94-435 ENR

CRS Report for Congress

The Florida Bay Economy and Changing Environmental Conditions

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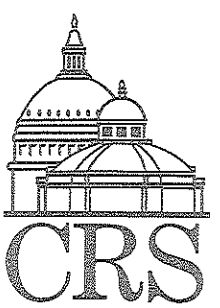
May 20, 1994



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SUMMARY

Florida Bay is a large, triangular coastal lagoon located at the southern tip of Florida, between Everglades National Park and the Florida Keys. Substantial changes in the vegetation of this shallow saltwater bay have occurred within the past decade. The mangroves that ring the mudflat islands are dying. The seagrass that carpets much of the Bay began dying in 1987, and the dieoff now affects nearly a quarter of the Bay. This seagrass dieoff is linked to blooms of blue-green algae that are, in turn, linked to a sponge dieoff. Finally, diatom blooms have become increasingly common in the western portions of the Bay since 1979.

Many are concerned that these changes in the vegetation of Florida Bay are affecting the resident fauna. Florida Bay contains resident and transient populations of bottlenose dolphins and provides habitat for the endangered manatee, several endangered sea turtle species, and along the north shore, the endangered American crocodile. The Bay provides feeding and nesting habitat for many bird species, but the number of ospreys and of wading bird colonies has declined. The Bay also provides nursery grounds for many species of finfish and shellfish, as well as habitat for other life stages for some species.

The Bay's finfish and shellfish are important foundations for the two major industries in adjacent Monroe County: commercial fishing and tourism. To date, the only measurable economic losses that coincide with the vegetation change are in commercial fishing, principally from the substantial decline in pink shrimp harvests. The losses since 1986, including indirect and induced effects, total about 500 jobs and $32 million in annual personal income. However, commercial harvests of spiny lobster, snappers, and groupers -- with about 2,800 primary and secondary jobs and $20 million in personal income -- are threatened by the vegetative changes.

Tourism is also threatened by the vegetative changes in Florida Bay. While precise estimates are impossible, it appears that tourism accounts for about a quarter of the Monroe County economy -- 12,000 jobs and $200 million in personal income. The threat is less direct than with commercial fishing, but is nonetheless real. The algae and diatom blooms have reduced water clarity in an area previously favored by recreational divers because of its pristine waters. The Bay provides habitat for several important sport finfish, such as spotted seatrout and red drum. The changes in the Bay may also threaten the oceanside coral reefs that attract sport divers.

The imprecision in estimating the tourism economy and in linking it with the vegetative changes makes it difficult to estimate the potential economic effects. Nonetheless, the changes are apparent to tourists and are attracting national attention as an example of ecosystem degradation. Losing a quarter of tourists and seasonal residents is certainly possible. Such a decline would threaten thousands of jobs and tens of millions of dollars in personal income -- probably exceeding the potential losses associated with a decline in commercial fishing. Furthermore, because changes in tourism are likely to lag behind changes in environmental quality, losses in the tourist economy are likely to persist, even if vegetation in the Bay were to recover quickly. Finally, economic declines would reduce local property values and tax collections.

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INTRODUCTION

Florida Bay is a large, triangular saltwater bay, located between Everglades National Park on the north and the Florida Keys on the southeast. The seagrass in this broad, shallow bay has suffered extensive dieoffs and damage since 1987, causing concern over the future of the commercial fishing and recreation/tourism industries of the area. Furthermore, some have asserted that the seagrass dieoffs and degradation of other resources in and near the Bay are the result of the extensive waterworks put in place since 1950 to control flooding in South Florida.

This report provides a brief overview of the resource conditions of Florida Bay and of the economy of the directly adjacent Monroe County. It does not examine causes of the environmental changes in depth, because of the substantial uncertainty over causes and the ongoing research efforts to document the causes. Rather, it focuses on the environmental changes that have occurred and on the economic changes that have occurred and that may be imminent.

PHYSICAL AND BIOLOGICAL RESOURCES

LOCATION AND PHYSICAL DESCRIPTION

Florida Bay is a large coastal lagoon located between Everglades National Park, at the south tip of Florida, on the north and the Florida Keys on the southeast. Estimates of its size vary from less than 400,000 acres (600 square miles) to nearly 550,000 acres (850 square miles), because the Bay's western edge merges into the Gulf of Mexico in an imprecise boundary.

Florida Bay is shallow, with average depths estimated at 3 to 6 feet. The Bay contains numerous mud islands, generally fringed with mangroves, and mud shoals. The shallow bottom and the relative clarity of the Bay's water has, in the past, promoted the growth of extensive beds of seagrass throughout the Bay. The waters of the Bay are generally saline, with hypersaline conditions (salt concentrations exceeding average ocean levels) occurring sporadically in various parts of the Bay. The coastal transition zone at the north edge of the Bay has generally brackish, estuarine conditions that differ from the offshore Bay.

