. For example, using the average number of traps per vessel (1,279) reported in the recent cost study by Milon et al. (1999) and the most conservative total effort level from this study (158,619 traps from the biomass utilization model), optimal fleet size would equal 124 vessels, a 75 percent reduction in the number of full-time operators.

The optimal bioeconomic solutions described in this paper are intended as a baseline against which other important factors can be considered, including: (1) equity issues within the fishery, such as the relative harvest of competing commercial or recreational participants; (2) social costs stemming from the re-allocation of effort to other fisheries; (3) the loss of jobs that might result from reductions in the total number of traps in the fishery; and (4) rising administrative costs. The bioeconomic analysis and the evaluation of the trap certificate program also provide valuable insights into the strengths and weakness of one of the nations first transferable rights programs. It provides an example of how economic analysis can be used to evaluate the effects of one approach to correcting problems in fisheries management. Other fisheries considering transferable licensing/effort permits may benefit from the experiences of the trap certificate program. Conducting a bioeconomic analysis prior to implementation would allow consideration of changes in the numbers of participants and effort levels that can be factored into feasibility and impact studies.

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CHAPTER 14

Restricting Groundwater Withdrawals to Protect Water Resources: Economic Impact Assessment

Grace Johns and Lisa A. McDonald

Economic analysis methods have been used in Florida to identify positive and negative financial impacts on those who are required to comply with proposed regulations for protecting water resources. In the Northern Tampa Bay area, economic analyses were used to develop regulations that restrict groundwater withdrawals, while having minimal negative financial impacts to the regulated entities, and to address concerns regarding potential significant negative economic effects. This case study describes how financial and economic analyses were used to establish minimum flows and levels for priority water resources. It also summarizes the environmental resource concerns, the legislative and regulatory actions taken, the purpose and uses of the financial and economic analyses, and the methods and results of selected analyses undertaken during this process.

ENVIRONMENTAL RESOURCE CONCERNS

The Southwest Florida Water Management District is a state agency responsible for managing water resources within all or parts of 16 counties on the west-central coast of Florida. The region supports growing urban areas, significant agricultural production, phosphate mining, and a diverse industrial base. The natural resources of the region include the Green Swamp, which is the headwaters for the Peace, Hillsborough, Withlacoochee, and Ocklawaha rivers, and three national estuaries: the Tampa Bay, Sarasota Bay and Charlotte Harbor estuaries. The area also contains many lakes, springs and streams, including Silver Springs and Weeki Wachi Springs.

One of the District's primary resource management tools is the permitting of freshwater withdrawals from surface and underground sources. Under certain statutory and regulatory conditions, persons who demonstrate a need for freshwater supply are permitted to pump water from the specific freshwater source. The water use permit specifies the maximum annual average daily withdrawal and the maximum daily withdrawal allowed. In most cases, water users who pump less than 100,000 gallons per day, on average, from the source are not required to obtain a water use permit.

The District also regulates development activities that have the potential to impact surface water quality and wetlands, and that can cause changes in stormwater storage and rate of discharge from a project site. These activities are regulated through the issuance of Individual Environmental Resource Permits.

Impact of Groundwater Pumping on Water Resources

The District has identified environmental and water quality impacts caused by concentrated withdrawals for public water supply in the Northern Tampa Bay area, which include:

- Lowered lake levels.
- Reduction in stream flow.
- Destruction of wetland habitat.
- Increased chloride levels in the vicinity of large freshwater withdrawals near the coast.

In response to these impacts, the District initiated a Water Resource Assessment Project (WRAP) in 1987 for the northern Tampa Bay area; Figure 14.1 depicts this Northern Tampa Bay WRAP Area (Southwest Florida Water Management District 1994).

The Floridan aquifer is a major source of public potable water supply to households and businesses in the northern Tampa Bay Area. Historic increases in groundwater pumping from the intermittently confined Floridan aquifer have impacted surface water resources. Impacts from groundwater withdrawals, which have been documented to date, include lake drawdowns, reduction in spring and stream flow and the drying of wetlands. The impacts to these surface water resources have then adversely impacted habitat functions, on which lake- and wetland-dependent species rely. Recreational and aesthetic qualities of these water resources have also been adversely impacted. These impacts are called externalities which, in the context of water resources, are the impacts to third parties as water is withdrawn from aquifers and surface water sources. Externalities that may occur from increased pumping of the Floridan aquifer are as follows.

- Damage to wetlands;
- Damage to lakes;
- Damage to streams and estuaries;
- Damage to uplands;
- Reduction in water quality;
- Land subsidence; and
- Lowered groundwater levels.

These negative externalities create costs to the public in the form of lost benefits and services these impacted ecosystems provide, including healthy and diverse wildlife populations, aesthetics and recreation opportunities.

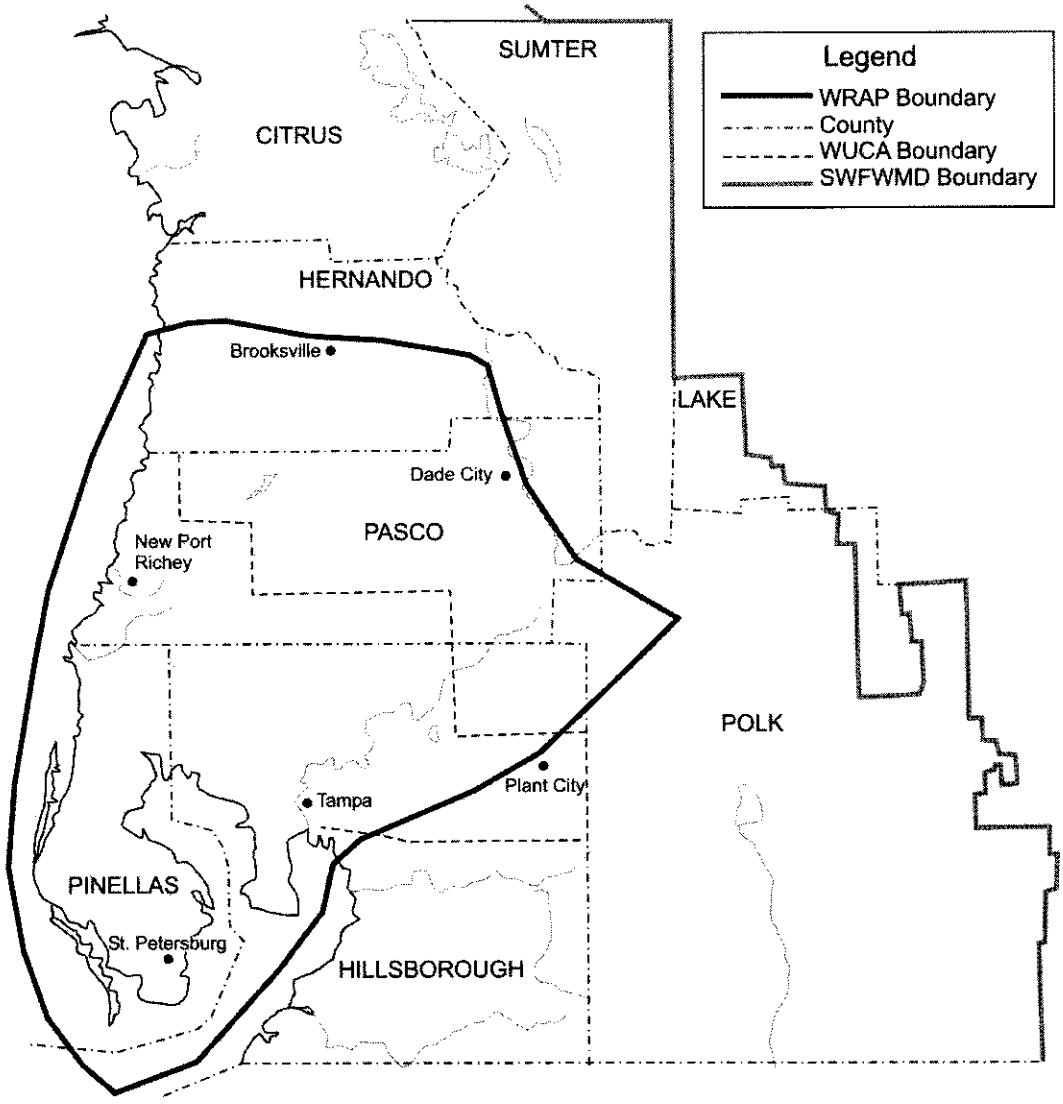

Figure 14.1. Location of the Northern Tampa Bay Water Resources Assessment Project Area.

The lowering of water levels in the surficial and Floridan aquifers can cause adverse impacts to private property owners. These external costs include damages to lakefront property due to lowered lake water levels, damages to agricultural property from the drying up of wells and ponds, and damages to private property from loss of well function, sinkholes and subsidence. In some cases well owners have been compensated for lost well function. In the 1990s, state legislation and District regulatory actions were initiated to address these externalities and their associated costs.

Legislative History and Proposed Regulations

The Florida Water Resources Act, Section 373.042, Florida Statutes, requires the Southwest Florida Water Management District to establish minimum flows or levels for priority water bodies. In response to this mandate, the District initiated efforts in 1996 to adopt minimum flows and levels for the following water resources in the northern Tampa Bay area:

- Floridan aquifer levels and wetland levels within the Northern Tampa Bay Water Resources Assessment Project study area.
- 15 lakes in the northern Tampa Bay area.
- The lower Hillsborough River and the Tampa Bypass Canal.

As a result, in 1998 the District Governing Board approved revisions to the following chapters of Florida Administrative Code:

- Chapter 40D-2, Consumptive Use of Water.
- Chapter 40D-8, Water Levels and Rates of Flow.
- Chapter 40D-4, Individual Environmental Resource Permits.

The actual water levels in some locations of the northern Tampa Bay area are below the proposed minimum levels. District direction regarding this issue is addressed in Section 373, Florida Statutes, which calls for a recovery strategy where the actual flows or levels are below the minimum flows or levels. In 1998, the Governing Board approved a new Chapter 40D-80, F.A.C., *Recovery and Prevention Strategies for Minimum Flows and Levels*. This chapter sets forth the regulatory portion of a recovery strategy for northern Tampa Bay.

In accordance with Section 120.541, Florida Statutes, Hazen and Sawyer prepared a *Statement of Estimated Regulatory Costs (SERC)* for the District. It addressed the requirements of this Section as related to the proposed revisions to Florida Administrative Code as described in the October 1998 Board Approved Version for F.A.W. publication.[1]

The rule revisions set minimum water levels for specific wetlands, lakes and Floridan aquifer locations. Proposed new withdrawals that, in combination with all existing legal withdrawals, cause the water level to fall below the minimum level will not be permitted. Specific exemptions are provided. For quantities already authorized to be withdrawn as of the effective date of the rule and located in areas where existing water levels are below minimum levels, allowable withdrawals by permittees are subject to reconsideration as provided for in the proposed Chapter 40D-80.

The complete prevention and recovery strategy described in Chapter 40D-80, F.A.C. seeks to reduce groundwater pumping and/or its impacts through the development of alternative water supply sources, environmental restoration projects, additional water

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[1] For complete information regarding the results, methods and data associated with the 1998 SERC, please refer to the original document, "Statement of Estimated Regulatory Costs for Revisions to Florida Administrative Code Regarding Minimum Flows and Levels in the Northern Tampa Bay Area," Hazen and Sawyer for the Southwest Florida Water Management District, Brooksville, Florida, November 25, 1998.

conservation programs and water shortage plans. The recovery strategy addresses two groups of water use permittees: (1) Tampa Bay Water (TBW), formerly known as the West Coast Regional Water Supply Authority, and its member governments; and (2) other water use permittees.

Tampa Bay Water develops water sources and provides water, in wholesale amenities, to the public water utilities of the member governments. The 11 water use permits assigned to TBW will be affected by the proposed rule revision. The permits are associated with wellfields referred to as the Central System Facilities. A specific timeline for reducing withdrawals from its Central System Facilities is provided. The withdrawal reductions would be offset by developing alternative water sources and additional water conservation programs. All other potentially affected wells pump significantly less water, on an individual basis, than the Central System wellfields owned by TBW. Therefore, the withdrawals of these "smaller" water use permittees will be addressed on a case-by-case basis at permit renewal.

On October 28, 1998, the District's Governing Board approved these revisions to the Florida Administrative Code. The revised rule went into effect in August 2000 after a scientific peer review and a challenge by certain entities under the Florida Administrative Procedures Act.

PURPOSE OF THE ECONOMIC ASSESSMENT

The assessment of costs associated with groundwater withdrawals and costs associated with reducing withdrawals began in 1996. The external costs associated with groundwater pumping were described but not monetized. Most of the effort was devoted to assessing the costs associated with developing and using alternative water sources as a substitute for a portion of the freshwater that was being pumped from the Central System wellfields. This was because the financial impacts to water utilities and their customers were of primary concern.

Through water utility financial modeling, Hazen and Sawyer made estimates of the reductions in wellfield withdrawals that could be replaced with alternative water sources while keeping customer water bills affordable. This information assisted the District in developing regulatory approaches that minimize negative financial and economic impacts while achieving the intent of Chapter 40D-80, F.A.C., *Recovery and Prevention Strategies for Minimum Flows and Levels.*

A major benefit of preparing a Statement of Estimated Regulatory Costs (SERC) is to address water utility, business and community concerns regarding potential significant negative financial and economic effects of proposed regulations. This can be achieved by evaluating the potential financial and economic impacts of the proposed rules and distributing the results to the public, prior to rule adoption, including the associated data and methods presented in layman's terms. Another benefit of a SERC is that it describes, in layman's terms, the requirements of households, businesses and government entities so that they can have a clear explanation of the actions they will have to take.

FINANCIAL AND ECONOMIC IMPACTS TO TAMPA BAY WATER, MEMBER GOVERNMENTS AND WATER CUSTOMERS

The West Coast Regional Water Supply Authority (WCRWSA) was established by the Cities of Tampa and St. Petersburg and the Counties of Hillsborough, Pasco and Pinellas in 1974. Each of these entities served as members of the WCRWSA Governing Board. WCRWSA was created for the purpose of developing, storing and supplying water for county or municipal purposes. One of its objectives is to supply this water while giving "priority to reducing adverse environmental effects of excessive or improper withdrawals of water from concentrated areas."[2] Under the recent Interlocal Agreement, New Port Richey is also a voting member of WCRWSA. In July 1998, the name "WCRWSA" was changed to Tampa Bay Water (TBW). The proposed Chapter 40D-80 refers to the five voting members as "member governments." TBW and its members control 15 ground and surface water supply sources in Pasco, Hillsborough and Pinellas counties.

Similar withdrawal reductions from the Central System wellfields that are required of TBW under the proposed rule revisions were already being sought under current rule. The primary difference is that the current rule addresses each permit renewal and application on a case-by-case basis, whereas the rule revisions address the combined groundwater withdrawals of facilities which serve Tampa Bay Water and its member governments while including provisions for other water use permittees.

In 1996, the Tampa Bay Water Board approved a Master Water Plan that identified and prioritized alternative water source development and other projects and activities with a schedule for implementation. On May 14, 1998, TBW, its members and the District approved the Northern Tampa Bay New Water Supply and Groundwater Withdrawal Reduction Agreement (also known as the Partnership Plan). Under this Partnership Plan, the District has agreed to provide $183 million, under certain conditions, to assist TBW in developing 85 mgd (million gallons daily) of water from new water sources. This Partnership Plan is referred to in the new Chapter 40D-80 as the method by which TBW and its member governments will implement a recovery strategy.

Tampa Bay Water prepared a document titled "New Water Plan" (June 15, 1998), as required under the Partnership Plan. The New Water Plan is a conceptual document that describes the new water supply projects anticipated for development over the next ten years along with a schedule for implementation and completion, expected water yields and expected costs. The TBW Board approved the New Water Plan and submitted it to the District. In general, the recommendations were consistent with those of the 1996 Master Water Plan.

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[2] Chapter 373.1962, F.S., "Water Resources - Regional Water Supply Authorities," and West Coast Regional Water Supply Authority, "Water Resource Development Plan," July 8, 1994, page 1-1.

Chapter 40D-80 and the Partnership Plan provide for a recovery strategy to bring wetland and lake levels toward the proposed minimum levels as established in Chapter 40D-8, F.A.C. The Partnership Plan specifies the water quantities which may be withdrawn from the Central System Facilities through 2010, and these quantities are based primarily upon implementation of the TBW Master Plan and the New Water Plan.

Financial and Economic Impact Model

During the rule-making process, the financial and economic impacts of the proposed rule revision to Tampa Bay Water and its member governments relative to current wellfield pumpage and planned alternative source development were evaluated. In addition, the affordability of household water bills was assessed. The example provided below compares the costs of the rule revision and the Partnership Plan with the costs of continued pumping from the Central System facilities at current pumping levels and the development of alternative water sources, as described in the 1996 TBW Master Plan and the 1998 New Water Plan.

The Tampa Bay Water Financial Model is a spreadsheet model developed by the SERC project team. It provides estimates of the 20-year financial and economic impacts to TBW and its members from proposed allowable water withdrawal alternatives from the Central System facilities, as described in the Partnership Plan. The model considers the costs of new water sources to supply increased future demand and to replace reductions in allowable withdrawals from existing water sources as defined under the baseline and alternative conditions of allowable wellfield withdrawals. Water from these sources is distributed to the member governments as needed. For a defined baseline condition and alternative condition, the model:

- Supplies current and future water demands of the member governments with water from existing sources up to the allowable withdrawal limits.

- Adds new water supplies to the system to supply new water demands or to replace withdrawal cutbacks.

- Estimates the change in total water costs to TBW and member governments from an alternative condition of allowable wellfield withdrawals relative to a baseline condition of allowable wellfield withdrawals.

- Estimates the change in household water bills due to the alternative condition and relative to the baseline condition.

- Estimates the affordability of household water bills.

The model was used to estimate the impact of the proposed rule revisions on the total water supply costs of TBW and its member governments and household utility bills. The method of allocating costs of TBW facilities, including the alternative (new) water sources, is based on the cost allocation to each member government described in the Amended and Restated Interlocal Agreement Reorganizing TBW. The counties of Hillsborough, Pasco and Pinellas, and the cities of St. Petersburg, Tampa and New Port Richey entered into this agreement on May 1, 1998.

This Interlocal Agreement includes the termination of existing contracts and expansion of the TBW with system-wide service. It also provides for TBW to purchase certain water supply facilities from the member governments and to charge a uniform rate per 1,000 gallons to each member government. The funding sources used in the model include the $183 million of District funding for alternative water source development. The remaining costs are financed by water utility customers.

The modeling results described in this chapter use the uniform rate billing method, the $183 million of District funding, and transfer payments from Tampa Bay Water to member governments for water supply facilities transferred to TBW as described in the Interlocal Agreement. The study period is 1998 to 2017, a 20-year planning period. The baseline and alternative conditions are summarized as follows.

Baseline Condition. The baseline condition allows for current wellfield pumpage and planned alternative source development of TBW and its member governments. TBW develops alternative water sources as described in the 1996 TBW Master Plan and the 1998 New Water Plan. In June 1998, TBW provided the schedule by which the alternative water sources would come on-line.

Alternative Condition. The alternative condition is identical to the baseline condition except that allowable withdrawals from the Central System facilities are as described in the Partnership Plan. The allowable withdrawals are as follows.

- 1998 through 2002: No more than 158 mgd.
- 2003 through 2007: No more than 121 mgd.
- 2008 through 2010: No more than 90 mgd.
- After 2010: Quantity will be determined based upon an evaluation of the water resources recovery accomplished.

Because the study period evaluated in this model extends to 2017, the allowable pumpage from the Central System facilities is kept at 90 mgd from 2011 to 2017. Alternative water sources are brought on-line as anticipated under TBW's New Water Plan.

Impacts to Tampa Bay Water and Its Members

With two exceptions, the baseline condition and the alternative condition are identical in terms of the types of alternative water sources constructed, the average daily quantities available from each alternative source, the costs, timing of debt service payments and the year when the source becomes operational. The exceptions are as follows:

- While potable water from seawater desalination comes on line in 2002 under both conditions, the average daily quantity is 23 mgd under the baseline condition and 26 mgd under the alternative condition.

- Under the alternative condition, beginning in the year 2014, 17.5 mgd is provided by the Alafia River Project as described in the New Water Plan. Alternatively, additional seawater or brackish water desalination could be developed.

There are two differences between the costs under the baseline condition and the alternative condition as they affect TBW and its members. First, because more water is available from the Central System wellfields under the baseline condition, TBW and its members can pump more water from these facilities than under the alternative condition. The annual operations and maintenance (O&M) costs of the alternative sources are typically higher than the annual O&M costs of the Central System wellfields. Thus, the total water supply cost to all members associated with the alternative condition is higher than under the baseline condition. The second difference is due to the capital and operations costs associated with the additional alternative water sources developed under the Alternative Condition.

The forecasts of water use, water supply and excess water supply under the Baseline and Alternative Conditions are provided in Tables 14.1 and 14.2, respectively. Under the baseline condition, TBW and its member governments have about 68 mgd of excess supply by the year 2005 and 60 mgd of excess supply by the year 2010. There is more than 40 mgd of excess supply through the year 2017. Under the alternative condition, excess supply is about 48 mgd in 2005 and 15 mgd in 2017. This indicates that the 1996 TBW Master Plan and the 1998 New Water Plan are consistent with reducing withdrawals from the Central System facilities, as described in the proposed Chapter 40D-80 and the Partnership Plan. Therefore, the financial impact of the proposed rule revision is negligible, because alternative water sources are being planned by TBW which will provide sufficient water supply to offset the recommended cutbacks in pumping from the Central System wellfields.