Florida Bay is part of a larger ecosystem, linking watersheds from central Florida through the coral reefs on the oceanside of the Florida Keys. One recent assessment noted:

> The ecosystems from the Kissimmee River, through the Everglades and the Bay and onto the barrier reefs off the Keys are, in fact, connected and constitute an interdependent landscape-seascape. Yet, to the extent that these environments have been purposefully managed at all, they have been managed as if they were in isolation from one another.[1]

Thus, concern over the biophysical changes in Florida Bay, and the resulting economic impacts, is not limited to the Bay and its users. Rather, management of the lands and waters of southern Florida affects the Bay, and the conditions of the Bay affect the waters of the Keys and the conditions of the reefs, even though these interrelationships are not well defined.

The National Park Service administers the majority of the Bay, as part of the Everglades National Park. Portions along the Keys are part of the Florida Keys National Marine Sanctuary, under the jurisdiction of the National Oceanic and Atmospheric Administration (NOAA). Thus, the Federal Government bears most of the immediate responsibility for management of Florida Bay. However, management of the lands and waters north of the Everglades has been affected by efforts to control floods, to drain wetlands, and to provide water for municipalities, industry, and agriculture. Therefore, decisions by the U.S. Army Corps of Engineers, the South Florida Water Management District, and innumerable private landowners also bear responsibility for the conditions affecting these interrelated ecosystems.

VEGETATION IN THE BAY

Mangroves generally ring the mud islands, although the island centers are often mats of blue-green algae.[2] There is concern about a dieoff of mangroves, although information on the location and extent of the dieoff seems limited. In addition, there is no scientific consensus on the cause of the dieoff.

The majority of the Bay is carpeted with several species of seagrass, although turtle seagrass (*Thalassia testudinum*) dominates. A seagrass dieoff began in 1987, and continues to spread. The dieoff now affects about 100,000 acres -- 20-25 percent of the Bay. Numerous possible causes have been, and are being, explored, including:

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[1]Donald F. Boesch, Neal E. Armstrong, Christopher F. D'Elia, Nancy G. Maynard, Hans W. Paerl, and Susan L. Williams. *Deterioration of the Florida Bay Ecosystem: An Evaluation of the Scientific Evidence. Report to the Interagency Working Group on Florida Bay*. Unpublished report. Sept. 15, 1993. p. 16. (Hereafter referred to as *Deterioration of Florida Bay*.)

[2]U.S. Dept. of Commerce, National Oceanic and Atmospheric Admin., Sanctuaries and Reserves Division. *Florida Keys National Marine Sanctuary. Draft Environmental Impact Statement/Management Plan*. Feb. 1994. p. 31 (Hereafter referred to as *Florida Keys Sanctuary Draft EIS*.)

1. A substantial reduction in the frequency of hurricanes and other major storms that clear and thin seagrass beds.
2. Landfill and development in the Keys that alter water circulation patterns.
3. An increase in nutrients, especially nitrogen and phosphorus, from agricultural and other activities in the watershed.
4. A reduction in the quantity and change in the timing of freshwater flowing into the Bay, because of the extensive drainage and flood control structures and activities in the watershed.

Various studies are examining these and other possible factors in the continued seagrass dieoff.[3]

The seagrass dieoff has also been linked to other vegetative changes. Blue-green algae blooms have occurred in the eastern and central portions of Florida Bay, and these blooms have been linked to the seagrass dieoff.[4] The seagrass dieoff has also been linked to the recent increase in turbidity (decreased clarity) of the water in an area known for clear water and excellent underwater visibility.[5] These blue-green algae blooms have also been identified as a cause of the dieoff of sponges in Florida Bay.[6]

In addition to the blue-green algae blooms, diatom blooms have occurred in western Florida Bay since 1979, and are becoming increasingly prevalent. Since the diatom blooms began before the seagrass dieoff, and because the seagrass dieoff is generally spatially separated from diatom blooms, these two occurrences appear to be unrelated. Rather, the diatom blooms "may be characteristic of a troublesome and growing trend of coastal eutrophication" (excessive nutrient enrichment) from both natural and anthropogenic sources.[7]

FLORIDA BAY FAUNA

A diverse fauna of finfish and shellfish, as well as other aquatic animals, inhabit Florida Bay. The Bay provides nursery habitats for spiny lobster, pink

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[3]*Deterioration of Florida Bay*, p. i-ii; Michael B. Robblee, W. Jill DiDomenico, and Louise E. King. *Florida Bay Seagrass Dieoff Studies: An Annual Report.* Homestead FL: Everglades National Park, South Florida Research Center, Oct. 1, 1991.