Impacts to Households. Impacts to households and the average household water bill vary among the member governments. The modeling results for each member government are presented in Table 14.3. Under the baseline condition, the estimated average monthly household water bill ranges from $10 to $21 in 1998 and from $11 to $39 in

TABLE 14.1. FORECASTS OF WATER USE AND WATER SUPPLY OF TAMPA BAY WATER AND MEMBER GOVERNMENTS BASELINE CONDITION.*

Year	1998	2000	2005	2010	2015	2017
Water Use — All Water Demand Planning Areas	238.4	244.4	252.3	260.6	269.1	272.7
Water Supply — Central System Facilities	147.1	152.1	143.3	143.3	143.3	143.3
Water Supply — Other Facilities	94.8	94.8	94.8	94.8	94.8	94.8
Water Supply — Alternative Water Sources						
Cypress Bridge Permit Increase	0.0	0.0	4.0	4.0	4.0	4.0
Brandon Urban Wellfield	0.0	0.0	8.0	8.0	8.0	8.0
Cone Ranch Dispersed Wells	0.0	0.0	12.0	12.0	12.0	12.0
Hillsborough Bay Resource Exchange	0.0	0.0	35.0	35.0	35.0	35.0
Seawater Desalination	0.0	0.0	23.0	23.0	23.0	23.0
Water Supply — Alternative Sources	0.0	0.0	82.0	82.0	82.0	82.0
Water Supply — All Sources	241.9	246.9	320.1	320.1	320.1	320.1
Excess Supply	3.5	2.5	67.8	59.5	51.0	47.4

* Million gallons per day

TABLE 14.2. WATER USE AND WATER SUPPLY OF TBW AND MEMBER GOVERNMENTS ALTERNATIVE CONDITION.*

Year	1998	2000	2005	2010	2015	2017
Water Use — All Water Demand Planning Areas	238.4	244.4	252.3	260.6	269.1	272.7
Water Supply — Central System Facilities	147.1	152.1	121.0	90.0	90.0	90.0
Water Supply — Other Facilities	94.8	94.8	94.8	94.8	94.8	94.8
Water Supply — Alternative Water Sources						
Cypress Bridge Permit Increase	0.0	0.0	4.0	4.0	4.0	4.0
Brandon Urban Wellfield	0.0	0.0	8.0	8.0	8.0	8.0
Cone Ranch Dispersed Wells	0.0	0.0	12.0	12.0	12.0	12.0
Hillsborough Bay Resource Exchange	0.0	0.0	35.0	35.0	35.0	35.0
Seawater Desalination	0.0	0.0	26.0	26.0	26.0	26.0
Alafia River	0.0	0.0	0.0	0.0	17.5	17.5
Total Alternative Sources	0.0	0.0	85.0	85.0	102.5	102.5
Water Supply — All Sources	241.9	246.9	300.8	269.8	287.3	287.3
Excess Supply (million gallons per day)	3.5	2.5	48.5	9.2	18.2	14.6

* Million gallons per day

2017 (in 1997 dollars). Under the alternative condition, the estimated average monthly household water bill ranges from $10 to $21 in 1998 and from $12 to $41 in 2017 (in 1997 dollars).

Because the baseline and alternative conditions are very similar from 1998 to 2010, the percent increase in the average monthly household water bill to customers under the alternative relative to the baseline is small, ranging from 0.1 percent to 12 percent, depending on the water utility. After 2010, the water bill under the alternative condition ranges from about five percent to 19 percent higher than under the baseline condition depending on the water utility.

Over the next twenty years, the water bill under the alternative condition will be no more than 20 percent higher than it would be under the baseline condition. For water customers of Pasco County and the City of Tampa, the water bill by the year 2017 under the alternative condition will be about five percent higher than under the baseline condition. For water customers of Hillsborough County and Pinellas County, water bills will be about 13 percent to 16 percent higher, respectively. For water customers of the Cities of New Port Richey and St. Petersburg, the water bill will be from 18 percent to 19 percent higher, respectively.

Under both the baseline and the alternative conditions, the average household water bill is less than two percent of annual median household income for all the member utilities. The size of the water bills under the alternative condition are considered reasonable according to U.S. EPA guidelines.

CONCLUSIONS

Throughout this rulemaking process, the financial and economic analyses of affected entities found that the proposed rule could be designed to minimize financial and economic impacts while meeting water management goals. Household water bills will still be affordable after alternative water sources are developed to compensate for the reduction in water pumped from the Central System well fields. While investments in alternative water sources will increase employment and income, at least some of these increases would be offset by the lost purchasing power of households and businesses who will be paying higher water bills. Because the U.S. EPA set guidelines regarding the affordability of water bills, the SERC project team relied on these guidelines in lieu of evaluating any household consumption adjustments that would have to be made to afford any increases in water costs.

The results of these analyses provided information to the District, affected entities and the public regarding the financial and economic impacts from proposed changes in water use permitting and environmental resource permitting. This information addresses business and community concerns, and assists in the design of regulations which minimize negative financial and economic effects while meeting water management goals.

TABLE 14.3. FINANCIAL AND ECONOMIC IMPACTS OF WATER USE REGULATIONS ON AVERAGE HOUSEHOLD WATER BILLS (7,480 GALLONS/ MONTH/ HOUSEHOLD).

Member\Impact	1998	2000	2005	2010	2015	2017
PASCO COUNTY						
Baseline water bill	$18.21	$21.12	$27.26	$32.36	$37.11	$39.10
Alternative water bill	$18.23	$21.14	$27.71	$33.42	$38.80	$40.74
Percent difference	0.1	0.1	1.7	3.3	4.5	4.2
Alternative bill as a percent of median household income	0.9	1.0	1.2	1.4	1.5	1.5
PINELLAS COUNTY						
Baseline water bill	$16.88	$17.39	$19.44	$19.72	$19.40	$19.37
Alternative water bill	$16.92	$17.42	$20.32	$21.73	$22.60	$22.49
Percent difference	0.2	0.2	4.5	10.2	16.5	16.1
Alternative bill as a percent of median household income	0.6	0.6	0.6	0.6	0.6	0.6
CITY OF ST. PETERSBURG						
Baseline water bill	$16.69	$17.12	$19.52	$19.88	$19.70	$19.76
Alternative water bill	$16.74	$17.16	$20.58	$22.32	$23.59	$23.54
Percent difference	0.3	0.2	5.4	12.3	19.7	19.2
Alternative bill as a percent of median household income	0.9	0.9	1.0	1.0	1.0	1.0
HILLSBOROUGH COUNTY						
Baseline water bill	$20.69	$22.00	$25.37	$26.87	$27.75	$28.47
Alternative water bill	$20.73	$22.04	$26.37	$29.17	$31.43	$32.05
Percent difference	0.2	0.2	3.9	8.6	13.2	12.6
Alternative bill as a percent of median household income	0.8	0.8	0.9	0.9	0.9	0.9
CITY OF TAMPA						
Baseline water bill	$10.15	$10.35	$10.54	$10.76	$10.97	$11.05
Alternative water bill	$10.15	$10.36	$10.64	$11.03	$11.51	$11.60
Percent difference	0.0	0.0	0.9	2.6	4.9	5.0
Alternative bill as a percent of median household income	0.5	0.5	0.4	0.4	0.4	0.4
CITY OF NEW PORT RICHEY						
Baseline water bill	$12.85	$14.31	$15.67	$15.64	$15.15	$15.07
Alternative water bill	$12.88	$14.34	$16.44	$17.41	$17.97	$17.82
Percent difference	0.2	0.2	4.9	11.3	18.6	18.2
Alternative bill as a percent of median household income	0.6	0.7	0.7	0.7	0.7	0.7

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CHAPTER 15

Economic Impact of the Florida Net Ban in Monroe County

Manoj Shivlani, David Letson and Christian Read Sawczyn

In November 1994, 2.8 million Floridians voted to eliminate the use of gill and other entangling nets within inshore state waters. Commonly referred to as the net ban, Amendment 3 affected thousands of commercial fishers across the state of Florida, who were forced to fish further offshore, invest in other fisheries or abandon fishing altogether. While the effects of the net ban were evident in central and western Florida, where a majority of inshore users primarily targeted single species, the effects were less clear in the Florida Keys, particularly the economic implications for fishers. Some of these fishers moved into offshore fisheries with consequent changes for economic activity in the region.

Highly diversified and spread across the Gulf of Mexico, Florida Bay and the South Atlantic, commercial fishers from Monroe County have traditionally targeted a variety of species such as spiny lobster and stone crab, and fished a host of locations to sustain their income (Milon et al. 1997). With statewide passage of a referendum that eliminated the use of gill and other entangling nets in Florida waters (up to three miles into the Atlantic and up to nine miles into the Gulf of Mexico), fishers were forced to make significant changes, among them, in fishing locations and gear and equipment. To determine what those effects were in the Florida Keys (Figure 15.1), a study was undertaken to identify and characterize the net fishers in the region, determine the economic costs of diversification into other fisheries and calculate the catch-per-unit-

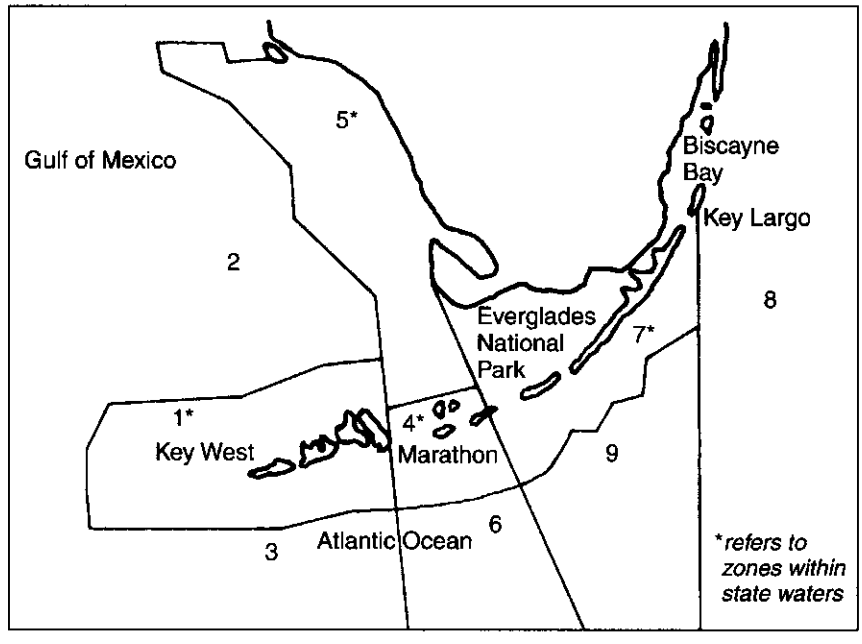

Figure 15.1. Map of the study region.

effort (CPUE) profiles in net and other fisheries. The net ban, while effective in reducing catch in the major net fisheries of the region, may have incidentally displaced effort into other, already exploited fisheries. Policy makers adopting gear restrictions, such as a net ban, must balance the benefits of fishing effort reduction with costly displacements of fishers into other targeted species and fishing grounds.

ECONOMIC ANALYSIS

Our study attempts to document the economic impact of the net ban on the local, commercial, net fisher population of the Florida Keys. Based on preliminary surveys conducted with existing fish houses, we learned that 67 net fishers operated in the region in 1994, the year prior to the net ban. That total diminished by 55 percent in 1996 to 30 fishers. We contacted and interviewed all 30 commercial fishers in person in order to conduct a comprehensive survey designed to provide information on three major concerns: demography of commercial harvesters, investment and catch profiles. The 30 net fishers we contacted represented about one percent of the 2,800 commercial harvesters holding Saltwater Product Licenses in 1996. To determine the impact of the 1994 net ban, the survey solicited investment information and catch profiles prior to 1994 and afterwards, in 1996. Net fisher surveys were exhaustive: interviews ranged from 20 minutes to over three hours, with an average duration of 45 minutes.

In addition to compiling survey profiles from each interview, we created a database for the net fisher surveys. Thus, both qualitative and quantitative information was collected from the fieldwork. We developed the net fisher survey questionnaire between July and August 1997, and conducted field interviews between September 1997 and February 1998. For the net fisher questionnaire, see the Division of Marine Affairs and Policy, University of Miami, web site: www.rsmas.miami.edu/divs/netban.pdf.

RESULTS OF SURVEY OF FISHERS AFFECTED BY THE NET BAN

The personal interviews yielded information about the demography of Monroe County fishers who were affected by the net ban and the shifts in their investments and catches prior to 1994 and in 1996, when they could no longer employ gill and other entangling nets in inshore waters. Sawczyn (1998) gives a more comprehensive description of the findings.

General and Demographic Information

Of the 30 net fishers surveyed, 72 percent were older than 40 years. Only ten percent were Hispanic/Cuban fishers, even though there is a greater diversity in the general fisheries of the region (Milon et al. 1997). More than half of the fishers surveyed had been net fishing in the Florida Keys for over 20 years, while 20 percent had net fished less than 10 years (Figure 15.1). Net fishers in the Lower (Area 1) and Middle (Area 4) Keys made up a majority, or 97 percent, of the sample; this skewed distribution is attributable to the net fishing grounds in those regions. Everglades National Park

represented the only shallow area suitable for net fishing in the Upper Keys and was closed to commercial fishing in 1986 (Marine Fisheries Commission 1993).

Investments in Fishery Gear and Maintenance, 1994 and 1996

Following the net ban, commercial fishers changed a majority of their investment profiles, thus indicating a shift of effort into other fisheries, which were already fully exploited. Tables 15.1, 15.2, and 15.3 summarize changes in investments, gear and maintenance costs. The total value of vessel investment in the fishery declined from over $3 million in 1994 to just over $2.6 million in 1996. Three respondents each reported selling one of their vessels in that time period. The average value of vessels decreased from 1994 to 1996 as well, declining 14.3 percent in that period (Table 15.1).

Changes in gear investments depended on the gear type and species targeted. As would be expected, the average number of nets and net costs declined from 1994 to 1996. Fishers held a total of 231 nets in 1994 compared to 120 nets in 1996 Similarly, the average investment in nets declined nearly 28 percent, from $53,779 in 1994 to $42,135 in 1996.

While the number of net fishers from the sample in the spiny lobster fishery declined from 83 percent in 1994 to 77 percent in 1996, the average amount of trap investments and the number of traps increased by 14.2 percent (Table 15.1) and 7.8 percent, respectively (Table 15.2). Therefore, net fishers did invest moderately in the lobster industry following the net ban. Their entrance into the fishery may, however, have been impeded by the limited-entry structure of the Spiny Lobster Trap Certificate Program (Milon et al.1998; Hunt 1994). Also, since trap certificate prices had increased substantially (from $2 and $5 in 1992 to more than $50 in 1997) (Milon et al. 1998; Shivlani and Milon 2000), the moderate increase in traps may represent a much higher investment than indicated by the changes in trap counts.

Unlike the spiny lobster fishery, the number of net fishers did not decrease in the stone crab industry following the net ban. However, the percentage did not increase either, due primarily to a Marine Fisheries Commission moratorium placed on stone crab licenses in 1995 (Florida Statute CH 370.13 (6) (a)). Over 83 percent of the sample fished for stone crab in 1994 and 1996. But the average number of traps increased by 8.3 percent (Table 15.2) during that time, and the average investment in the fishery increased by 16.8 percent (Table 15.1). Therefore, although no new net fishers entered the stone crab fishery after the net ban, those who fished stone crab considerably increased their effort in the fishery between 1994 and 1996.

Finally, maintenance costs changed after the net ban. In 1994, the respondents spent an average of almost $4,992 on net maintenance, which declined by 16 percent in 1996, to $4,213 (Table 15.3). Conversely, the average costs for trap maintenance increased by almost 54 percent from 1994 to 1996. Although costs associated with vessel maintenance may not demonstrate the overall shifts in costs since the net ban, the trap and net maintenance costs strongly indicate that net fishers have transferred their efforts from nets to traps since the net ban.

TABLE 15.1. 1994 VERSUS 1996 INVESTMENTS.

Investment	1994 Average Cost[1]	1996 Average Cost[1]	Percent Change
Vessel(s)	106,603	91,413	–14.3
Net(s)	53,779	42,135	–21.7
Spiny lobster traps	18,390	21,007	+14.2
Stone crab traps	20,611	24,082	+16.8
Hook-and-line gear	1,228	1,133	–7.7

[1] In dollars.

TABLE 15.2. 1994 VERSUS 1996 GEAR TOTALS.

Gear	1994 Average Total[1]	1996 Average Total[1]	Percent Change
Net(s)	7.9	5.7	–27.8
Spiny lobster traps	1,103	1,189	+7.8
Stone crab traps	1,377	1,491	+8.3

TABLE 15.3. 1994 VERSUS 1996 MAINTENANCE COSTS.

Maintenance	1994 Average Cost[1]	1996 Average Cost[2]	Percent Change
Dockage	3,662	3,647	–0.4
Vessel maintenance	10,759	12,654	+17.6
Net maintenance	4,992	4,213	–15.6
Trap maintenance	5,786	8,892	+53.7

[1] In dollars.

Catch Profiles: 1994 vs. 1996

Catch profiles changed for several species after the net ban (Table 15.4). Trap fishery totals were similar between 1994 and 1996, although the catch-per-unit-effort (CPUE) did decline in both the spiny lobster and stone crab fisheries. Also, no major changes occurred in the catch profiles of reef fish, pelagics or king mackerel due to the net ban. Although king mackerel catch declined from 565,500 pounds in 1994 to 412,500 in 1996, that was due to the fishery closing after reaching total allowable catch (MSAP 1998).

The harvest of all inshore net species (Spanish mackerel, baitfish and pompano; Table 15.4) declined considerably after the net ban. For example, baitfish landed in 1996 were less than a third of the 1994 total, while the number of fishers in the sector decreased by 70 percent. Three fishers landed only 16,500 pounds of pompano in 1996, compared with the 99,800 pounds landed by 11 fishers in 1994. However, the most precipitous decline was observed in Spanish mackerel landings: harvests plummeted to 41,000 pounds in 1996, from almost 1.2 million pounds in 1994. Of the 18 fishers in 1994, only 5 fished Spanish mackerel in 1996. While the total allowable catch for Spanish mackerel in the Gulf of Mexico in 1995-96 was 8.6 million pounds (MSAP 1998), commercial landings were less than 1.1 million pounds, down from 2.5 million pounds in 1994-95 (the year prior to the net ban). Total catch of the Gulf of Mexico stock of Spanish mackerel in 1995-96 was only 2.65 million pounds.

Because the ban relegated net fishers from inshore waters, the respondents who did net fish in 1996 did so in federal waters. Figures 15.2, 15.3 and 15.4 show changes in spatial fishing patterns for net-caught species from 1994 to 1996, namely Spanish mackerel, baitfish and pompano. As Figure 15.2 indicates, more than half the Spanish mackerel landed in 1994 were caught within state waters west of Marathon (Area 1). Net fishers also harvested a significant percentage within state waters in the Middle Keys (Area 4). Since the net ban, the effort has shifted primarily to federal waters in the Gulf of Mexico (Area 2). Unlike 1994, fishers could no longer target inshore Middle Keys waters. Figure 15.3 shows that the respondents targeted baitfish, harvested only with

TABLE 15.4. 1994 VERSUS 1996 CATCH AND USER TOTALS.

	Total Catch[1]		CPUE[2]		User Total	
Fishery	1994	1996	1994	1996	1994	1996
Lobster	464,200	428,900	16.8	15.7	23	22
Stone crab	128,400	113,000	4.2	3.4	21	17
Reef fish	37,250	41,750	142.2	203.7	10	8
Pelagics[3]	8,500	6,000	164.6	222.2	4	2
King mackerel	565,500	412,500	5,707.0	4,532.9	12	13
Spanish mackerel	1,171,600	41,000	3,376.0	1,138.9	18	5
Baitfish	1,729,700	501,700	2,089.0	2,866.9	10	3
Pompano	99,800	16,500	397.6	311.3	11	3

[1] Total catch estimated in number of pounds.
[2] CPUE for spiny lobster and stone crab fisheries refers to pounds per trap per season; all other CPUE estimates are based on the number of pounds landed per trip.
[3] Pelagics refers to offshore species, such as dolphin, cobia, and tunas.

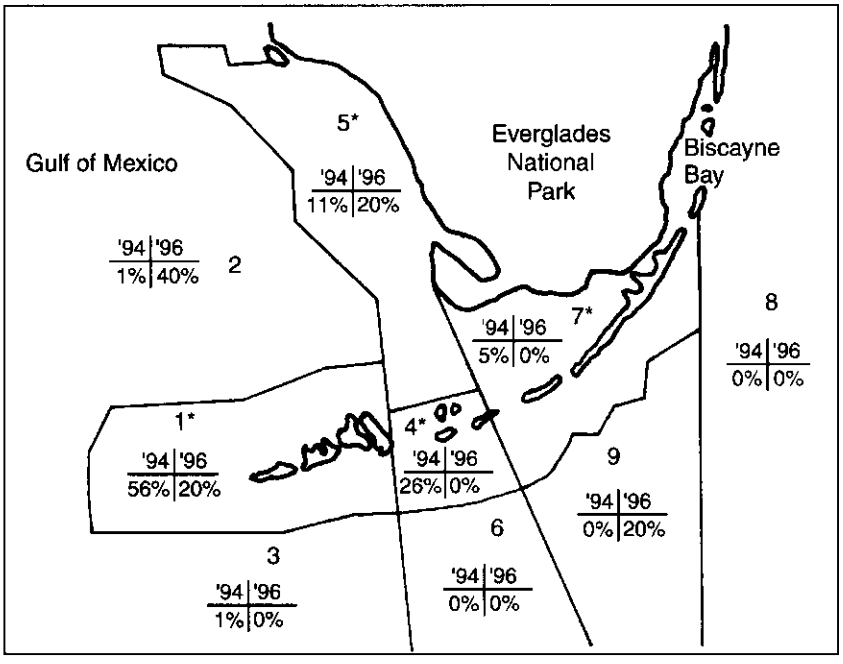

Figure 15.2. Percentage of Spanish mackerel catch, 1994 and 1996.

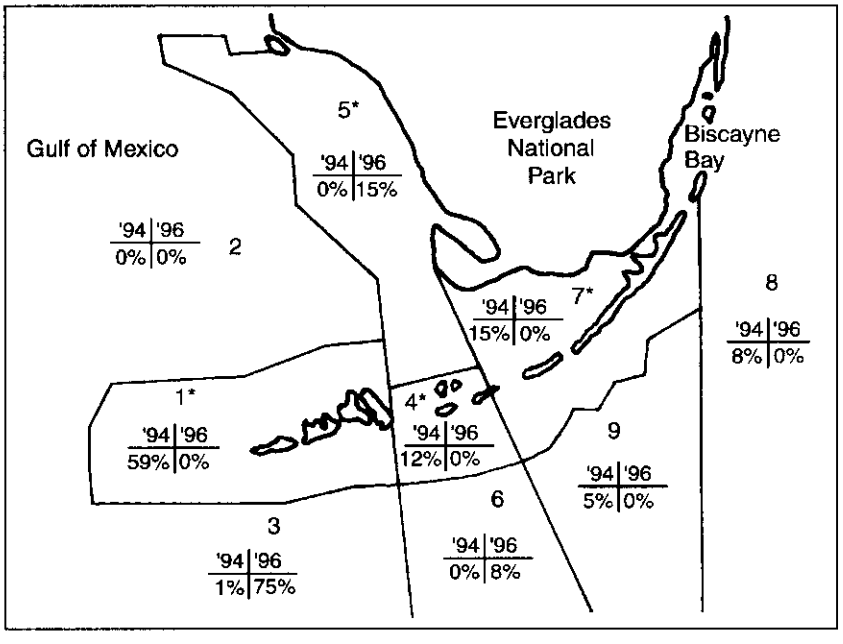

Figure 15.3. Percentage of bait fish catch, 1994 and 1996.

nets, almost exclusively in state waters in 1994 (Areas 1, 4 and 7). After the net ban, fishers moved into offshore waters both north into the Gulf of Mexico and south into the Atlantic Ocean (Areas 3 and 5) to harvest baitfish. Finally, pompano catch patterns (Figure 15.4), which were primarily inshore in 1994 (Areas 1 and 4), shifted offshore after the net ban (Areas 3 and 5).

The shift by fishers to other areas and gear has meant either higher operating costs or declining catch. Interestingly, the only net fishery in which operating costs have increased since the net ban has been the baitfish industry. Trip costs have increased in that fishery from an average of $94.5 per trip in 1994 to $147.3 per trip in 1996. Operating costs have not increased in the Spanish mackerel ($263.9/trip in 1994 versus $226/trip in 1996) or pompano ($159.6/trip in 1994 versus $121.3/trip in 1996) fisheries. However, a major reason for lower operating costs in these fisheries is due to fewer mates employed per trip. Several mackerel fishers explained that they no longer take 4 or 5 mates on Spanish mackerel trips because of the erratic supply in offshore waters. Though this change in crew size greatly lowers operating costs, it also affects the ability of the fishers to harvest large totals. In addition, trip costs are lower in these fisheries because more fishers now utilize other, cheaper gear to target these species, such as hook and line gear. Even though the operating costs of fishing alternate gear and utilizing less labor are lower, these changes have not improved the overall catch per unit effort.

IMPLICATIONS OF ANALYSIS

The Florida Net Ban in effect reallocated fish stocks to recreational fishers at the expense of commercial fishers (Barnes 1995). Economic analysis can contribute to policy discussions as to whether this reallocation was efficient or fair. While we do not yet know what additional recreational catches the net ban enabled or what values recreational fishers may have for them, our study has documented the cost of the net ban to commercial fishers.

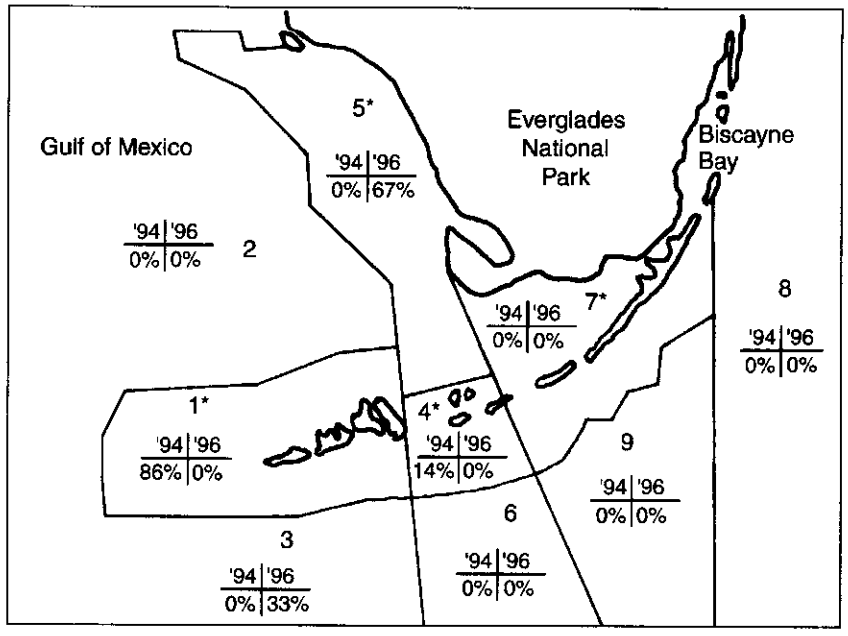

Figure 15.4. Percentage of pompano catch, 1994 and 1996.

From a fishery management perspective, the net ban in the Florida Keys was an inefficient way to restrict fishing effort and is highly selective in the population of fishers it targets. None of the species landed by nets within state waters were seriously overexploited (MSAP 1998). Net fishers harvested only Spanish mackerel and baitfish in large quantities; the other species, including pompano and mullet, were targeted according to their seasonal abundance and mostly on a subsistence basis (DeMaria 1996). The net ban reduced commercial harvest of these species (drastically in the case of Spanish mackerel), and forced remaining users into offshore waters and other fisheries. While net fishers could not enter the limited-entry spiny lobster and stone crab fisheries, those who were already participants in these fisheries increased their effort following the net ban. The overall effect of the net ban in the Florida Keys was minor, mainly because of the small number of individuals affected. In the Florida Keys, 37% of the original 67 fishers left net fishing. However, that total of 67 represents only approximately 2 percent of the Keys fishing population. Similarly, there were declines in the three main net fisheries in the Florida Keys in 1996, but that does not indicate negative effects to the overall fishing output of the region. The study demonstrates, however, that such indiscriminate gear restrictions can increase effort within the affected fisheries by moving fisheries offshore, displace fishers into other fisheries, and reduce local production of some species.

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ACKNOWLEDGEMENT

We gratefully acknowledge research funding from a University of Miami research grant. We also gratefully acknowledge publication permission from the Florida Geographer, where a longer version of this paper appeared in Vol. 29, in 1998.

APPENDICES: ECONOMIC VALUATION METHODOLOGIES

CHAPTER 16

FLORIDA NATURAL RESOURCE USE VALUE DIGEST

Frederick W. Bell

METHODOLOGIES FOR ESTIMATING USE VALUE OF NATURAL RESOURCES

Contingent Valuation Method (CVM)

In its simplest form, this method consists of asking questions to the user of a natural resource with respect to what they would either be willing to pay (WTP) or willing to sell the right to use a specific resource such as a day at the beach. This method may be open-ended where respondents (i.e., users) are asked to state their WTP. In other cases, respondents may be given a dollar figure for the natural resource use and asked to respond "yes" or "no." In this way, the respondent has a dichotomous choice. There are many statistical techniques that can be used in conjunction with the dichotomous choice such as the Turnbull Distribution; logit; and probit methods to arrive at the use value of the natural resource. In the digest that follows, the user will have to either consult the annotated bibliography or the original citation to explore how the contingent valuation method (CVM) was implemented and what particular statistical techniques were used.

Travel Cost Method (TCM)

This method employs the relationship between number of trips (or days) to the site of the natural resource and the travel cost to the site. It is hypothesized that the number of days will decline as travel cost increases for the individual and groups of people at a particular site. The travel cost is calculated in terms of expenses to get to the site, sometimes on-site costs, and may include the opportunity cost of time (i.e., a user could be working rather than recreating). The digest simplifies analysis by using two classes of the travel cost method: (1) The TCM using travel cost and/or the opportunity cost of time and (2) the random utility model (RUM), which employs not just one site, but all alternative sites that could be chosen.

All Other Methods (HPM; MPM)

This third classification is meant to include all other approaches other than the CVM and the TCM discussed above. This includes the hedonic pricing models (HPM) where actual market prices of good related to natural resources are used in conjunction with

attributes of these goods. For example, housing prices may be used to reflect the WTP for air quality, a natural resource. Another method employs the marginal productivity of a natural resource to a user group to estimate the market value of that resource when it is not ordinarily priced in a market such as wetlands. There are numerous other methods that have been used to estimate use value of the resource. These are usually variations of the CVM discussed above.

A LISING OF GENERAL TOPICS IN THE USE VALUE DIGEST (SEE TABLE 16.1)

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HOW TO USE THE USE VALUE DIGEST

If you would like to know the use value found in the literature for a particular natural resource and/or recreational activity using that natural resource, first refer to the above listing or categories of resources. For example, if a beach has been damaged by oil, you might want to know the range of beach use values found at various places in the State of Florida. Look under beaches. A fishery may be reduced in abundance because of a toxic spill. In this case, you may wish to look at the use values found for various groups or species of fish. When you have found the relevant category, we have listed the authors of the study first followed by, in most case, the WTP (willingness to pay) per day. This is the "use value" with which the use value digest is concerned. The WTP/day is followed by more specifics on what the number refers to such as location of the resource and kinds or species. For example, if you look under fisheries, you may

be concerned with king mackerel. This is found in the last column of the digest along with whether the number refers to residents (R) of Florida or visitors from outside this area (V). Of special significance, please look at the numbers in parentheses. These are footnotes to the digest that give qualifications to the entry. Be sure to read these carefully. For example, a king mackerel daily use value may only refer to that segment of the industry involved in charter boat fishing. Finally, be sure to consult the annotated bibliography (Chapter 17) cited in the digest to get a fuller description of the study and where the original study may be found. If any problem arises in obtaining the original study, please call the NOAA Economist at 301-713-3000, ext. 138. It is hoped that this will be a useful tool for all persons interested in use value of a resource. Remember, the "use value" is the willingness of the user to pay for the use of a natural resource for which there is no organized market for exchange.

TABLE 16.1. A COMPREHENSIVE INVENTORY OF USE VALUE PER UNIT OF TIME FOR RECREATIONAL/OTHER NATURAL RESOURCES IN FLORIDA COMPILED FROM THE ANNOTATIVE BIBLIOGRAPHY IN 1998 DOLLARS.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine					
Fisheries (A) Values per Unit of Time					
	Arndorfer & Bockstael (1986)	$269-$982	TCM	Gulf of Mexico/ King Mackerel[1]	R/V
	Leeworthy (1986)	$68	TCM	All Florida/ King Mackerel[2]	R/V
	Leeworthy (1997)	$69	TCM	Florida Keys/ All Species	R/V
	Platt (1989)	$70	TCM	Destin/Panama City/Grouper[1]	R/V
	Green (1989)	$94	TCM	All Florida/ Red Drum	R/V
	McConnell & Strand (1994)	$107	RUM	All Florida/ All Species	R/V
	Glasure (1987)	$24	TCM	All Florida/ All Species	R
	Green (1984)	$84	TCM	All Florida/ All Species	V
	Green (1984)	$21	CVM	All Florida/ All Species[3]	V
	Green (1984)	$70	CVM	All Florida/ All Species[4]	V
	Bell (1992)	$ 4	CVM	All Florida/ All Species	V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Fisheries (Cont'd.)					
	Bell & Leeworthy (1981)	$69	CVM	All Florida/ All Species	V
	Bell & Leeworthy (1981)	$52	CVM	All Florida/ All Species	R
	Green et al. (1992)	$810	TCM	Gulf of Mexico/ Reef Fish	R/V
	Green et al. (1997)	$1.71	RUM	Tampa Bay/ All Species[5]	R/V
	Green et al. (1997)	$3.73	RUM	Tampa Bay/ All Species[6]	R/V
	Milon & Apogee (1996)	$1.76	TCM	Indian River Lagoon/Redfish[7]	R
	Milon & Apogee (1996)	$1.85	TCM	Indian River Lagoon/Snook[7]	R
	Milon & Apogee (1996)	$2.37	TCM	Indian River Lagoon/Trout[7]	R
(B) Incremental Value Per Fish					
	Platt (1989)	$67-$73	TCM	Destin/Panama City/ Grouper[8]	R
	Green (1989)	$48-$64	TCM	All Florida/ Red Drum[9]	R
	Arndorfer & Bockstael (1986)	$149-$460	TCM	Destin/Panama City[8]	R

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
(B) Incremental Value Per Fish (Cont'd.)					
	Milon et al. (1994)	$1.68-$2.26	CVM	Indian River Lagoon/Redfish[9]	R
	Milon et al. (1994)	$ .14-$ .81	CVM	Indian River Lagoon/Seatrout[9]	R
	Milon et al. (1994)	$ .01-$ .03	CVM	Indian River Lagoon/Mullet[9]	R
	Milon et al. (1994)	$ .12-$ .23	CVM	Indian River Lagoon/ Sheepshead[9]	R
	Milon et al. (1994)	$ .13-$ .34	CVM	Indian River Lagoon/Pompano[9]	R
	Milon et al. (1994)	$.34-$ .79	CVM	Indian River Lagoon/King Mackerel[9]	R
	Milon et al. (1988)	$3.47-$6.42	TCM	Gulf of Mexico/ King Mackerel[9]	R
Mammals					
	Bendle & Bell (1995)	$16.70	CVM	All Florida/ Manatee[10]	R
	Fishkind (1993)	$71.00	CVM	4 FL Counties/ Manatee[10]	R
Reptiles					
	Milon & Remal (1997)	$60.26-$108.11	CVM	Florida/Sea Turtles[10]	R

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Wetlands					
	Bell (1989)	$51.01	MPM	Gulf of Mexico/ Saltwater Marsh/ All Estuarine-Dep Commercial Fish[11]	R/V
	Bell (1989)	$826	MPM	Atlantic Ocean off FL/Saltwater Marsh/Recreational Fishers[12]	R/V
	Bell (1989)	$ 80	MPM	Gulf of Mexico/ FL/Saltwater Marsh/ Recreational Fishers	R
	Lynne et al. (1981)	$.91	MPM	Gulf of Mexico/ Saltwater Marsh/ Blue Crab Com. Fish Only[11]	R
	Milon & Remal (1997)	$82.23- $115.06	CVM	Florida/Seagrass[10]	R
	Milon & Remal (1997)	$3.98- $ 62.72	CVM	Indian River Lagoon/ Wetland Land Acquisition[10]	R
	Milon & Remal (1997)	$1.42- $51.61	CVM	Indian River Lagoon/ Wetland Rest-oration[10]	R
Beaches					
	Curtis & Shows (1984)	$6.93	CVM	Jacksonville Beach	R

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Beaches (Cont'd.)					
	Curtis & Shows (1984)	$6.98	CVM	Jacksonville	V
	Curtis & Shows (1982)	$3.75	CVM	Delray Beach	R
	Curtis & Shows (1982)	$3.77	CVM	Delray Beach	V
	Bell (1986)	$2.60	CVM	Pompano	R
	Bell (1986)	$1.80	CVM	Spanish & Red Reef Parks/ Boca Raton	R
	Bell (1986)	$8.51	CVM	Spanish & Red Reef Parks/ Boca Raton	V
	Bell (1992)	$2.50	CVM	All Florida	V
	Bell & Leeworthy (1990)	$54.00	TCM	All Florida	V
	Bell & Leeworthy (1986)	$2.06	CVM	All Florida	R
	Bell & Leeworthy (1986)	$2.28	CVM	All Florida	V
	Bell & Leeworthy (1986)	$16.08	TCM	All Florida	R
	Bell & Leeworthy (1986)	$46.08	TCM	All Florida	V
	Leeworthy (1997)	$67.00	TCM	Florida Keys	R/V
	Leeworthy (1994)	$70.00	TCM	Clearwater	R/V
	Leeworthy (1994)	$18.61	TCM	Honeymoon Island State Rec. Area	R/V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Beaches (Cont'd.)					
	EERG (1998)	$22.75	RUM	Pinellas County	R
	Stronge & Schultz (1997)	$4.31	CVM	Broward County/ Weighted Average/ All Visitors	R/V
	Stronge & Schultz (1997)	$3.93	CVM	Broward County/ County Residents	R
	Stronge & Schultz (1997)	$4.27	CVM	Broward County/ Other FL Residents	R
	Stronge & Schultz (1997)	$4.52	CVM	Broward County/ Other U.S. Visitors	V
	Stronge & Schultz (1997)	$5.20	CVM	Broward County/ International Visitors	V
	Stronge & Schultz (1997)	$4.94	CVM	Delray Beach	R/V
	Stronge & Schultz (1997)	$4.12	CVM	Anna Marie Island	R/V
	Stronge & Schultz (1997)	$7.00	CVM	Captiva Island	R/V
	Leeworthy (1999)	$32.06	TCM	Daytona Beach	R/V
	Leeworthy (1999)	$34.27	TCM	Hugh Taylor Birch State Rec. Area/Ft. Lauderdale Beach	R/V
	Leeworthy (1999)	$47.76	TCM	St. Andrews State Recreation Area	R/V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Beaches (Cont'd.)					
	Leeworthy (1999)	$42.59	TCM	St. George Island State Park	R/V
	Leeworthy (1999)	$31.19	TCM	Gulf Islands National Seashore	R/V
Artificial Reefs					
	Bell et al. (1998)	$9.01-$11.32	TCM	Northwest FL/ Reef Fish/ Weighted Avg. All Modes	V
	Bell et al. (1998)	$4.94-$6.54	TCM	Northwest FL/ Reef Fish/ Own Boat	V
	Bell et al. (1998)	$11.63-$16.44	TCM	Northwest FL/ Reef Fish/ Charter Boat	V
	Bell et al. (1998)	$5.96-$6.55	TCM	Northwest FL/ Reef Fish/ Party Boat	V
	Bell et al. (1998)	$4.22-$8.63	TCM	Northwest FL/ Reef Fish/ Private Rental	V
	Bell et al. (1998)	$4.08-$8.50	CVM	Northwest FL/ Reef Fish/ All Boat Modes	V
	Bell et al. (1998)	$3.35-$6.97	CVM	Northwest FL/ Reef Fish/ All Boat Modes	V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/ Marine (Cont'd.)					
Artificial Reefs (Cont'd.)					
	Bell et al. (1998)	$2.16-$4.92	CVM	Northwest FL/ Reef Fish/ All Boat Modes	R
	Bell et al. (1998)	$1.80-$4.10	CVM	Northwest FL/ Reef Fish/ All Boat Modes	R
	Milon (1988)	$1.36-$2.02	CVM	Dade County/ Reef Fish	R
	Milon (1988)	$ .24-$1.57	CVM	Dade County/ Reef Fish	R
Natural Reefs					
	Milon & Remal (1997)	$74.71-$109.62	CVM	Florida/Coral[10]	R
Parks					
	Leeworthy (1989)	$469	TCM	John Pennekamp Coral Reef Park/ Diving/Boating	R/V
	Leeworthy (1999)	$ 79.37	TCM	Everglades National Park Coastal part of park	R/V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Coastal/Marine (Cont'd.)					
Water Resources					
	Leeworthy (1997)	$74.64	TCM	FL Keys/ Snorkeling	V
		$75.39	TCM	FL Keys/ Scuba Diving	V
		$71.33	TCM	FL Keys/ Personal Water-craft Use	V
		$63.31	TCM	FL Keys/ Sailing	V
		$74.40	TCM	FL Keys/ Other Boating	V
		$59.24	TCM	FL Keys/ Windsurfing	V
	Milon & Rimal (1997)	$27.13-$68.51	CVM	Indian River Lagoon/Storm-water Control To Improve Water Qual[10]	R
Freshwater					
Lakes & Rivers					
	Bell et al. (1995)	$4.16	TCM	Lake Jackson/ Leon County/ Multi-Use	V
	Bell et al. (1998)	$3.20	TCM	Lake Tarpon/ Pinellas County/ Multi-Use	V

TABLE 16.1. CONTINUED.

Resource Class	Author/Date	Wtp/Day (Dollars)	Method	Site/Kind	User R=Resident V=Visitor
Freshwater (Cont'd.)					
Lakes & Rivers (Cont'd.)					
	Stratis & Bendle (1995)	$13.41	TCM	Rodman Reservoir/ Putnam County/ Fishing	V/R
	Stratis & Bendle (1995)	$11.12	TCM	Rodman Reservoir/ Putnam County/ Fishing	R
	Stratis & Bendle (1995)	$9.07	TCM	Oklawaha River/ Marion County/ Multi-Use	V/R
	Stratis & Bendle (1995)	$7.52	TCM	Oklawaha River/ Marion County/ Multi-Use	R

Footnotes:

(1) Charter boats only
(2) All modes of fishing
(3) Shore fishing only
(4) Offshore fishing only
(5) Tampa Bay only
(6) Tampa Bay and Pinellas County
(7) WTP per fish caught per trip. Must be multiplied by average number of fish caught per day to derive WTP/day
(8) One additional kept fish per trip for charter boat fishing only
(9) One additional kept fish per trip
(10) WTP/Household/Year
(11) Ex Vessel Value/Acre/Year
(12) WTP/Acre/Year

CHAPTER 17

ANNOTATED BIBLIOGRAPHY: FLORIDA ENVIRONMENTAL RESOURCE VALUATION CASE STUDIES

Vernon R. (Bob) Leeworthy, Frederick W. Bell and Grace Johns

Adams, C. A. 1992. Economic Activities Associated with the Commercial Fishing Industry in Monroe County. Staff Paper SP 92-27. 1990. 12-1-1992. Gainesville, Florida: Food and Resource Economics Department, IFAS, University of Florida, Gainesville.

The commercial fishing industry represents an important source of revenue for Monroe County, Florida. This paper estimates (a) economic activity (b) earnings and (c) employment generated by the commercial fishing industry in 1990.In 1990, commercial fishermen landed 19.7 million pounds of finfish, shellfish and other aquatic organisms, valued at $48.4 million dockside. The total wholesale value of the various products landed by the commercial fishing industry in Monroe County was $64 million. The estimated economic impact generated includes economic activity - $90.4 million, earnings - $32.2 million; and employment - 2,230 FTEs.

Alvarez, J., G. Lynne, T. Spreen and R. Solove. 1994. The economic importance of the EAA and water quality management. *In* Water, Soil, Crop and Environmental Management. A.B. Bottcher and F.T. Izano, eds. Everglades Agricultural Area (EAA). Gainesville, Florida: University Press of Florida.

Draining the Everglades and converting it to productive farmland was an act of capital formation. This chapter of the book, Water, Soil, Crop, and Environmental Management describes the resulting agricultural economic activity. Case studies are performed on the production factors of major crop sectors, such as sugarcane, vegetables, sod and rice. The EAA Mathematical Programming Model is used to evaluate the profit maximizing levels of production for producers when water quality standards are imposed.

Anderson, D.L. and E.G. Flaig. 1995. Agricultural Best Management Practices and Surface Water Improvement and Management. Water Science and Technology 31(8).

The Florida Surface Water Improvement and Management (SWIM) Act of 1987 and the Lake Okeechobee SWIM plan have established measures by which agricultural producers can reduce phosphorus (P) loads in stormwater draining into specific areas. The Everglades Forever Act of 1994 additionally emphasized the linkage of these landscapes and consequent protection and restoration of the Everglades. This paper summarizes the development of comprehensive water management in South Florida and the agricultural BMPs carried out to meet regulatory requirements for Lake Okeechobee and the Everglades.

Apogee Research, Inc. 1996. Lake Apopka Economic Analysis. Final Report submitted to the St. Johns River Water Management District. Contract No. 96G307. Palatka, Florida.

Prior to implementing comprehensive restoration measures for Lake Apopka, this study analyzes the potential economic impact of purchasing and retiring 14,000 acres of muck farms to reduce phosphorus loading into the Lake. The comprehensive plan calls for other measures such as wetland filtration, control of rogue aquatic species, and hydrological planning. The analysis estimates the impact of the policy implementation on agricultural production and agricultural employment, property taxes, and lake-related recreational activities.

Apogee Research, Inc., in association with Resource Economics Consultants, Inc. 1996. Economic Assessment and Analysis of the Indian River Lagoon – Natural Resource Valuation of the Lagoon. Submitted to the Finance and Implementation Task Force, Indian River Lagoon National Estuary Program, Melbourne, Florida.

This study estimates the total economic value of the Indian River Lagoon (IRL) for the purpose of implementing the Comprehensive Conservation and Management Plan for the Indian River Lagoon National Estuary Program. Existing surveys on recreation and commercial activities were used as a basis for the research. A random sample telephone survey and a random sample intercept survey were conducted to supplement the information base. The total recreational value of the IRL was estimated at $627.4 million in 1995. The distribution of the annual economic value of the Lagoon across the five counties ranges from $193 million in Brevard County to $43.3 million in Indian River County.

Arndorfer, D.J. and N. Bockstael. 1986. Estimating the Effects of King Mackerel Bag Limits on Charter Boat Captain and Anglers , Environmental Resources Management North Central, Inc., Palatine, Illinois. Report Prepared for the National Marine Fisheries Service, Southeast Fisheries Center, Miami, Florida.

This study applied the standard travel cost technique with the value of time to a data set on anglers using charter boats out of Destin/Panama City in 1985. The authors focused on the catch of king mackerel. From the analyses, the authors suggest that a lower bound for the annual use value of a king mackerel angler using a charter boat is about $300. The upper bound may be as high as $1,100 according to the authors. Anglers using charter boats usually chartered boats, on average, about 1.7 times per year. Thus, the use value of the king mackerel recreational fishery in the northeast Gulf of Mexico ranges from a high of $647 per angler day to a low of $177 per angler day (expressed in 1985 dollars).

Ault, J.S., J.A. Bohnsack and G.A. Meester. 1997. A Retrospective (1979-1996) Multi-species Assessment of Coral Reef Fish Stocks in the Florida Keys, USA. Washington D.C.: Fishery Bulletin/U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Concern about habitat degradation and growing resource uses resulted in the establishment of the Florida Keys National Marine Sanctuary (FKNMS) in 1990. To support management decision making, this paper provides a baseline multi-species assessment of Florida Keys reef fish using a systems approach. The Keys reef fishery exhibits classic 'serial overfishing' in which the large, desirable species are the most vulnerable to fishing. The article discusses a six-point strategy to improve multi-species assessments and the prospects for sustainable reef fisheries management.

Bell, F.W. 1997. The Economic Valuation of Saltwater Marsh Supporting Marine Recreational Fishing in the Southeastern United States. Working Paper No. 95-02-02. 2-1-1995. Tallahassee, Florida: Florida State University, Department of Economics. Also, see same title in Ecological Economics 21: 243-254.

In this study, six proposed methods of wetland valuation are considered and found to be deficient. Following Lynne et al. (1981), a production function approach to valuing the importance of saltwater marshland to marine recreational fisheries has been advocated. To simplify the analysis, the rather complicated production function, which was linked to a demand function for recreational fisheries, was approximated with a Cobb-Douglas form. For 1984, capitalized values of an acre of saltwater to the recreational finfish fishery alone were $6,471 and $981 for the east and west coast of Florida, respectively.

Bell, F.W. 1995. Estimation of the Present and Projected Demand and Supply of Boat Ramps for Florida's Coastal Regions and Counties. TP-77. Gainesville: Florida Sea Grant College Program.

Registered boats less than 26 feet in Florida have expanded from 449,995 in 1982 to 620,548 in 1993. Boats of this size are likely to be hauled to boat ramps for access to water bodies around the state. Of the present boat ramps in Florida, 53 percent are provided by the public sector. A projection model was used to estimate the number of boats registered in each of Florida's 28 coastal counties to the year 2005. The projected registered boats were further broken down into those having a high probability of using boat ramps. With the existing supply as of 1992 of boat ramps, it was projected that 10 of the 15 coastal regions will need additional boat ramps over the 1992 base year. The number of ramps required would range from 9 lanes in Region 1 (Escambia and Santa Rosa) to 98 lanes in Region 15 (Duval and Nassau). By the year 2010, only 3 of the 15 regions will not need additional boat lanes.

Bell, F.W. 1995. Estimating the Projected Demand and Needed Supply of Boat Ramps: A Case Study of South Florida. Working Paper No. 95-02-04. Tallahassee, Florida: Florida State University, Department of Economics.

This article develops a theoretical framework for boat ramp demand and supply and formulates a model estimating the demand for boat ramp services using an untraditional demand approach. The entire State of Florida is used as a case in point. The model proved that although boat registrations will increase, the probability of buying a boat will fall due to rising affluence, age and boat size in Florida. The projection of boat registrations together with the conditional probability of using a boat ramp resulted in a forecasted expansion in demand for boat ramp services in Florida by 25 and 35 percent using logit and OLS respectively over the 1992-2005 period. This expansion in demand will create a need for an additional 2,108 or 2,534 boat lanes (i.e., logit versus OLS) by the year 2005 in Florida using the 30-foot boat scenario.

Bell, F.W. 1993. Current and Projected Tourist Demand for Saltwater Recreational Fisheries in Florida. SGR 111. Gainesville: Florida Sea Grant College Program.

The central purpose of this report is to estimate the current and projected demand for saltwater recreational fisheries by tourists visiting Florida. This report is both an update of the Bell, Sorensen and Leeworthy (1982) study conducted in 1981 and an extension of this work to a forecast of the demand pressures likely to occur on Florida's coastal fisheries. The study data was obtained using a face-to-face survey of 3,900 tourists visiting Florida between August 1991 and February 1992 stratified by auto and air access into Florida.

The study found that about 16.5 percent of the tourist population engaged in saltwater recreational fishing sometime during the year. The study also found that, in 1991, with about 3 million tourists participating in saltwater recreational fishing, total direct spending of $1.306 billion was generated. The total direct spending supported 23,518 retail and service jobs and wages of approximately $235 million. This spending was estimated to have generated about $62 million in revenue to the State of Florida in the form of sales, gasoline, and corporate income taxes. Tourist saltwater anglers are expected to double to about 6 million by the year 2010. Expenditures are also expected to double by 2010, generating over $2.6 billion (1991 prices)

Bell, F.W. 1992. Actual and Potential Tourist Reaction to Adverse Changes in Recreational Coastal Beaches and Fisheries in Florida. TP-64. Gainesville: Florida Sea Grant College Program,.

This study was designed to test the hypothesis that selected natural resource supply constraints in Florida's coastal zone will moderate the projected growth in Florida tourism. A survey was conducted to determine beach users willingness-to-pay for beach use. The application of the contingent valuation method to estimate use value revealed that tourist saltwater anglers were willing to pay $3.18 per day for their recreational experience.

Bell, F.W. 1989a. Application of Wetland Valuation Theory to Commercial and Recreational Fisheries in Florida. Florida Sea Grant Report No. 95. 1984. 6-1-1989. Gainesville, Florida: Florida Sea Grant College Program. Also see Ecological Economics 21 (1997): 243-254 for the recreational segment and the Journal of Economic Research 3 (1998): 1-20 for the commercial segment of this report in condensed form.

This paper is concerned with placing an economic value on the contribution of wetlands in supporting both the recreational and commercial marine fisheries in Florida. Production functions linking fishing effort and wetlands to fishery value are used to demonstrate the marginal productivity theory approach to valuing wetlands. Chapter 2 reviews the biological and economic functions of wetlands. Chapter 3 reviews methods for economic valuation of wetlands. Chapter 4 presents the marginal productivity theory approach to valuing wetlands. Chapter 5 examines marginal productivity theory applied to Florida's east and west coast marine fisheries; and Chapter 6 estimates the fishery component of wetlands and the calculated asset values of the wetland resources under alternative discount rates.

Bell, F.W. 1989b. An Analysis of the Economic Base of Monroe County, Florida with Implications for Oil and Gas Explorations. Tallahassee, Florida: Department of Economics, Florida State University.

The study identifies the economic base of Monroe County over the 1969-1988 period. Kearney/Centaur (1990) produced it as a companion to the study titled Impacts of Oil and Gas Development on Recreation and Tourism Off the Florida Straits. Location quotients, along with professional judgments, were used to separate the Monroe County economy into local and export sectors. Estimates of personal and export income were used to derive an income multiplier for the county. Using information from a 1989 survey of Florida Keys visitors regarding responses to a hypothetical oil spill, the impacts of an oil spill were assessed with respect to the impacts on Monroe County's personal income for year 1987.

Bell, F.W. 1989c. Economic Impact of Bluebelting Incentives on the Marina Industry in Florida. SGR 99. Gainesville: Florida Sea Grant College Program.

This report assesses the economic impact of five alternative methods of providing incentives to marina owners to address the issue of public access to public water bodies throughout the State of Florida. The report focuses on the economic benefits, cost and limitations of all forms of bluebelting for marinas in

the State of Florida. Bluebelting is derived from the practice of granting tax relief to farmers to preserve agricultural land called greenbelting. The report assesses the lessons learned from greenbelting as they might be applied to marinas in Florida to preserve access to Florida's public water bodies.

Bell, F.W. 1987. The Economic Impact and Valuation of the Recreational and Commercial Fishing Industries of Lake Okeechobee, Florida. Tallahassee, Florida, Final Report submitted to the Florida Game and Freshwater Fish Commission and Florida Department of Environmental Protection.

This report provides estimates of the baseline economic impact and value of both the commercial and recreational fisheries of Lake Okeechobee, Florida. The economic base approach was used to estimate the economic impact. For fiscal year 1985-86, the study estimated a combined economic impact of over $28 million in sales/output, almost 1,000 jobs, and about $1.2 million in tax revenues from the commercial and recreational fisheries of Lake Okeechobee. The study also estimated the annual user value of the recreational fishery to be about $8.3 million. Using a conservative assumption that the annual value remains constant in the future, and employing a real discount rate of 8.625 percent, the asset value of the resource was estimated to be about $100 million.

Bell, F.W. 1986. Economic policy issues associated with beach renourishment. Policy Studies Review, 6(2): 374-381.

The study sought to understand how use value of beaches varies with crowding. In 1984-85, a sample of 744 Florida residents was interviewed by phone regarding their saltwater beach use in Florida. Respondents were asked a contingent value (CV) question regarding their willingness-to-pay for beach use. The money collected would be used for preservation of the beach. The willingness-to-pay, or use value, was found to rise with space available per person and then declined as crowding occurs. For Pompano Beach, Florida, this beach standard would lead to a use value of $1.71 per beach user per day (in 1984-85 dollars). There is some evidence that out-of-state tourists are willing to pay more (i.e., have a higher use value) for beaches than residents. If so, the benefit-cost analyses may be conservative.

Bell, F.W., G. Antonini, E. Kamper, R. Swett and H. Tupper. 1997. Planning for Public Boating Access: A Geographic Information System Approach to Evaluate Site Suitability for Future Marinas, Ramps and Docks in Charlotte County, Florida. TP-87. Gainesville: Florida Sea Grant College Program.

Charlotte County, Florida faces a major planning dilemma: how to balance population growth and coastal development with conservation and management of its estuarine resources. This study seeks to provide answers to this question. The Charlotte County boater population was projected to increase from 13,876 pleasure craft in 1992 to 43,103 in 2010. The study results provide Charlotte County with a planning instrument that specified the type, quantity and location of public shore access and boating facilities (marinas, ramps, docks) needed to meet anticipated demand, such as boating, through the year 2010.

Bell, F.W., M.A. Bonn and V.R. Leeworthy. 1998. Economic Impact and Importance of Artificial Reefs in Northwest Florida, a contract report to the Florida Department of Environmental Protection (Office of Fisheries Management and Assistance), Contract Number MR235, Tallahassee, Florida.

This study evaluated the economic impact of artificial reefs in Northwest Florida covering Bay through Escambia counties plus the use value of artificial reefs. It was found that residents and visitors to the five-county area spent $414 million on goods and services that were related to the use of artificial reefs in the Gulf of Mexico. This spending generated 8,163 jobs with a payroll of nearly $84 million. This eco-

nomic impact occurred over the 12-month period from 1997 to 1998. Three methods were used to estimate the use value of an artificial reef per angler per day for the five counties: (a) the Turnbull Distribution, (b) the dichotomous choice method and (c) the travel cost method. The asset value for artificial reefs off Northwest Florida ranged from $656 million to $1.168 billion. Given that only about $5 million has been spent on artificial reef development since 1980, the artificial reef program has produced a large return on public expenditures.

Bell, F.W. and V.R. Leeworthy. 1995. Implementing User Charges for Public Goods: The Case of the Florida Keys National Marine Sanctuary. Working Paper No. 95-03-02. Tallahassee, Florida: Florida State University, Department of Economics.

The authors conducted a case study of the Florida Keys National Marine Sanctuary (FKNMS) from which they examine the feasibility of placing a decal fee on pleasure boats as a form of user charge. The U.S. Congress as a new revenue source to pay for added spending suggested this user charge. Using a sample of boaters in Florida, the authors found that boaters' willingness-to-pay for a boat decal was positively related to income, boat length, household size and the use of the FKNMS and ranged, on average, from $9.62 to $16.56 per year. It was clear from protest bids that a boating decal fee would have strong political opposition.

Bell, F.W. and V.R. Leeworthy. 1992. The Potential Revenues from a Boating Decal Fee for the Florida Keys National Marine Sanctuary: A Preliminary Assessment. Tallahassee, Florida: Department of Economics, Florida State University, Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This working paper investigates the potential revenue from a boating decal for the Florida Keys National Marine Sanctuary (FKNMS). The thrust of this paper is to investigate some recent factual data obtained from a statewide boating survey in the State of Florida as it relates to a boating decal fee in the FKNMS. Estimates of boat use in the FKNMS and boater's willingness-to-pay for a boating decal were used to estimate potential revenue collections. These estimates were then combined with a boating demand model to forecast potential future revenues. Limitations of the analysis are discussed, and recommendations for future research presented.

Bell, F.W. and V.R. Leeworthy. 1990. Recreational demand by tourists for saltwater beach days. Journal of Environmental Economics and Management 18:189-205.

This analysis addresses tourists (out of state) who come from significant distances for the primary purpose of enjoying the beach resources of Florida. It is argued that those that use the conventional travel cost method do not recognize its potential spatial limitations. The study concludes that the annual consumer demand by individual tourists for Florida beach days is positively related to travel cost per trip and inversely related to on-site cost per day. Using the on-site cost, the consumer surplus per person per day (i.e., use value) for saltwater beach use was estimated at $34 (in 1984 dollars) without the opportunity cost of time. Using a 10 percent discount rate and an estimated 70 million beach days for the tourist segment of the market for beaches, it was estimated that the asset value (i.e., capitalized value) of Florida's saltwater beaches is $23.74 billion. This does not include the resident part of the asset value.

Bell, F.W. and V.R. Leeworthy. 1986. An Economic Analysis of the Importance of Saltwater Beaches in Florida. SGR 82. Gainesville: Florida Sea Grant College Program.

To evaluate the economic impact and recreational value of saltwater beaches in Florida, two surveys were conducted over the 1983-84 period. The first surveyed out-of-state tourists as they left the state.

Tourists are an important aspect of Florida's economy and thus the role of beaches. The second survey was a telephone survey of Florida residents. The estimated economic impact of tourists while at Florida's saltwater beaches was over $3.4 billion in sales, supporting 142,638 jobs with an annual payroll of $860 million, considering direct and indirect effects. Florida residents spent over $1.1 billion while at the beach, supporting 36,619 jobs with an annual payroll of $240 million.

Bell, F.W. and V.R. Leeworthy. 1984. Estimation of the Demand and Supply of Marina Services in the State of Florida - 1969-1983. Tallahassee, Florida: Florida Department of Natural Resources, Division of State Lands.

The study answers the following questions. What is the present demand for marina facilities in Florida? How is this demand likely to increase in the future? What is the existing supply of marina facilities? And is it likely that demand for marinas will place great pressure on limited wetland resources? A demand model was used to predict the probability that a registered boat will be berthed at a marina (use marina services). The estimated demands for marina wet slips and dry racks were then projected into the future using the boat registration forecasts and forecasts of the probabilities that registered boats will be berthed in marinas.

Bell, F.W., H. McGinnis, C. Story and P. Rose. 1995. The Economic Value of Lake Jackson. Marietta, Georgia: A. L. Burruss Institute of Public Service, Kennesaw State College. Prepared under EPA grant, No. X821524-01-1.

The purpose of this study was to estimate the economic impact on Lake Jackson, Florida on the economy of Leon County, Florida. In addition, the zonal travel cost method was employed with the value of time to estimate the use value of a recreational day at this freshwater lake. When the Leon County multiplier was applied, it was estimated that Lake Jackson accounted for $10.3 million in spending in 1993, supporting almost 100 jobs. The estimated daily use value of the lake was $3.68 for all kinds of recreation (expressed in 1993 dollars).

Bell, F.W., H. McGinnis, C. Story, C., Sloope and P. Rose. 1998. The Economic Value of Lake Tarpon, Florida and the Impact of Aquatic Weeds. Kinnesaw, Georgia. A.L. Burruss Institute of Public Service, Kennesaw State University. Prepared under a contract with the Florida Department of Environmental Protection (Division of Aquatic Weeds).

Lake Tarpon is located in Pinellas County, Florida (Tampa Bay Area). This study estimated the economic impact of Lake Tarpon on the surrounding areas and estimated the user value of the lake. Results from a phone survey proved that 9.5 percent of the local population use the lake. It was estimated that including multiplier impacts on activities on the coast of Lake Tarpon, the economic impact area generated $50.4 million that are lake-related. This in turn generated $9 million in wages and 711 jobs. Applying the zonal travel cost method to the users of Lake Tarpon, it was found that the use value per day was $3.20 including the opportunity cost of time. The study concluded that participation in the recreational activities would increase if level of existing aquatic weeds were reduced.

Bell, F.W. and M. McLean. 1996. The Impact of Manatee Speed Zones on Property Values: A Case Study of Fort Lauderdale, Florida. Florida State University, Department of Economics: Tallahassee, Florida; Save the Manatee Club: Maitland, Florida.

The study addresses the relationship between manatee speed zones and the market value of property in Fort Lauderdale, Florida. The study used a hedonic property value model that relates the selling price of

a piece of property to the property's characteristics including the property's location relative to manatee speed zones. The study found that, contrary to popular belief, manatee speed zones increased property values in Fort Lauderdale, Florida while holding other property characteristics constant. The hedonic property value model found that manatee speed zones increase property values from 15 to 20 percent.

Bell, F.W. and P.E. Sorensen. 1993. A Socioeconomic Impact Assessment of Selected Management Strategies: Florida Keys National Marine Sanctuary. Tallahassee, Florida: Department of Economics, Florida State University; Silver Spring, Maryland: National Oceanic and Atmospheric Administration.

This study provides a socioeconomic impact assessment of 24 selected management strategies for the Florida Keys National Marine Sanctuary. The strategies included in the assessment were chosen based on their relative importance and because they were representative of the types of impacts across groups and industries. Strategies addressed included boating, fishing, land use, recreation, water quality, and education.

Bell, F.W., P.E. Sorensen and V.R. Leeworthy. 1982. Economic Impact and Valuation of Saltwater Recreational Fisheries in Florida. SGR 47. Tallahassee: Florida Sea Grant College Program.

This study explored the economic impact and recreational valuation of all saltwater recreational fisheries in Florida. With respect to the economic impact, it was found there were 2.1 million resident marine anglers and 3 million tourist marine anglers in 1980. These two groups spent over 58 million angler days on fishing, generating over $5 billion in direct and indirect spending in the State of Florida. These expenditures supported over 44,000 jobs. In 1980-81, anglers were asked how much they would be willing to pay to preserve the fisheries in Florida and continue fishing in the state. This contingent valuation question established some of the first use value estimates for recreational saltwater fishing in Florida. It was estimated that the total annual use value was over $2 billion. Using a discount rate of 7.625 percent, Florida's capitalized (asset) value for marine recreational fisheries was an estimated $27.4 billion in 1980-81.

Bendle, B.J. and F.W. Bell. 1995. An Estimation of the Total Willingness to Pay by Floridians to Protect the Endangered West Indian Manatee through Donations. Tallahassee: Florida Department of Environmental Protection, Economic Analysis Section and Florida State University, Department of Economics.

This study uses a variation of one of the existing techniques known as Contingent Valuation by surveying a random sample of 951 Floridians in the winter of 1992-93. The survey elicited information about current donations to several of causes, including the plight of the manatee. A contribution continuum method was used for the analysis. This method was reinforced by other empirical techniques. The analysis estimated Floridians' total asset value on protection of the manatee population to be $2.6 billion, or $14.78 per year, per household. Given that there were an estimated 1,800 to 2,000 manatees left in existence, this might be interpreted as meaning that protection of each manatee is conservatively worth $1.5 million to Floridians.

Bhat, M.G. 1999. Valuation of Recreation Benefits of Marine Reserves in the Florida Keys: A Combined Revealed and Stated Preference Approach. Environmental Studies Department, Florida International University. University Park, Miami, Florida.

The quality of the coral reefs in the Florida Keys is essential to sustain tourist's interest in the Keys. The recently established marine reserves (MR), are expected to improve the quality and quantity of various attributes of the reefs, including coral and fish abundance and diversity. This study demonstrates how

one could measure the recreation benefits of MR-induced quality improvement of the coral reefs. A sample survey was used to obtain data on visitors' travel costs and number of trips under existing reef condition, and their stated preference for trips in response to the MR-related reef improvement. A recreation demand model is derived using the survey data.

Boggess, W.G. 1994. A case study of nutrient management for Florida dairies. Economic Issues Associated with Nutrient Management. *In* P.E. Norris and L.E. Danielson, eds. Southern Regional Information Exchange, pp. 109-127. Group-10, Southern Rural Development Center, Mississippi State University, Mississippi.

As is the case with many potential pollutants, it is easier to reduce or prevent their release into the environment than to capture or confine them once they are released. The objective of this study is to put in perspective the impact that management options can have on nutrient management on dairy farms. This study analyzes different regulatory and incentive-based policies for controlling non-point source pollution from dairy farms in areas north of Lake Okeechobee. Technical and economic barriers for implementing various policy alternatives are identified.

Boggess, W.G., E.G. Flaig and C.M. Fonyo. 1991. Florida's Experience with Managing Non-point Source Phosphorous Runoff into Lake Okeechobee. Paper prepared for presentation at the 1991 AERE Workshop, The Management of Non-point Source Pollution, Lexington Kentucky. Food and Resource Economics, University of Florida, Gainesville, Florida and South Florida Water Management District, West Palm Beach, Florida.

This report first describes then examines what has been learned from Florida's 15 years of experience with trying to control phosphorous runoff from agricultural lands into Lake Okeechobee. The report provides a brief description of the natural system, an overview and chronology of phosphorous management/control programs, outlines and describes the evolution of monitoring programs and analysis, outlines the evolution of phosphorous control technologies and incentives for adoption, examines the costs and impacts of various programs, and derives lessons and implications for other similar problems.

Boggess, W.G., G. Johns and C. Meline. 1997. Economic impacts of water quality programs in the Lake Okeechobee watershed of Florida. Journal of Dairy Science 80(10): 2682-2691. (See also Hazen and Sawyer full report.)

In an effort to reduce phosphorus loads into Lake Okeechobee from dairies and other agricultural lands, in the 1980s state agencies, including the South Florida Water Management District (SFWMD), implemented three programs. These programs were (1) the Dairy Rule, (2) the Dairy Buyout Program, and (3) the Okeechobee Works of the District (WOD) Rule. Direct economic impacts from all three programs included the following: (a) mean annual reductions in milk sales of $28 million and in employment, 274 jobs; (b) total economic impact (i.e., direct, indirect, and induced) included a $38.2 million decrease in sales, (c) an $18 million (4 percent) decline in incomes, and a loss of 492 jobs. Relocation incentives and milk production increases helped maintain retail milk prices.

Bohnsack, J.A., D.E. Harper and D.B. McClellan. 1994. Fisheries trends from Monroe County, Florida. Bulletin of Marine Science 54(3):982-1017.

Fishing is an important activity in the Florida Keys National Marine Sanctuary(FKNMS). Concern exists that excessive fishing could be deleterious to individual species, disrupt marine ecosystems, and damage the overall economy of the Florida Keys. Data from commercial, recreational, and marine life fisheries in Monroe County, Florida were examined. In 1992, the total reported commercial landings were composed of 52 percent invertebrates (4,090,000 kg), 28 percent reef fishes (2,190,000 kg) and 21

percent non-reef fishes (1,620,000 kg). In the recreational headboat fishery, reef fishes account for 92 percent of 107,000-kg average total annual landings from the Dry Tortugas and 86 percent of 201,000 kg landed from the Florida Keys since 1981. Average annual landings for other recreational fisheries were estimated at 1,790,000 kg for reef fishes (45 percent) and 2,170,000 kg for non-reef fishes (55 percent) from 1980 through 1992.

Burton, S., C. Vickery and K. Weiss. 1994. Public Education Survey for the Indian River Lagoon, National Estuary Program. FAU/FIU Joint Center for Environmental and Urban Problems; U.S. EPA (National Estuary Program); St. John's River Water Management District.

The Indian River Lagoon(IRL) spans some 156 miles along Florida's central east coast. It is listed as an estuary of national significance and included in the National Estuary Program. Results from the survey provided a basis for determining a desirable and acceptable approach to educating the public about the environmental issues of concern and their potential solutions as they relate to the IRL. Furthermore, the survey may also be used to better understand how to target various audiences within the general population for public information and education. Survey information was obtained through telephone interviews with 407 randomly selected residents from the five counties that form the IRL system: Brevard, Indian River, Martin, St. Lucie and Volusia.

Centaur Associates, Inc. 1986. Socioeconomic Assessment of Fishery Management in Everglades National Park: Final Report. Washington D.C., Everglades National Park, National Park Service, U.S. Department of the Interior.

This report focussed on the Everglades and Florida Bay, providing the requisite socioeconomic impact assessment and unavoidable adverse effects associated with the commercial and recreational activity related to 24 fishery management alternatives. The approaches for the various alternatives are variable. However, all approaches evaluated the incremental effect of the alternatives relative to current conditions. Where possible, financial impacts were projected.

Centaur Associates, Inc. 1986. Socio-Economic Analysis of Commercial and Recreational Fisheries in Everglades National Park. Washington D.C., Everglades National Park, National Park Service, U.S. Department of the Interior.

This report examines the impact of fishing in Everglades National Park. It summarizes the economic impact trends for various Park fisheries and compares the economic impact of fishing in the Park with surrounding Florida areas or counties. Commercial data were compiled on the ex-vessel value of landings for Everglades National Park, the State of Florida as a whole, and the counties of Dade, Collier and Monroe (counties surrounding the park). Multipliers were used, and 12 species of fish were identified. Recreational expenditures were split into two categories: private boat; and, guide party recreational fisheries.

Center for Economic and Management Research. 1995. Economic Impact of Commercial Fisheries in the Florida Keys: Case Study-Florida Keys National Marine Sanctuary. Draft Management Plan (under contract to the Monroe County Commercial Fishermen, Inc.). Tampa, Florida: University of South Florida.

The purpose of this study is twofold: first, to demonstrate the level of economic activity arising from commercial seafood harvested in Monroe County, Florida; second, to demonstrate the change in economic activity, which may be expected to arise from implementation of selected fishery restrictions. This included restrictions such as those proposed by the Florida Key National Marine Sanctuary (FKNMS).

An IMPLAN input-output model was used to estimate economic impact in terms of output, income and employment in Monroe County. Economic impact was estimated for 1994 using Monroe County landings of finfish and shellfish for that year. A survey of Monroe County fishermen was used to derive the impacts of two proposed sanctuary replenishment reserves (Sambos and Dry Tortugas).

Central and Southern Florida Project Comprehensive Review. 1996. Indian River Lagoon Restoration Feasibility Study (Project Study Plan, Version 4.0). U.S. Army Corps of Engineers, South Florida Water Management District.

The Indian River Lagoon (IRL) spans some 156 miles along Florida's central east coast. It is listed as an estuary of national significance and included in the National Estuary Program. The habitat provides for a variety of commercially, recreationally, and ecologically important aquatic organisms. The IRL Restoration Feasibility Study was initiated in July 1996. It examined alternative surface water management options and developed a regional plan for addressing water resource opportunities specific to the canal watershed in Martin and St. Lucie counties. Two major goals of the study included enhancing ecological values and enhancing economic values and social well being.

Cofer-Shabica, S.V., R.E. Snow and F.P. Noe. 1990. Formulating policies using visitor perceptions of Biscayne National Park and seashore. *In* Paolo Fabbri, ed. Recreational Uses of Coastal Areas, pp. 235-254. Kluwer Academic Publishers, Norwell, Massachusetts.

Visitor surveys were handed to randomly selected visitors to the park in the winter and summer and returned by mail. A mail-out survey was sent to registered boat owners in Dade County. From a park management perspective, Biscayne's data suggest a need for sensitivity to expectations that different ethnic groups brought to the Park when designing services and programs. Data also suggested addressing issues of whether marine recreational areas should have increased development and formal control to maximize visitor satisfaction, or remain undeveloped.

Continental Shelf Associates, Inc. 1990. Synthesis of Available Biological, Geological, Chemical Socioeconomic, and Cultural Resource Information for the South Florida Area. Miami, Florida. Minerals Management Service, Atlantic OCS Region.

The specific objectives of the study were to review and synthesize geological, chemical, biological, cultural resource and socioeconomic information for the study area; to evaluate potential effects of offshore oil and gas exploration and development; and to recommend mitigation measures and identify future research needs. This synthesis of existing information will help federal and state policy makers reach informed decisions about future lease offerings and environmental restrictions on offshore oil and gas operations.

Correia, M.E. 1995. Economic Impact Study of Federal Interest Lands in South Florida. FAU/FIU Joint Center for Environmental and Urban Problems.

This report is a compilation of available information on the significance of: Everglades National Park; Loxahatchee National Wildlife Refuge; National Key Deer Refuge; Crocodile Lake National Wildlife Refuge; Key West National Wildlife Refuge; Great White Heron National Wildlife Refuge; Florida Panther National Wildlife Refuge; J.N. Ding Darling national Wildlife Refuge; and Florida Keys National Marine Sanctuary to their local economy. The study used the Money Generation Model developed by the National Park Service's Socio-Economic Studies Division. The model calculated how expenditures by tourists, the Federal government, and other non-local parties resulted in sales benefits and new job benefits.

Correia, M.E. and C. Diamond. 1995. Application of Valuation Methodologies to South Florida Externalities. FAU/FIU Joint Center for Environmental and Urban Problems, and Resource Analysis and Management for 1000 Friends of Florida.

This paper summarizes various valuation techniques based on their applicability to the problem of simulating markets and estimating values of South Florida's environmental resources. The paper identifies the types of externalities associated with these resources and their likely sources or causes. It also lists the likely environmental impacts and the valuation techniques. The paper also makes recommendations for using externalities as a basis for policy-making in the South Florida region.

Curtis, T.D. and E.W. Shows. 1984. A comparative Study of Social and Economic Benefits of Artificial Beach Nourishment – Civil Works in Northeast Florida, prepared for the Division of Beaches and Shores, State of Florida, STAR Grant to the University of South Florida, Tampa Florida.

The purpose of this study was to estimate the beach use value for Jacksonville Beach in Northeast, Florida. The beach use values would be compared with nourishment cost to derive a benefit/cost ratio for the artificial nourishment of this beach. Using a contingent value (CV) approach, the mean willingness to pay for beach nourishment was an estimated $4.44 per beach user per day (in 1983 dollars) for Florida residents and $ 4.88 per beach user per day (in 1983 dollars) for out-of-state users. The benefit/cost ratio for the proposed project was between 2.23 and 2.46 and is thus favorable to continued beach nourishment. Direct expenditures into the local economy was estimated at $3 million by tourists while an income multiplier from 1 to 2.62 was suggested for this direct injection into the local economy.

Curtis, T.D. and E.W. Shows. 1982. Economic and Social Benefits of Artificial Beach Nourishment Civil Works at Delray Beach, prepared for the Division of Beaches and Shores, State of Florida, STAR Grant to the University of South Florida, Tampa, Florida.

The purpose of this study was to estimate the beach use value for Delray Beach in the West Palm Beach area of Florida. The beach use value would be used to compare to nourishment cost and derive a benefit/cost ratio for the artificial nourishment of this beach. Using a contingent value (CV) approach, the mean willingness to pay for beach nourishment was $2.07 per beach user per day (in 1981 dollars) for Florida residents, and an estimated $2.09 per beach user per day (in 1991 dollars) for those from out of state. The calculation of the benefit/cost ratio of 2.2 strongly supports the conclusion that the Delray Beach nourishment project was economically viable. Direct expenditures by out-of-state visitors was an estimated $26.7 million into the local economy in 1981/82. A multiplier of 2.62 was suggested for this direct impact.

Davis, G.E. 1981. On the role of underwater parks and sanctuaries in the management of coastal resources in the Southeastern United States. Environmental Conservation 8(1): 67-70.

Aquatic resources in parks and reserves are not as adequately protected as comparable terrestrial resources. The seven underwater parks or sanctuaries established since 1935 in Florida and the U.S. Virgins Islands exhibit wide variations in the degree of protection accorded to aquatic resources. Protection ranges from nearly complete protection in the first park that was established to virtually no protection at all in recently established parks. The consequences of permitting consumptive use of aquatic resources in parks and reserves need to be objectively evaluated. Unless these consumptive uses are significantly reduced or eliminated, the primary values of the parks and reserves may never be realized.

DeWitt, J. 1996. Protecting a Profitable Paradise: The National Ocean Service Leads Multi-agency Planning in the Florida Keys. Washington, D.C: Center for Competitive Sustainable Economics, National Academy of Public Administration.

As defined in recent work at the National Academy of Public Administration, four key elements of governance are considered. These elements are: (1) public purposes; (2) roles of public agencies and other entities; (3) tools used to achieve public purposes; and (4) strategies for change to improve performance and to adapt to new information. The paper also describes how the Keys planning process measures up to eleven criteria for marine governance which have been identified by the NAS Committee on Marine Area Governance and Management. The paper concludes with an assessment of whether NOAA's activities in the Keys have produced desired results.

English, D.B.K., W. Kriesel, V.R. Leeworthy and P.C. Wiley. 1996. Economic Contribution of Recreating Visitors to the Florida Keys/Key West. From June 1995 to May 1996. Sponsored by U.S. Forest Service, Outdoor Recreation and Wilderness Assessment Group. Athens: University of Georgia, Department of Agricultural and Applied Economics. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division. Fisheries Statistics of the United States. National Marine Fisheries Service. Fishery Statistics Division.

This report provides estimates of the economic impact that visitors to the Florida Keys have on both Monroe County and the larger South Florida regional economies. Estimates are made for output/sales, income, and employment and include both direct and secondary economic impacts. This report provides the basis for demonstrating the income producing asset value of the natural resources of the Florida Keys/Florida Bay. Estimated business output derived from tourist activity between June 1995 to May 1996 was $1.33 billion (61 percent of Monroe's economy). Impact on income for the period was $0.51 million (45 percent of Monroe's economy), and impact on employment was 21,848 jobs (46 percent of Monroe's economy). The impact of tourist activities in the Florida Keys/Key West on output (sales) for the rest of South Florida (Dade and Broward Counties) was $1.61 billion. The impact on income was $1.37 billion, and the impact on employment was 8,300 full time equivalent jobs.

Environmental Economics Resource Group (EERG). 1998. Natural Resource Damage Assessment for the Tampa Bay Oil Spill: Recreational Use Losses for Florida Residents. Unpublished Report to the Florida Department of Environmental Protection, Tallahassee, Florida.

In 1993, a tank barge collided with a freighter near the entrance of Tampa Bay causing an oil spill that flowed out into the Gulf of Mexico and came ashore on Treasure Island Beach. This damage was estimated using a random utility model (RUM) including the value of time for the month or so that the beach was unable to be used by residents of Florida. The question arose as to the willingness to pay (WTP) per day for a beach visit to the oiled beaches assuming this damage had not taken place. The RUM estimated that the daily WTP by residents to the damaged area was $22.75 per day. Estimating the number of days lost during the oiled beach period, it was concluded that damages amounted to a conservative figure of $3.98 million dollars owed to beach goers.

Fishkind and Associates, Inc. 1993. Economic Impact of the Manatee Sanctuary Act – Technical Report. Volusia County Board of County Commissioners, Deland, Florida.

This report provides an economic impact analysis for the Manatee Sanctuary Act for Volusia and Brevard counties in Florida and for the entire State of Florida. The report includes a review of the types of economic impacts of the Manatee Sanctuary Act, calculates the total costs and benefits resulting from

the Act, estimates the level of net economic impact, and identifies any mitigating measures required due to the Act. The willingness to pay per household per year for the protection of the manatee was estimated at $59.

Florida Department of Community Affairs. 1996. An Economic Impact Statement under Chapter 120.54, F.A.C. for Rule Establishing F.A.C. 28-20; Part II: Amendment to the Monroe County Proposed Rule 28-200.100. Tallahassee, Florida.

This paper fulfills the requirement under Chapter 120.54, F. A. C.; an economic impact statement prior to adoption of the proposed rule for Monroe County 28-20.100, which includes amendments to the Monroe County Comprehensive Plan and Land Development Regulations. The proposed amendments address local funding initiatives, and alternatives for implementation of the plan; use of the County's Point Allocation System to direct development away from important natural resources and maintain acceptable hurricane evacuation times; and development controls which adequately protect hammocks, pinelands, wetlands, marine resources and water quality.

Florida International University. 1997. Visitor Survey in Florida Keys (Key Largo to Islamorada). Environmental Studies Department, Miami, Florida.

This survey gathers visitors' information on travel profile, recreational activity types, and number of visitations under different levels of quality and quantity of attributes of sanctuary preservation areas (i.e., fish population, visitor congestion, water quality and coral quality).

Fogg, G. A. 1990. Study of South Florida Recreational Patterns. United States Department of the Interior, National Park Service, Big Cypress National Preserve.

The goal of this study was to develop an understanding of South Florida's multifaceted user groups, and relate this information in a useful manner to the appropriate decision-makers. The information generated will enable various participating resource oriented agencies and businesses to better understand the user needs they serve and where there is room and/or need for improvement and/or expansion of Big Cypress National Preserve, (Public Law 1000-301). The National Preserve is required to identify the users of the Preserve. This report addresses, in part, these legislative requirements. It explores who is using the park and surrounding areas

Furse, J.B. and D.D. Fox. 1994. Economic fishery valuation of five vegetation communities in Lake Okeechobee, Florida. *In* Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 48:575-591.

Vegetated areas of the littoral zone of Lake Okeechobee were sampled with 0.8-ha block nets during the fall of 1989, 1990 and 1991 to estimate fish assemblages and standing crops in 5 vegetation communities common in Florida. Data were used in conjunction with economic impact data of known cause fish kill events, Rule 17-11.01(animal damage valuation), Chapter 403, Florida Statues, to estimate monetary values of the fisheries of important Lake Okeechobee vegetation communities. Mean total impact values per hectare of vegetated areas range from $44,626 to $59,738. Replacement economic values made up at least 88.9 percent of the total impact value in the valuation of all vegetation types. Recreational values per hectare of vegetated areas ranged from $447 to $5,378.

Glasure, Y.U. 1987. An Economic Evaluation of the Florida Saltwater Resident Recreational Fishery. Doctoral dissertation, Florida State University. Tallahassee, Florida.

The purpose of this study was to estimate the displayed use value of saltwater recreational fishing for Florida residents. A sample of 1,002 resident saltwater anglers in Florida was used. The sample was collected between July 1980 and June 1981. The model used for deriving use value for all saltwater species was a variation of the travel cost and the Gibbs approach. The travel cost method was rejected in favor of the Gibbs approach. Use value was estimated at $142.31 per resident angler day (expressed in 1981 dollars). The estimated daily use value was $13.26 per saltwater angler day.

Governor's Commission for a Sustainable South Florida. 1996. Initial Report, Coral Gables, Florida.

The Initial Report details the Commission's conclusions regarding the present state of South Florida and offers 110 recommendations for the future of the region with a central theme of sustainability. Three broad components are identified: society, economy, and the environment. The report concludes that these must be fully integrated and balanced to achieve sustainability in South Florida. These components encompass a variety of human and natural system issues that are closely intertwined and require a holistic approach.

Governor's Commission for a Sustainable South Florida. 1996. A Conceptual Plan for the C&SF Project Restudy. Coral Gables, Florida.

The C&SF Project is a predominant feature affecting water resources in South Florida. Modifications to the existing project, termed the Restudy, are crucial to restore South Florida's water quality, flood protection, and water supply for the agriculture and urban areas as well as the natural system. This study describes the Commission's preferred alternatives to the U.S. Army Corps of Engineers and the South Florida Water Management District and other agencies that pursue the Restudy. The Commission selected a list of 40 preferred options to be evaluated, and designed these options to improve and expedite the Restudy efforts.

Green, G., C.B. Moss and E.M. Thunberg. 1992. Estimation of Recreational Anglers Value of Reef Fish in the Gulf of Mexico, unpublished paper under contract with the National Marine Fisheries Service, USDC, Marine Fisheries Initiative Program. St. Petersburg, Florida.

Several public policy issues in the Gulf of Mexico region involve the value of the reef fish recreational fishery. This study estimates the economic impact of this fishery using a travel cost procedure. Demand for recreational reef fishing is estimated as a function of travel costs and other costs paid, and success of catch. The results indicate that a 20 percent reduction in the average catch reduces expenditures by $32.1 million. The fishery is estimated to generate $385.6 million in total expenditures within the State of Florida annually. Using the travel cost method in conjunction with the MRFSS data, the authors conclude that reef fish caught off Florida generates $675.52 per trip for each angler (expressed in 1991 dollars).

Green, G., C.B. Moss and T.H. Spreen. 1997. Demand for recreational fishing in Tampa Bay, Florida: A random utility approach. Marine Resource Economics 12:293-305.

An estimation of demand for recreational fishing in Tampa Bay, Florida, can facilitate the environmental management of the bay. A nested random utility (RUM) travel cost model was used to estimate access values to Tampa Bay. Average value of welfare losses per resident angler were calculated at $1.68 per

trip for the loss of the bay itself and $3.66 for the loss of both the bay and Pinellas County together (expressed in 1992 dollars). Because of a large number of substitute water bodies in the west central part of Florida, considered by the RUM model, the trip values per angler to the bay is relatively low compared to other estimates for angling using less flexible techniques.

Green, T.G. 1984. Compensating and Equivalent Variation of Florida Saltwater Tourist Fishery. 1980-81. Doctoral dissertation, Florida State University, Tallahassee, Florida.

The purpose of this study was to estimate the use value (i.e., consumer surplus) for the tourist recreational marine angler visiting Florida. Estimates of use value covered all marine species and modes of fishing in the aggregate. The Gibbs on-site model was used to estimate the demand curve for the Florida tourist engaged in saltwater fishing. The equivalent and compensating variation versions were estimated between $43.83 and $40.31 respectively per angler day (in 1981 dollars). Based upon a compensating variation (CV) estimate of $46.17, the asset value of the tourist saltwater fishery in Florida was estimated at $10 billion using a 7.6 percent discount rate. Among marine angler modes, CV was estimated at $11.67 and $38.89 per day for shore and offshore respectively. The offshore modes ranged from a high of $89.33 per day for charter boats to a low of $15.77 for those engaged in reef fishing by any kind of mode. Finally, it was found that tourist marine anglers were relatively insensitive to changes in catch rates or fish caught per day, indicating that tourism is not heavily discouraged by a declining or over-fished fishery stock.

Hamann, R. 1993. Assessment of Water Rights, Uses, Laws and Regulations, Everglades National Park - Draft Final Report. Homestead, Florida: National Park Service, Everglades National Park.

As a review and analysis of federal and Florida State water laws and regulations, this study was designed to assess the water rights of Everglades National Park. Section One examines the federal law of water rights, exploring the extent to which the federal government may have rights under federal law for delivery of water to the Park. Section Two focuses on state law governing water rights in Florida, the Water Resources Act of 1972, and the common law in effect before then. It discusses ways in which the water rights of Everglades National Park can be protected under Florida law.

Harwell, M.A. and J.F. Long. 1992. U.S. Man and the Biosphere Program Human-Dominated Systems Directorate: Workshop on Ecological Endpoints and Sustainability Goals. University of Miami, Rosenstiel School of Marine and Atmospheric Science. United States Man and the Biosphere Program. Department of State, Washington, D.C.

The ultimate objective of the HDS core project is to develop a process or approach that can be used to better integrate ecological and societal issues, extending beyond the specifics of the three case studies analyzed in this workshop: the Everglades, Pinelands, and Virginia Coastal Reserve. The goals of the core project are to: (1) define ecological sustainability in terms of ecological endpoints, (2) evaluate the patterns of human uses of environmental resources and other anthropogenic stresses imposed on the ecosystems, (3) examine societal and institutional factors influencing ecological sustainability, and (4) assess the potential for various societal policies and institutions to be compatible with essential characteristics of ecological sustainability. It is clear that the most important sustainability goal for the South Florida region is the reestablishment and maintenance of hydroperiod and water quantity within the historical pattern.

Hazen and Sawyer, P.C. 1998. Estimated Economic Value of Resources. Prepared for the Charlotte Harbor National Estuary Program (NEP). North Fort Myers, Florida.

In preparation for its Comprehensive Conservation and Management Plan (CCMP), Charlotte Harbor NEP commissioned an evaluation of the economic value of resources within the Charlotte Harbor watershed. The study estimated consumer surplus and total income values associated with the natural resources of the Charlotte Harbor watershed. Non-market values of the watershed were estimated using benefits transfer. IMPLAN multipliers were used to estimate total income for the region. The study found that the Charlotte Harbor National Estuary provides about $1.8 billion per year in net value to recreators and Florida households, and was used to produce about $3.2 billion per year in income to the area.

Hazen and Sawyer, P.C. 1997. Economic Assessment of Recreational and Commercial Uses of Orange and Lochloosa Lakes in the Orange Creek Basin. Prepared for the St. Johns River Water Management District. Palatka, Florida.

This study describes the recreational and commercial uses associated with Orange and Lochloosa Lakes, in North Central Florida. The study found that, during the 1990s, there were significant declines in recreational fishing activity and local income associated with the lakes. Total annual recreational fishing expenditures in the study area were an estimated $6.2 million annually from 1985 to 1998 and then fell to a low of $2.4 million in 1994. Total annual income to all businesses in the study area that was generated from fishing at Orange and Lochloosa Lakes was estimated to be $1.8 million from 1985 to 1988. This total income fell to a low of $679,000 in 1993. In 1996, total income from recreational fishing at the lakes recovered a bit to almost $1 million.

Hazen and Sawyer, P.C. 1997. Economic Incentive Approaches to Water Resources Management. Prepared for the Southwest Florida Water Management District. Contract No. 95CON000104.

This report evaluates methods that create economic incentives to individuals, water utilities, and businesses to conserve freshwater and develop alternative water supplies within the Southwest Florida Water Management District area. The methods are evaluated in terms of: (1) maximizing the efficiency in allocating water to permittees; (2) improving the efficiency of water use by permittees; and (3) promoting the development of economically feasible alternative water sources

Hazen and Sawyer, P.C. 1996. Funding Source Inventory for Comprehensive Conservation and Management Action Plans. Prepared for the Tampa Bay National Estuary Program (TBNEP).

This study identifies alternative funding sources to support the CCMP action plans including existing local, state and federal funding sources for which TBNEP could qualify. This study also identified the current funding sources and levels for existing programs that protect the environmental resources of the Tampa Bay estuary. This study is a resource document for environmental project funding within the Tampa Bay area.

Hazen and Sawyer, P.C. 1995. Analysis of Economic Impact: Water Quality Programs, Lake Okeechobee Watershed. Prepared for the South Florida Water Management District. Final Report, Contract No. C-5138. (See also Boggess, Johns and Meline.)

This ex-post study estimates the economic impacts of the dairy programs north of Lake Okeechobee during and after their implementation period (1987 to 1993). All impacts were measured as the difference between what would have likely occurred without these programs versus what actually occurred.

The study found that much of the observed slowdown in economic activity during the study period was due to the national recession. However, the negative economic impact of the dairy programs was evident from the available data. The impact of these programs was a three to seven percent contraction of the Okeechobee County economy during the study period (depending on the year) and less than one percent contraction of the larger regional economy.

Hazen and Sawyer, P.C. 1993. Twenty Year Evaluation: Economic Impacts from Implementing the Marjory Stoneman Douglas Everglades Restoration Act and the United States Versus SFWMD Settlement Agreement. Contract Completion Report. Prepared for the South Florida Water Management District, Contract No. C-4157.

In 1992 and 1993, a regional and statewide economic impact analysis was prepared to estimate the ex-ante changes in sales, earnings and employment that could be expected from alternative stormwater management programs in the Everglades, Agricultural Area (EAA). The study's forecast period was 1994 through 2013.

Hazen and Sawyer, P.C., in association with HSW Engineering. 1998. Statement of Estimated Regulatory Costs for Revisions to Florida Administrative Code Regarding Minimum Flows and Levels in the Northern Tampa Bay Area. Prepared for the Southwest Florida Water Management District, Brooksville, Florida.

As required by Florida Statutes, the Southwest Florida Water Management District established minimum flows and levels and, where appropriate, recovery strategies for the following water resources in the Northern Tampa Bay area: (1) Florida aquifer levels and wetland levels within the Northern Tampa Bay Water Resources Assessment Program study area; (2) fifteen Northern Tampa Bay area lakes; (3) the lower Hillsborough River; and, (4) the Tampa Bypass Canal.

In accordance with Florida Statutes, a Statement of Estimated Regulatory Costs (SERC) was prepared. This SERC provides a good faith estimate of the number and types of individuals and entities likely to be required to comply with the rule. It also estimates the cost to the agency (District) to implement and enforce the rule, and the direct costs likely to be incurred by those complying with the rule. The SERC also reviews the impact of the rule on small businesses, small counties and small cities, and a description of the benefits associated with adopting the rule.

Hazen and Sawyer, P.C., in association with Natural Resource Damage Assessment, Inc. 1992. Economic Benefit Evaluation of Everglades Restoration and Preservation. Prepared for South Florida Water Management District. Contract Completion Report, Contract No. C-3172.

This study provides value estimates for generalized sets of damages to the Everglades ecosystem using the benefits transfer approach. These values are inferred through the use of two study methods. The first method uses the wetland function valuation approach, which values the specific outputs of the wetlands. The second method uses the contingent valuation survey approach to place a dollar value on a natural resource as a whole.

Hazen and Sawyer, P.C., in association with Resource Economics Consultants, Inc., and HSW Engineering. 1994. Economic Impact Statement: for Revisions to Chapter 40D-2, F.A.C., Water Use Permitting, and Chapter 40D-8, F.A.C., Water Levels and Rates of Flow, Including Rules Specific to the Southern Water Use Caution Area. Prepared for the Southwest Florida Water Management District. Project No. P261.

Under certain conditions, Florida Statutes require that, prior to adopting a rule revision, an economic impact statement describing the financial and economic impacts to all persons directly affected by the

proposed revision should be prepared. This study is a comprehensive evaluation of the costs and benefits associated with implementation, monitoring, and complying with the proposed rule that limits the amount of fresh water withdrawn from the Florida aquifer, the area's major water source.. Cost and benefits to all types of water use permittees are described and/or estimated. District and other government agencies are studied; large users and small business interests are evaluated; and potential alternative methods to the rule are described.

Hershman, K.L. 1994. Water for the Everglades: The Evolution of Water Policy in South Florida. Master's thesis, University of Virginia, Charlottesville, Virginia.

This study gives a history of Everglades water supply issues and policies. It points out the often-contradictory objectives of these policies. Over the years, policy regarding water for the Everglades has been one of crisis management rather than the development of policies to guide water management. For this study, interviews with relevant experts and reviews of primary and secondary water policy documents were made and descriptions of the impacts of these policies on the Everglades ecosystem were given.

Jansen, D.K. Big Cypress Public Use Study, July 1983-June 1986. U.S. Department of the Interior, National Park Service, Big Cypress National Preserve.

Through personal interviews, the study determines that the most popular activity of park users was hunting. Fishing and frogging are other park uses. The survey gives demographic information and describes the activities of the average park user.

Kleppel, G.S. and The Estuarine Theme Panel. 1996. Part 1. A Synopsis of Florida's Estuarine Resources with Recommendations for their Conservation and Management. Review Draft. Gainesville: Florida Sea Grant College Program.

This report describes the current status or condition of Florida's estuaries. The findings will help to develop an agenda for researchers associated with the Florida Sea Grant and Florida Coastal Management Programs. Contributors to the report were selected for being authorities within their selected areas of specialty. The report is the first of two volumes. The first volume has a broader audience and is therefore written to ensure easy understanding by scientists and non-scientists alike. This report also identifies data gaps and categorizes them as areas that require additional research.

Leeworthy, V.R. 1999. Personal communication: Estimates from NOAA's Public Area Recreation Visitors Survey (PARVS) in Coastal Areas. Silver Spring, Maryland: Special Projects Office, National Ocean Service, National Oceanic and Atmospheric Administration.

NOAA surveyed nine sites in Florida between 1987 and 1990. Travel cost models were estimated for all nine sites but results were only published for three of the sites. Dr. Leeworthy supplied estimates for the other six sites. Travel cost models were estimated in a variety of specifications including a variety of functional forms using ordinary least squares and Poisson and negative binomial models with truncation using maximum likelihood methods. Best model results were reported. All models reported did not include the value of time. Survey samples were of all visitors (residents and visitors). Consumer's surplus values per person per day (in 1998 dollars) were: $31.19 for Gulf Islands National Seashore; $34.27 for Hugh Taylor Birch State Recreation Area/Ft. Lauderdale Beach; $32.06 for Daytona Beach; $42.59 for St. George Island State Park; $47.76 for St. Andrews State Recreation Area; and $79.37 for the coastal portion of Everglades National Park.

Leeworthy, V.R. 1996. Potential Losses to the Commercial Fishing Industry in Monroe County Resulting from the Sambos Ecological Reserve, 1994. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This paper documents the estimated potential impacts on small businesses, especially the commercial fishing industry, resulting from the prohibition of fishing due to sanctuary regulations in the Sambos Ecological Reserve. The maximum loss assuming that a fishing enterprise cannot replace the lost catch was estimated at $8,801 per commercial fishing enterprise. This loss represented the returns to capital and labor for the fishing enterprise. The maximum loss per seafood dealers/processor to capital and labor was estimated at $9,577.

Leeworthy, V.R. 1996. Technical Appendix: Sampling Methodologies and Estimation Methods Applied to the Florida Keys/Key West Visitors Surveys, June 1995-May 1996. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This document was prepared to provide detailed documentation on how various measurements were derived as reported for visitors to the Florida Key/Key West in Visitor Profiles: Florida Keys/Key West (Leeworthy and Wiley 1996) and Economic Contribution of Recreating Visitors to the Florida Keys/Key West (English et al. 1996). This document is intended for researchers that want to do further analyses with the visitor data and may want to replicate the study in the future. Chapter 1 provides details on the sampling methodologies and methods for estimating the total number of visitors or person-trips (visits) and the number of person-days of visitation. Chapter 2 documents the sample weighting applied to both the on-site and mail-back samples. Chapter 3 provides details on the results of analyses conducted to determine the existence of non-response bias in the various mail-back surveys. Chapter 4 documents the methods used to estimate participation rates and the total number of participants in each activity by seasons. Finally, Chapter 5 documents the methods used for estimating the economic contribution visitors had on Monroe County.

Leeworthy, V.R. 1991. Recreational Use Value for John Pennekamp Coral Reef State Park and Key Largo National Marine Sanctuary, Winter 1988-Spring 1989. Rockville, Maryland: National Oceanic and Atmospheric Administration.

The purpose of this study was to estimate the use value of John Pennekamp Coral Reef State Park and Key Largo National Marine Sanctuary in Florida, which provides recreational activities including diving, boating and other park-related activities. A sample of 342 visitors (i.e., residents and out-of-state tourists) to this area was analyzed using data from 1989. The travel cost method was used to estimate the use value of this area with and without the value of time. The author feels that a realistic estimate of use value for the park is between $285 and $426 per day or an average of $356, in 1989 dollars.

Leeworthy, V.R. 1990. An Economic Allocation of Fishery Stocks Between Recreational and Commercial Fishermen: The Case of King Mackerel, 1986. Doctoral dissertation: Florida State University, Tallahasee, Florida.

A short run economic allocation model was implemented to test whether the 1986 allocation of catch between recreational and commercial fishers maximized the net value of the king mackerel resource or whether the maximum sales, employment and wages impact on the Florida economy was achieved by the 1986 allocation. Using the simple travel cost model for recreational anglers (i.e., both tourists and residents) without the value of time, it was found that the best estimate of use value of the king mackerel resource was $45.60 per resident/tourist angler trip, in 1986 dollars. The asset value of the east and west coasts king mackerel resource to recreational anglers was estimated at $2.8 billion.

Leeworthy, V.R. and J.M Bowker. 1996. Non-market Economic User Values of the Florida Keys/Key West. June 1995 -May 1996. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division; Athens, Georgia: U.S. Forest Service, Outdoor Recreation and Wilderness Assessment Group.

This study estimated the use value of various forms of outdoor recreation involving visitors to the Florida Keys/Key West area. Use values were estimated from the basic travel cost model without the value of time using statistical techniques called the truncated Poisson and truncated negative binomial. These values were obtained from a sample of 4,360 visitors over the 1995-96 period. Day-trippers to the area were very sensitive to price while others, except Hispanics, were not highly sensitive to price with respect to a reduction. The total annual use value for various recreational activities was estimated at about $.9 billion dollars. When capitalized at a discount rate of 3 percent, the asset or capitalized value was about $30.1 billion for just the visitor segment of use value in the Florida Keys/Key West.

Leeworthy, V.R., G.M. Johns, F.W. Bell and M. Bonn. 2001. Socioeconomic Study of Reefs in Southeast Florida, for National Oceanic and Atmospheric Administration, Florida Fish and Wildlife Conservation Commission, and the Counties of Broward, Palm Beach, Miami-Dade and Monroe, Florida. Final Report. October 19, 2001.

This study used survey research to estimate the net economic value of Southeast Florida's natural and artificial reef resources to the local economies and reef users. The study area includes, from north to south, the cities of West Palm Beach, Fort Lauderdale, Miami and the Florida Keys. Data obtained from sport fishers, reef divers, reef snorkelers, glass bottom boat observers and general area visitors, through intercept and mail-out surveys, were used to estimate over a 12-month period (June 2000 to May 2001): (1) total reef use of residents and visitors in terms of person-days and person-visits; (2) economic contribution of natural and artificial reefs in terms of sales, income and employment; and (3) willingness of reef users to pay to maintain the natural and artificial reefs of southeast Florida in their existing condition and willingness of reef users to pay for additional artificial reefs in southeast Florida. Reef users spent 9.9 million person-days using artificial reefs and 18.1 million person-days using natural reefs. Reef users are willing to pay $85 million per year to protect the artificial reefs and $231 million per year to protect the natural reefs in southeast Florida. Income generated from reef-related expenditures was estimated at $194 million in Palm Beach County, $1,049 million in Broward County, $619 million in Miami-Dade County, and $139 million in Monroe County. Total Employment generated from reef-related expenditures was 6,300 jobs in Palm Beach County, 36,000 jobs in Broward County, 19,000 jobs in Miami-Dade County, and 10,000 jobs in Monroe County.

Leeworthy, V.R. and D. Schruefer. 1990. A Socioeconomic Profile of Recreationists at Public Outdoor Recreation Sites in Coastal Areas: Volume 4. Rockville, Maryland: National Oceanic and Atmospheric Administration.

This report summarizes information collected during the winter and spring of 1989 through surveys conducted at four state parks in Florida. Florida residents and out-of-state visitors were sampled regarding their activities in the parks and their willingness to pay for the use of these parks. The visitors were also asked to rate the parks regarding facilities and other characteristics. The willingness to pay per day per person to use the park was estimated as follows: Hugh Taylor Birch SRA - $.31; Coral Reef State Park - $.57; Honeymoon Island SRA - $.26 and Everglades National Park - $.61.

Leeworthy, V.R., D.S. Schruefer and P.C. Wiley. 1991. A Socioeconomic Profile of Recreationists at Public Outdoor Recreation Sites in Coastal Areas: Volume 6. Rockville, Maryland: National Oceanic and Atmospheric Administration.

This study continued the work of Volume 4 under Leeworthy and Schruefer (1990) contained in this bibliography. The reader is referred to that citation for details on the entire study. In this volume, two sites in Florida were included. These sites were Clearwater City Beaches and Daytona Beach City Beaches. All visitors (Floridians and out-of-state) were willing to pay $5.85 and $9.25 for an annual vehicle pass covering all individuals in the vehicle respectively. For these two beaches, the group size and visits per year were: (l) Clearwater, 3.27 and 10.79; and (2) Daytona, 2.61 and 16.03. The value for each beach-goer was $0.17 per day for Clearwater and $0.14 per day for Daytona.

Leeworthy, V.R. and P.C. Wiley. 1997. Technical Appendix: Sampling Methodologies and Estimation Methods Applied to the Survey of Monroe County Residents. June 1996-May 1996. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This document was prepared to provide detailed documentation of how various measurements were derived and reported for residents of Monroe County in A Socioeconomic Analysis of Recreation Activities of Monroe County Residents in the Florida Keys/Key West . Chapter 1 provides details on sampling methodologies and methods for estimating the total number of Monroe County residents that participated in outdoor recreation activities in the Florida Keys/Key West. Chapter 2 documents the sample weighting methods for both the telephone and mailback samples. Chapter 3 provides details on the results of analyses conducted to determine the existence of non-response bias in the various mail-back surveys. Chapter 4 documents the methods used to estimate participation rates and the total number of participants in 66 recreation activities in four regions of the Florida Keys. It also documents how intensity of use was estimated for 37 selected activities by region.

Leeworthy, V.R. and P.C. Wiley. 1997. A Socioeconomic Analysis of the Recreation Activities of Monroe County Residents in the Florida Keys/Key West. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This report describes the results from a 1996 survey of Monroe County residents. The survey used a combination of telephone and mail-back contacts to generate the samples. Over 2,900 Monroe County households completed the telephone survey and over 600 completed the mail-back portion of the survey. The telephone sample was used to collect information on the demographic characteristics of Monroe County households, participation in outdoor recreation activities in the Florida Keys/Keys West, ratings of the quality of life in Monroe County, and the primary reason for locating in Monroe County. The mail-back survey collected detailed information on the types of activities and intensity of involvement.

Leeworthy, V.R. and P.C. Wiley. 1996. Importance and Satisfaction Ratings by Recreating Visitors to the Florida Keys/Key West. June 1995-May 1996. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This report provides an easy-to-use analytical framework for assessing the ratings by visitors in terms of importance and satisfaction with 25 selected natural resource attributes, facilities, and services of the Florida Keys. For 11 of the 25 items, comparisons were made between visitors' current satisfaction ratings and their ratings of these items five years prior. Statistical tests were conducted to highlight significant differences.

Leeworthy, V.R. and P.C. Wiley. 1996. Visitor Profiles: Florida Keys/Key West. June 1995-May 1996. Silver Spring, Maryland: National Oceanic and Atmospheric Administration, Strategic Environmental Assessments Division.

This report summarized the results of an extensive survey of visitors. Included is information on the number of visitors and number of days, place of residence age, sex, race/ethnicity, income, education, employment, recreation activity participation and extent of use by region and season, and detailed spending profiles. Multi-dimensional views of visitors to the Florida Keys are presented. Dimensions include views by season, mode of access (e.g., Auto, Air and Cruise Ship), and domestic vs. foreign visitors.

Leeworthy, V.R. and P.C. Wiley. 1994. Recreational Use Value for Clearwater Beach and Honeymoon Island State Park, Florida. Strategic Environmental Assessment Division, National Oceanic and Atmospheric Administration.

The purpose of this study was to estimate the use values for Clearwater Beach and Honeymoon State Park, Florida. Using the travel cost method (TCM) with the value of time, the use value per day for Clearwater Beach, Florida was found to be $55.96 per day per beach-goer (in l990 dollars). For Honeymoon State Park, the use value per day per user was estimated at $14.91 (in 1990 dollars). Both estimates were for a combination of residents and visitors from out-of-state. It was estimated that the two recreational sites (i.e., beaches) generated over $300 million per year (use value) and would yield an asset value of $10 billion using a discount rate of 3 percent.

Lin, C.T.J. and J.W. Milon. 1995. Contingent valuation of health risk reductions for shellfish products. *In* Caswell, J.A., ed. Valuing Food Safety and Nutrition. Boulder, Colorado: Westview Press.

Introduces the contingent valuation method for valuing the reductions in heath risks associated with the consumption of shellfish products (in the Southeastern U.S., including Florida). The purpose of the analysis was to investigate (1) the relationship between valuation and the magnitude of food-borne risk reductions and (2) whether risk information presented in relative terms and in absolute terms produces different valuation responses. A survey of 1,094 respondents in the Southeast was conducted in early 1990 that asked respondents about their oyster consumption and preferences. The estimated mean willingness to pay to reduce the heath risk from eating oysters relative to the health risk associated with eating chicken ranged from $0.54 to $0.73 depending on the question format and treatment of outliers. The estimated mean WTP to reduce the absolute heath risk from eating oysters ranged from $0.54 to $0.80 depending on the treatment of outliers and the level of absolute risk reduction considered.

Marion, J. L., J.W. Roggenbuck and R.E. Manning. 1993. Problems and Practices in Backcountry Recreation Management: A Survey of National Park Service Managers. National Resources Report NPS/NRVT-NRR-93/12. Denver, Colorado: U.S. Department of the Interior, National Park Service. Natural Resources Publication Office.

The objective of this study was to describe the nature and diversity of visitor-related backcountry (described as primitive, undeveloped portions of the parks) management problems, practices, and solutions in National Park Service areas. Mail-back questionnaires were sent to 106 National Park Service units, including Biscayne National Park and Fort Jefferson National Monument, which have substantial overnight visitation. Results of the survey will arm backcountry recreation managers with a diverse array of management actions that can be applied to a variety of problems.

McClellan, D.B. 1996. Aerial Surveys for Sea Turtles, Marine Mammals, and Vessel Activity along the Southeast Florida Coast, 1992-1996. NOAA Technical Memo., NMFS-SEFSC-390. Miami, Florida: National Marine Fisheries Service, Southeast Fisheries Service Center,

A cooperative agreement was established in September 1992 between the U.S. Coast Guard Miami Air Station and the Miami Laboratory of the National Marine Fisheries Service to monitor marine animals and vessel activity in the Florida Keys. The area included the waters of Biscayne National Park (BNP) and the proposed Florida Keys National Marine Sanctuary (FKNMS). The survey was extended north to Melbourne, Florida to include the Oculina Bank Habitat Area of Particular Concern (HAPC). Through March 21, 1996, a total of 71 surveys were completed and 1,919 sea turtles, 1,118 dolphins, and 12,816 vessels were documented. Sea turtle and dolphin distribution and frequency are presented from Melbourne to Key West.

Milon, J.W. 1991. Measuring the economic value of angler's kept and released catches. North American Journal of Fisheries Management. 11:185-189.

Elaborates on the travel cost methodology used in the study of the economic impact of the Gulf of Mexico king mackerel fishery (see Milon 1989a). The paper focuses on the importance of distinguishing between kept and total (aggregate) catch when assessing angler's valuation of recreational fishing trips. Statistical tests for pooled site travel cost demand models for anglers of king mackerel in the Gulf of Mexico region showed that indicators of kept and released catches outperformed an aggregate indicator. Accounting for the composition of catch had a significant effect on economic measures of the gains and losses from catch regulations and suggested that aggregate indicators may give misleading estimates of the change in economic value due to regulations.

Milon, J.W. 1989a. Contingent valuation experiments for strategic behavior. Journal of Environmental Economics and Management. 17:293-308.

Elaborates on the contingent valuation methodology used in the study of the economic value of artificial reefs in Dade County, Florida (see Milon 1988a). The paper summarizes the results of an experiment that tested for the effects of variations in the Dade County mail survey form on respondent's willingness to pay for artificial reef use and their ability and willingness to disclose their personal valuation.

Milon, J.W. 1989b. Estimating Recreational Angler Participation and Economic Impact in the Gulf of Mexico Mackerel Fishery. Prepared for Southeast Regional Office, National Marine Fisheries Service St. Petersburg, Florida under Contract No. NA86WC-H-06116, RAS/CC31, as part of the Marine Fisheries Initiative. Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Presents the results of the first study to examine the use of the NMFS's Marine Recreational Fisheries Survey (MRFSS) to estimate the economic value of recreational fishing in the Gulf of Mexico. The study concludes that the MRFSS can be used to provide data for the economic evaluation of recreationally caught king mackerel and other species. However, in order to provide reliable economic information, greater consideration in the MRFSS must be given to (1) fishermen's site and species substitution alternatives, (2) fishing activity at different times of the year, and (3) the opportunity cost of time spent in fishing activities.

Milon, J.W. 1988a. The Economic Benefits of Artificial Reefs: An Analysis of the Dade County, Florida Reef System. SGR 90. Gainesville: Florida Sea Grant College Program.

Presents results from a research project to identify recreational uses of artificial reefs by private boat owners in Dade County, Florida and to evaluate merits of alternative methods to measure the economic benefits of artificial reef development. First, the contingent value method was employed (CVM) in three different ways: (l) Open ended/Voluntary, (2) Referendum and (3) Bidding Game. The annual user values for these three methodologies were $18.04, $19.75 and $26.57 per user of artificial reefs. The average user of artificial reefs visited a site about 10 times each 6 month period or about 20 times per year. On a per day basis, this would yield a use value from the three techniques of $.90; $.99 and $1.33 respectively. Various travel cost techniques were used to estimate the use value per year of artificial reefs. The results ranged from $3.14 (nested multinomial Logit) to $20.70 (single site with substitute prices). On a per day basis, this would range from $.16 to $1.04. All values are in 1984 dollars. The capitalized or asset value of the reef system off Dade County was estimated $128.3 million using a discount rate of 3%. This is based on private boat use and does not include party or charter use of artificial reefs.

Milon, J.W. 1988b. A nested demand shares model of artificial marine habitat choice by sport anglers. Marine Resource Economics 5:191-213.

Discusses the development and compares alternative specifications of the nested multinomial travel cost demand model used in the study of the economic value of artificial reefs in Dade County, Florida (see Milon 1988a). The modeling approach uses information on the location of fishing sites to construct a decision hierarchy that represents the choices for an individual private boat sport angler deciding whether to use a specific habitat site.

Milon, J.W. 1988c. Travel cost methods for estimating the recreational use benefits of artificial marine habitat. Southern Journal of Agricultural Economics. July: 87-101.

Compares and discusses the single and multi-site travel cost demand models used in the study of the economic value of artificial reefs in Dade County, Florida (see Milon 1988a). Theoretical concerns about price and quality effects of substitute sites, corner solutions in site choice and econometric estimation are considered. Results from the case study indicate that benefit estimates are influenced by the way these concerns are addressed, but relatively simple single site models can provide defensible estimates. Practical limitations on data collection and model estimation are also considered.

Milon, J.W., C.M. Adams and D.W. Carter. 1998. Floridians' Attitudes about the Environment and Coastal Marine Resources. TP95. Gainesville: Florida Sea Grant College Program.

Provides a description of a research project designed to assess Floridians' attitudes about the environment and coastal marine resources and their support for programs to protect these resources. A statewide survey of nearly 1,800 adult residents elicited information on: preferences for expenditures on various state programs, attitudes about the environment and specific marine resources, participation in coastal recreation activities, and general socioeconomic and demographic characteristics. The survey results indicate that Floridians are broadly committed to an environmentally oriented world view. They are concerned about the health of coastal resources and the adequacy of existing programs to protect these resources. While there were differences in the intensity of these attitudes across respondents, the consistency of the responses indicates that these attitudes are not random and idiosyncratic, but rather, reflect the personal philosophies, interests, and experiences of the respondents.

Milon, J.W., C.F. Kiker, and D.J. Lee. 1998. Adaptive ecosystem management and the Florida Everglades: More than trial-and-error? Water Resources Update 113(1998d):37-46.

Updates the paper by Milon, Kiker, and Lee published in the Journal of Agricultural and Applied Economics (1997). Discussion is extended to include an evaluation of how adaptive management principles have been utilized to deal with the diverse and complex problem of the Everglades/South Florida restoration. Three main issues are highlighted: the interaction between water demand and supply used in the modeling and evaluation process; the use of natural and social sciences in developing plan alternatives; and, the expected use of monitoring and decision making during the implementation.

Milon, J.W., C.F. Kiker and D.J. Lee. 1998. Conflict and Cooperation on Trans-Boundary Water Resources. In R. Just and S. Netanyahu, eds. Ecosystems and Social Conflict: Lessons from the Florida Everglades. Boston, Massachusetts: Kluwer Academic Publishers.

A heuristic framework is presented to consider the interplay between ecosystems and social institutions in ecological-economic organizations. The framework is used to compare three periods in the historical development of the Everglades to illustrate the changes in the ecologic-economic organization of the South Florida region. The analysis indicates a social adaptation process leading to a transformation of ecosystem attributes and, ultimately, to centralized management. It remains to be determined whether new initiatives to restore the ecosystem can succeed without causing more social conflict.

Milon, J.W., C.F. Kiker and D.J. Lee. 1997. Ecosystem management and the Florida Everglades: The role of social scientists. Journal of Agricultural and Applied Economics 29:99-107.

Discusses role of the social sciences in the ecosystem management approach to environmental protection and regulation with special reference to the Florida Everglades. An adaptive procedure to guide interdisciplinary research is described and illustrated with highlights of recent progress and pitfalls from the restoration initiative for the Everglades/South Florida ecosystem. Two components of the Central and Southern Florida Project Restudy are pointed out as areas that scientists should address in an interdisciplinary setting. These components are: agricultural land use, water quality, and terrestrial habitat; and, hydroperiods, terrestrial and marine habitats, and wildlife.

Milon, J.W., S.L. Larkin, D.J. Lee, K.J. Quigley and C.M. Adams. 1998. The Performance of Florida's Spiny Lobster Trap Certificate Program. SGR 116. Gainesville: Florida Sea Grant College Program.

Assessment and review of Florida's Spiny Lobster Trap Certificate Program (TCP) that included estimates of administrative costs incurred, revenues collected, and the transfer of certificate ownership and use. Actual costs and revenues were compared to initial estimates to determine whether the TCP has fulfilled expectations about its viability as a regulatory mechanism. Results indicate that the TCP has fulfilled initial expectations by reducing the total number of traps and increasing the yield per trap. The analysis also identified several factors that have inhibited the performance and could potentially jeopardize the overall success of the TCP. Management proposals are discussed that could address these factors.

Milon, J.W., D. Mulkey, P.H. Riddle and G.H. Wilkowske. 1983. Economic Impact of Marine Recreational Boating on the Florida Economy. SGR 54. Gainesville: Florida Sea Grant Program.

Presents the results of an input-output analysis of Florida's recreational boating industry. The purpose was to identify the output, employment, and income directly produced by the industry and to estimate the indirect and induced effects of the industry on other Florida industries. Results of the analysis were

that in 1980 the industry: employed approximately 15,300 employees, paid $232 million in wages and salaries, produced total output valued at $752 million, and contributed $345 million of value added. Including secondary effects the impacts of the industry 1980 can be summarized as follows: total employment was 30,000 employees; total income generated was $543 million; and total economic activity associated with the industry was $1.5 billion.

Milon, J.W. and P.H. Riddle. 1982. Employment and Sales Characteristics of Florida's Recreational Boating Industry. SGR 52. Gainesville: Florida Sea Grant College Program.

The purpose of this report was to provide economic information on Florida's marine recreation industry with particular emphasis on the characteristics of employment and sales in recreational boating. Important findings from the report include: from 1964 to 1981, the number of recreational boats registered in Florida increased by 360,010 (298 percent), and the number of recreational boats per thousand residents increased from 21.4 boats to 47.6 boats. Boat registration data in the ten largest boating counties reflect differences in the types of recreational boating enjoyed in Florida. Florida's market accounted for 10.5 percent of the national market for retail sales of boats, motors, trailers and marine accessories during 1980. Retail sales for marine recreation in Florida increased 313 percent from 1970 to 1981. Wages of employees in the boat building and repairing sector were considerably higher than the minimum wage, but lower than wages in total manufacturing. Labor turnover rates were high in the boat/ship building and repairing sectors compared to labor turnover rates for total manufacturing.

Milon, J.W. and A. Rimal. 1997. Substitution, Sequencing and Starting Point Effects in the Valuation of Composite Environmental Goods. Food and Resource Economics Department Staff Paper, University of Florida, Gainesville, Florida.

Presents the results from a contingent valuation experiment with survey data from the Indian River Lagoon National Estuary Program (see Apogee Research et al. 1996) and the Coastal Resources Survey (see Milon et al. 1998a). The study estimated willingness to pay for various combinations of six different environmental programs: sea grass restoration and protection, sea turtle protection, coral reef restoration and protection, wetland conservation measures, a wetland restoration trust fund, and stormwater controls. The mean annual willingness to pay for the individual Indian River Lagoon environmental programs ranged from $58.71 to $112.05 and from $79.25 to $405.02 for the combined programs. Similarly, the mean annual willingness to pay for the individual Coastal Resources Survey environmental programs ranged from $1.36 to $65.39 and from $46.61 to $216.90 for the combined programs.

Milon, J.W., D.O. Suman, M. Shivlani and K.A. Cochran. 1997. Commercial Fishers' Perceptions of Marine Reserves for the Florida Keys National Marine Sanctuary. TP89. Gainesville: Florida Sea Grant College Program.

Presents the results of a survey of 337 commercial fisher's in the Florida Keys regarding their perceptions and attitudes about NOAA's Draft Management Plan for the Florida Keys National Marine Sanctuary (FKNMS) and the proposed replenishment reserves. Information on fishing effort and catch (by species) within the FKNMS and participation in the Plan development process was also collected. A large majority did not believe that stocks of commercially important species such as spiny lobster and reef fish would increase outside the reserve area. Most believed that the primary effect would be to conserve and protect corals, fishes, and other marine life within the boundaries of each reserve. Respondents were nearly unanimous in their opinion that recreational divers, not commercial and recreational fishers, would be the primary beneficiaries of the proposed reserves and that there would not be a positive long-term effect on the economy in the Keys.

Milon, J.W., E.M. Thunberg, C.M. Adams, J.C. Crotts, S.M. Holland and C.T.J. Lin. 1993. A Regional Analysis of Current and Future Florida Resident Participation in Marine Recreational Fishing. SGR 112. Gainesville: Florida Sea Grant College Program.

Describes and summarizes the results from a statewide survey of Florida households regarding their participation in marine recreational fishing, their motivations for fishing, and attitudes toward management of Florida's fisheries. Data from the survey were used to estimate a forecasting model to project recreational fishing in seven Florida regions through the year 2010. Statistical results from the survey showed that anglers were more likely to be white males, younger, come from larger households, and have higher income than non-anglers. The portion of resident angler expenditures related to wholesale and retail goods produced in Florida contributed to a total value of economic output associated with marine recreational fishing of $949.1 for the State. Anglers cited enjoyment of nature, relaxation, and the challenge of catching fish as important motivations for fishing. Also, the majority of anglers preferred to catch and release fish and they supported the use of bag limits to control recreational catch.

Milon, J.W., E.M. Thunberg, C.M. Adams and C.T.J. Lin. 1994. Recreational Anglers' Valuation of Near-Shore Marine Fisheries in Florida. Prepared for the Florida Marine Fisheries Commission under Contract No. C-705, from the Florida Department of Natural Resources. Food and Resource Economics Department, University of Florida, Gainesville, Florida.

This report describes and summarizes the results from a statewide survey of Florida resident saltwater anglers. The researchers use the contingent valuation method to collect angler responses regarding their willingness to pay for proposed management changes associated with selected marine species. Findings from the study showed that recreational anglers did place an economic value on marginal changes in catch regulations. However, a high percentage or respondents gave a zero willingness to pay; interpreted as: they placed no value on the particular management changes that were presented.

Milon, J.W. and R. Welsh. 1989. An Economic Analysis of Sport Fishing and the Effects of Hydrilla Management in Lake County Florida. Food and Resource Economics Department Economics Report 118, University of Florida, Gainesville, Florida.

This study used the results of telephone and mail surveys to identify sport anglers' preferences and associated economic values for aquatic plant control in Lake Harris and Lake Griffin in Lake County, Florida. The survey evaluated the effect of hydrilla management on anglers' preference and willingness to pay for control of the aquatic weed. Total annual willingness to pay for controlling hydrilla ranged from $50,000 to $176,000, depending on the level of hydrilla preference displayed by anglers. Local anglers derived greater benefit from the lakes than non-resident anglers did. The estimated total annual lake-related expenditure in 1985 was an estimated $1.75 million.

Milon, J.W., G. Wilkowske and G.L. Brinkman. 1983. Financial Structure and Performance of Florida's Recreational Marinas and Boatyards. Florida Sea Grant Report SGR 53. Gainesville: Florida Sea Grant College Program.

Presents the results of a survey of 283 (71 responses) Florida private and public marinas conducted from June 1981 to March 1982. The data indicated considerable regional diversity among marinas in terms of annual revenues, number of employees, age, size, utilization, and market versus book value. On a statewide basis, the average age of a private (public) marina was 19 (29) years and, on average, the 1981 owners had owned private (public) marinas for 11 (22) years. Private (public) marinas with 1981 annual

revenues under $1 million reported average annual revenues of $444,854 and marinas with 1981 annual revenues over $1 million reported average annual revenues of $2,494,173. Around 33 (14) percent of the private (public) marinas' business was from tourists in 1981. In general, smaller marinas were found to perform at least as well as the larger marinas in terms of liquidity ratios. The median return on investment for all Florida marinas of 10.2 percent was virtually the same as the returns experienced at other Southern and New England marinas, although Florida marinas used less leverage.

Milon, J.W., J. Yingling and J.E. Reynolds. 1986. An Economic Analysis of the Benefits of Aquatic Weed Control in North-Central Florida. Food and Resource Economics Department Economics Report 113, University of Florida, Gainesville, Florida.

This study was conducted to: identify fishing use of freshwater sites in North-Central Florida; determine anglers' preferences for alternative levels of aquatic weed control; estimate the economic impact of recreational fishing on two North Florida lakes; and, estimate the economic value of alternative levels of aquatic weed control on both lakes. A mail survey was used to collect primary data to conduct the analysis. The analysis concluded that the annual economic benefits of maintaining a weed control program for both lakes in 1985 was an estimated $383,063. Total annual gross expenditures by local and non-resident anglers was an estimated $5.6 million. Multiplier effects determined that the total economic activity was an estimated $10.8 million per year. The study demonstrated that survey research could be used to identify user group preferences for aquatic weed control and the economic benefits and impacts of such controls.

Mulkey, D., S. Gran and C.A. Adams. 1994. Monroe County: An Economic Overview. Final Report of a Component Study (Volume II) for the Economic Adjustment Assistance Development Grant for Monroe County, Florida. Food and Resource Economics Department, University of Florida, Gainesville, Florida.

Available secondary data were compiled and assimilated to describe a variety of economic and social characteristics of Monroe County. Data were obtained from a number of sources, both from county and state agencies. Data are related to population, income, employment, unemployment, retail sales, tourism development tax proceeds, and commercial and recreational fishing activities. Data are presented for major economic sectors of the local economy, and more detailed data are presented for the service and retail sales sectors due to their relative importance.

Parker, S.L. 1989. Report on a Survey of Floridians' Attitudes about Environmental Issues, Prepared for Florida Department of Environmental Regulation (Now Department of Environmental Protection). Tallahassee, Florida.

This study involved a phone survey of approximately 1,000 residents of the State of Florida regarding their attitude toward various environmental issues facing the state. Among all other issues (e.g., unemployment, taxes, etc.), the environment ranked first in the public's mind. Most individuals in the survey characterized themselves as environmentalists. Main concerns were air and water quality and the protection of endangered species. Most individuals would be willing to pay more for environmental control.

Platt, J.L. 1989. Estimating the Economic Impacts of Hypothetical Grouper Bag Limits in the Destin/Panama City, Florida Charterboat Fishery. NOAA Technical Memorandum NMFS-SEFC- 227, 1-72.

The purpose of this study was to estimate the use value of recreational grouper fishing by anglers using charter boats off the Destin/Panama City, Florida area. The policy purpose was to find out how use

value varies with bag limits, a fishery management regulatory tool. A sample of 434 charter boat anglers was collected in 1985. The travel cost technique was applied to this sample to determine use value/consumer surplus. Analytical results indicated a median of 1.69 trips and $78 per angler per year without bag regulations. Closure of the grouper fishery (i.e., catch and release) would reduce demand to 1.55 trips and $66 annually. The value of time was integrated into all use value estimates. Anglers included Florida resident and those from out-of-state.

Robinson, S.D. 1971. Tortious water and land use in the Big Cypress Swamp. University of Miami Law Review 25(4).

This article reviews scientific and policy literature related to the Big Cypress Swamp, and reviews Florida law decisions and the relationship between them. This article attempts to tie solutions to environmental problems to an existing common law system as in the case of Florida water law and the crisis in the Big Cypress Swamp. Previously, economic consideration such as profitable use of private property, expansion of the economic base, increased production, and meeting the housing needs of a growing population, have been salient. Modern water law permits us to make value judgments to resolve these competing factors. These judgments must necessarily stress factors which are environmental.

Rockland, D.B. 1988. The Economic Impact of the Sport and Commercial Fisheries of the Florida Keys, 1986. Washington, D.C.: Sports Fishing Institute.

The purposes of this study were to estimate the economic impact of the sport and commercial fisheries in the Florida Keys on the economy of Monroe County, Florida and the State of Florida. Economic impact is defined in terms of sales/output, income, employment, and tax revenues generated by spending associated with each of the fisheries. A main objective was to provide comparable information for both the sport and commercial fisheries so valid comparisons could be made between each of these user groups.

Ross, D.M. 1985. Report on Everglades National Park Visitor Survey. Miami, Florida: Everglades National Park, Air Resource Specialists, Inc.

The purpose of the visitor's survey was to collect information to determine how important visibility-related attributes are to other attributes found in Everglades National Park. Such information was obtained from randomly selected visitors from the park's Visitor's Center who completed and mailed back their surveys. Results of the surveys have provided park management with a typical visitor profile, the most popular park locations, and the most important attributes of the recreational experience.

Sharp, W.C., R.D. Bertelsen and J.H. Hunt. 1998. The 1994 Florida Recreational Spiny Lobster Fishing Season: Results of a Mail Survey. Gulf and Caribbean Fisheries Institute 48:29.

Since 1991, the Florida Department of Environmental Protection has conducted annual mail surveys of recreational spiny lobster fishers in Florida. These surveys concern lobster fishing activity during the periods of the Special Two-Day Sport Season and the first month of the regular season and allow us to estimate the recreational harvest, the number of people that fished, fishing group size, and the catch per unit effort (CPUE) for those times. An estimated 362,369 lobsters were harvested by 51,510 fishers during the 1994 Special Two-Day Sport Season and about 1,320,045 lobsters were harvested by 63,225 fishers during the first month of the 1994 regular season. Most (64 percent) of the total number of lobsters captured during these two survey periods were harvested in the Florida Keys, and those fishing in the Florida Keys had the highest mean CPUE.

Stewart, W.P. and M.I. Ivy. 1990. A Sociology Study of Wintertime Backcountry Users at Everglades National Park. Technical Report No. 14. National Park Service Cooperative Park Studies Unit. College Station: Texas A&M University.

The study of winter season backcountry users at Everglades National Park was used to build a sociological database that could also be used as a basis for effective management decisions. Recommendations made by the study emerged from an on-site and mail-out survey of day and overnight users; the effectiveness of policies at analogue park areas; the collective professional judgment of scholars and land managers associated with outdoor recreation; and the author's past experience and opinions. Among such recommendations are: (l) enhance and expand the density of recreational experience afforded by the park's backcountry; (2) expand the number of designated sites within close proximity to trailheads; and (3) maintain and improve backcountry trip planning facilities.

Stratis, N. and B. Bendle. 1995. A Socio-economic Study of the Rodman Reservoir. Florida Department of Environmental Protection, Economic Analysis Section, Office of General Counsel Tallahassee, Florida.

This report was developed to address the economics of restoring the Oklawaha River. Four options were assessed: (1) full retention of the Rodman Reservoir (status quo); (2) partial retention (smaller reservoir); (3) partial restoration (removal of the Rodman Dam); and, (4) full restoration (restoration of the Oklawaha River as close as possible to its pre-impoundment condition. Non-market recreation user values were estimated for both the Rodman Reservoir and the Oklawaha River using the travel cost method. The study estimated the consumer's surplus per person per day of $12.17 for the Rodman Reservoir for all visitors and $10.09 for those living within a 75-mile radius. For the Oklawaha River the study estimated a consumer's surplus per person per day of $8.18 for all visitors and $6.78 for those living within a 75-mile radius of the site. Estimates were in 1994 dollars.

Stronge, W.B. and R.R. Schultz. 1997. Broward County Beaches: An Economic Study 1995-96. Technical report 97-03. Prepared for the Broward County, Department of Natural Resource Protection, Biological Resources Division, Ft. Lauderdale, Florida by Regional Research Associates, Inc., Boca Raton, Florida.

This report developed estimates of both the market and non-market economic values of Broward County beaches for year 1995-96. Market economic values estimated included direct expenditures, indirect expenditures, tax revenues, and the number of jobs in Broward County, Southeast Florida and all of Florida. In addition, property values related to proximity to the beaches are also estimated. Non-market economic use values are estimated using a contingent valuation question. Overall the study estimated that there were 7,169,447 visits to Broward County beaches that generated a total annual non-market economic user value of $29,677,770. Per visit values, in 1998 dollars, were reported for Delray Beach ($4.94), Anna Marie Island ($41.2) and Captiva Island ($7.00).

Suman, D.O. and M.P. Shivlani. 1997. Catch and Effort Profiles of Commercial Fishermen in the Florida Keys National Marine Sanctuary. Draft report. Division of Marine Affairs and Policy, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida.

The draft article presented catch and effort profiles for the major fisheries in the Florida Keys, as reported by 340 commercial fishermen during a 1995-96 study. The article demonstrated the importance of the Florida Keys National Marine Sanctuary region to the major commercial fisheries, where over 90 percent of the spiny lobster and reef finfish, and two-thirds of the stone crab catch were landed in 1994-95. The article also demonstrated the geographical importance of certain species, such as migratory mackerels and deep-water pelagics. The article also gave effort information by fishery.

Suman, D.O. and M.P. Shivlani. 1997. Data and Results from Dive Operator Surveys in the Florida Keys: Use and Perceptions of the Florida Keys National Marine Sanctuary. Draft report, Division of Marine Affairs and Policy, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida.

The draft report summarizes the results of a study conducted with dive operators in the Florida Keys in 1995-96. The study surveyed dive operators in the region, and provided estimates of the economic investments and annual operating costs of dive operators, the total number of divers taken by the operators on an annual basis, and the intensity of site use and trip frequency within Florida Keys National Marine Sanctuary proposed zones. The study also reports the perceptions of dive operators regarding the Sanctuary planning process and zoning strategy. Dive operators were generally in favor of zones in the Florida Keys but disapprove of the Sanctuary zoning strategy. Most respondents believed that diving and snorkeling activities do affect marine resources and that mooring buoys had a positive effect on the environment. However, a majority of the dive operators were unwilling to support either a dive operator-funded or diver-funded mooring buoy program in the Sanctuary.

Suman, D.O. and M.P. Shivlani. 1997. Preliminary Results from Mail Survey by Means of Three Florida Keys-based Environmental Groups and their Perceptions on the Florida Keys National Marine Sanctuary Zoning and Designation Process. Division of Marine Affairs and Policy, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida.

The study was conducted using mail surveys between late 1995 and early 1996. The study describes and analyzes the use preferences and perceptions of members from three Florida Keys-based environmental groups regarding the Florida Keys National Marine Sanctuary (FKNMS). Environmental group members were generally in favor of the FKNMS, but their levels of support were much lower towards the Sanctuary's zoning strategy. The respondents perceived the zoning strategy more as a means of conserving and protecting biodiversity, rather than for maintaining fish stocks within the region. A majority of the members are in favor of increasing the percentage of zones in the FKNMS and are willing to contribute towards zone management via user fees.

Suman, D.O. and M.P. Shivlani. 1996. Commercial Fishermen and the Florida Keys National Marine Sanctuary. The Coastal Society, First Conference Proceedings.

The paper discusses the perceptions of commercial fishermen regarding the Florida Keys National Marine Sanctuary and its proposed zoning strategy, based on a survey study conducted with 340 fishermen in the Florida Keys. The study determined that 79 percent of the respondents are against the establishment of the Sanctuary, and 87 percent disapprove of the Sanctuary zoning strategy. Only six percent believe that their group will be the primary beneficiary of the zoning plan, and more fishermen perceive that the purpose of the zones is to protect and conserve biodiversity than to augment stocks either within or outside the zones. A majority of the respondents disapprove of the Sanctuary planning process, and almost two-thirds of the fishermen believe that participation in the process is futile because of their inability to influence the decisions.

Thunberg, E.M., C.M. Adams and C.E. Cichra. 1991. Economic Regulatory and Technological Barriers to Entry Into the Florida Aquaculture Industry. Florida Sea Grant Report E1 91-8. Gainesville: Florida Sea Grant College Program.

A mail survey was conducted in 1991 to identify barriers-to-entry into the Florida Aquaculture industry. The survey was administered to all 586 individuals on the Florida Agricultural Statistics Service Aquaculture industry participant list. The survey results showed that economic factors (financial and

marketing) presented the greatest barriers-to-entry into the Florida Aquaculture industry, while regulatory barriers were relatively less problematic. Barriers were found to be highest for catfish culturists, followed by ornamental fish, bivalves, aquatic plants, and alligators.

Tilmant, J.T. 1989. A history and an overview of recent trends in the fisheries of Florida Bay. Bulletin of Marine Science 44(1):3-22.

This paper presents a historical review and description of the fisheries of the Florida Bay. Documented interest in the fishery resources of Florida Bay dates from the earliest accounts of human activity. and harvest of both commercial and recreational fisheries up to the present time. The total recreational fish harvest from Florida Bay by guided and non-guided parties has ranged between 700,000 and 800,000 fish per year since 1984. The National Park Service (NPS) monitoring program has provided detailed data on the fishing effort.

Tilmant, J.T., E.S. Rutherford, R. Dawson and E.B. Thue. 1986. An Analysis of the Recreational and Commercial Estuarine Fisheries Harvest within Everglades National Park 1958-1985, Report SFRC 86/08. Homestead, Florida: Everglades National Park.

This study examines and reports on both recreational and commercial fisheries data in the estuarine areas of Everglades National Park from 1958-1985 as well as stock assessments that were conducted on major species harvested. Permitting and voluntary reporting of 1965 commercial fishery harvest provided data for the report, in addition to boat ramp interviews with fishermen for recreational harvest data.

Tilmant, J.T., G.P. Schmahl and D. Morrison. 1986. An Ecological Assessment of Biscayne National Monument's Coral Reefs in Relation to Recreational Use. Homestead, Florida: U.S. Department of the Interior, National Park Service, Everglades National Park.

The emphasis of this coral reef study, initiated in 1977, was to provide basic ecological data and determine possible impacts of recreational reef use. Environmental conditions of four buoyed patch reefs were compared to four similar unmarked control reefs. On each study reef, periodic observations were made of fish populations, coral communities, etc., and levels and types of visitor activities. Significant ecological impact from recreational use was evident.

United States Department of the Interior. 1994. The Impact of Federal Programs on Wetlands: A Report to Congress by the Secretary of the Interior, United States Department of the Interior. Vol. II, Chapter 7. Washington, D.C.

Chapter 7 of the Secretary of the Interior's Report gives a physical description of the past and current extent of the Everglades ecosystem. Some recommendations and potential solutions that were elicited may alter the Federal government's role in the Everglades Ecosystem. Where feasible, agencies should minimize the wetland effects of their programs. Where this proves infeasible, agencies should furnish Congress with an explanation of why adjustments cannot be instituted.

United States Department of the Interior. 1991. E.N.P. An Assessment of Recreational Boating and Its Potential Impact on Resources within the Crocodile Sanctuary at Everglades National Park. Washington, D.C.

This study reevaluated the concept of the Florida Bay Crocodile Sanctuary for the purposes of incorporating and allowing recreational boaters into the sanctuary while minimizing known and possible adverse efforts upon the endangered American crocodile. Methods used in this study include a literature

search and consultations with park staff and various agency and university specialists. The study determined that providing certain limited and seasonal recreational access to the sanctuary would not adversely impact either the threatened or endangered species in the area.

United States General Accounting Office (USGAO). 1995. Restoring the Everglades: Public Participation in Federal Efforts. Resources Community, Economic Development Division. RCED-96-5. Washington, D.C.: USGAO.

This document reviews the implications of involving non-federal entities (stakeholders) in the policy development process for specific environmental concerns in South Florida. Constraints imposed by external factors often dictate the extent to which federal agencies can involve non-federal stakeholders in their activities. Furthermore, although consensus among federal and non-federal stakeholders is desirable, restoration efforts are inherently contentious, and consensus on solutions that directly affect various interests may not be attainable. In addition, stakeholders express dissatisfaction with the process for non-federal involvement. In many cases, a public policy decision cannot be disassociated from stakeholder dissatisfaction with the outcome of the process. Therefore, the most that federal agencies may be able to achieve is an open airing and full consideration of all views within the constraints imposed by external factors.

Vrana, K.J. and E.M. Mahoney. 1995. Impacts on Underwater Cultural Resources: Diagnosing Change and Prescribing Solutions. Underwater Archaeology, Annual Proceedings, 176-180.

The paper identifies and discusses impact assessment concepts from different management and research fields, as applied to underwater cultural resources (in particular, shipwrecks). Concepts discussed include: (1) shipwrecks as exhaustible, nonmarket resources; (2) impacts and effects upon these sites; (3) classification of impacts; (4) carrying capacity concepts; and (5) impact decision-making frameworks (e.g., recreation opportunity spectrum; visitor management process, limits of acceptable change, visitor impact management). The review of literature provides some conclusions about impact assessment for shipwrecks, and shipwreck management in general.

Ward, J.M. 1994. The Economic Implications of Bycatch and Discards in the Gulf of Mexico Shrimp Fishery. St. Petersburg, Florida: National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southeast Fisheries Center. (See also, the bioeconomic implications of a bycatch reduction devise as a Stock Conservation Management measure. Marine Resource Economics 9:227-240).

The proposed regulations to reduce bycatch and discarding of finfish in the Southeastern region of the United States is a gear modification that excludes finfish from shrimp trawls. This regulation was analyzed using a simple theoretical model of a multispecies fishery whose bycatch was harvested in a direct fishery consisting of commercial and recreational fishermen. The no-cost reduction in by-catch fishing mortality imposed on the multi-species fishery does not result in an increased stock size for the bycatch fish species or a substantial increase in its level of harvest. Instead, the fish stock is reallocated from the multi-species fishery to the fishery directed at the bycatch species causing fishing effort to expand in the bycatch species fishery that drives the stock size down to the previous existing equilibrium level. Recreational harvest and effort levels remain unchanged since the model is linear in effort and the commercial fishery is given access to the fishery first.

Wiedman, D. 1976. The individual and innovation in the process of socio-cultural adaptation to frontier situations. Papers in Anthropology, University of Oklahoma 17(1):107-116.

This paper outlines a process of human adaptation to new environments. Ethnographic fieldwork and historical data from the Chokoloskee Bay area of Southwest Florida are used in a comparative analysis of three frontier areas of the World. This process is suitable for understanding the various cultural groups as they adapt to South Florida environments, for example, their settlement patterns, use of resources and technological innovation.

York, M. and J. O'Brien. 1996. Eastward Ho! Financial Impediments and Solutions. Florida Department of Community Affairs (DCA), FAU/FIU Joint Center for Environmental and Urban Problems, Tallahassee, Florida.

This project examines the financial impediments that deter development and redevelopment in the established urban corridor areas in South Florida. It seeks to offer solutions to these problems in order to strengthen these urban communities while lessening some of the development pressure in the less developed western portions of the three South Florida counties.

Zubrow, E.B.W., J.R. Schumm, S. Finn, G.A. Panetski and J. Van Ness. 1995. The Biological Reserve: The future's last stand. Futures, Cedar Falls, Iowa 27(4):437-446.

This article addresses the societal and cultural aspects of bio-reserves and environmental restoration programs. It begins with a discussion of bioreserves, then uses the example of a Man and Biosphere (MAB) inspired study of the U.S. Everglades to illustrate how land has been shaped historically by culture and technology. It then demonstrates how current conflicts of values and culture, from both inside and outside the region, and from interest groups with both pragmatic and emotional attitudes, are determining the future of an environment such as the Everglades. The article thereby shows how human values and perceptions impact on the development of a sustainable Everglades, using the findings of surveys and public meetings to highlight the interests of the competing communities, ethnic and interest groups involved.

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Florida Sea Grant College Program
PO Box 110400
University of Florida
Gainesville, FL 32611-0400
(352) 392-5870
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