[4]*Deterioration of Florida Bay*, p. 12.

[5]Tom Armiento, Mike Robblee, Peter Ortner, Nancy Thompson, Dave Ruddnick, and John Hunt. *Interagency Florida Bay Science Plan: Working Draft.* Unpublished report. Jan. 7, 1994. p. 10.

[6]*Deterioration of Florida Bay*, p. 14.

[7] *Deterioration of Florida Bay*, p. 12.

shrimp, stone crab, groupers, snappers, seatrout, snook, and red drum. It is also important for other life stages of these finfish.

The seagrass dieoff and resulting blue-green algae blooms and sponge dieoff are probably reducing the shellfish populations, and may be reducing finfish populations, as well. Commercial landings of shellfish -- spiny lobster, pink shrimp, and stone crab -- in Monroe County have declined substantially since 1985.[8] Landings in the county averaged 17.6 million pounds annually from 1971 to 1985, but only 12.2 million pounds annually from 1986 to 1990, a decline of more than 30 percent.[9] Much of this decline has been in pink shrimp landings, historically the largest commercial fishery in Monroe County; landings in 1990 (4.0 million pounds) were only 25 percent of 1981 landings (15.6 million pounds).[10]

Direct links between the decline in shellfish landings and the seagrass dieoff have not been definitively established. Pink shrimp juveniles are associated with seagrass and shrimp harvests have been correlated with freshwater inflows,[11] but associations and correlations are not definitive proof. However, the sponge dieoff that is almost certainly due to the seagrass dieoff and resulting blue-green algae blooms will probably (and may already have begun to) reduce commercial spiny lobster harvests, because the sponges are critical habitat for juvenile spiny lobsters. Finally, declines in the recreational harvests of spotted seatrout and red drum have been reported.[12]

A wide variety of wading birds feed and nest in and around the Bay. To the extent that populations of aquatic species (finfish as well as invertebrates of varying sizes and life stages) have been reduced by the vegetative changes in the Bay, feeding habitat for wading birds is less productive. Furthermore, the mangrove dieoff is reducing nesting sites, and a decline in wading bird nesting around Florida Bay has been reported.[13]

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[8]Commercial landings of shellfish and finfish that depend on Florida Bay habitats might also have declined in other counties, but direct linkages have not been clearly established between Florida Bay's condition and commercial fish landings outside Monroe County.

[9] Chuck Adams. *Economic Activities Associated With the Commercial Fishing Industry in Monroe County, Florida.* Staff Paper SP92-27. Gainesville, FL: Univ. of Florida, Inst. of Food and Agricultural Sciences, Dec. 1992. p. 3.

[10]*NOAA Workshop on the Restoration of Florida Bay.* (Bradford Brown and Peter B. Ortner, Conveners.) Unpublished report. Miami, FL: July 14-16, 1993. pp. 34-35. (Hereafter referred to as *NOAA Workshop on Florida Bay.*)

[11]*NOAA Workshop on Florida Bay*, p. 72.

[12]*Deterioration of Florida Bay*, p. 13; *NOAA Workshop on Florida Bay*, p. 35-37.

[13]*Deterioration of Florida Bay*, p. 13.

Florida Bay is also the home to several endangered reptiles: American crocodile; loggerhead sea turtle; green sea turtle; and Kemp's ridley sea turtle. While it is unclear whether the vegetative changes in the Bay have harmed the sea turtles, hypersaline conditions in the transition zone along the north edge of the Bay have affected crocodile nesting patterns.[14]

Finally, Florida Bay provides habitat for two species of marine mammals. The West Indian manatee is an endangered species found throughout the Bay, especially in estuarine habitats, that appears to migrate to warmer waters in the winter.[15] The bottlenose dolphin is also found throughout the Bay, and may include both resident and transient populations.[16] It is unclear whether any of the vegetative changes in Florida Bay have affected either species of marine mammal.

THE MONROE COUNTY ECONOMY

OVERVIEW

The economy of Monroe County is highly dependent on the resources of Florida Bay. Monroe County encompasses the western half of the onshore part of Everglades National Park, and all of Florida Bay and the Florida Keys. Dade County lies to the east, and borders on eastern Florida Bay. However, the Dade County economy is dominated by Miami and its environs, and contains no direct human land access to Florida Bay. Thus, the Bay has a minor, and probably negligible, impact on the Dade County economy.

It should be noted that economic activity dependent on Florida Bay probably has linkages beyond the borders of Monroe County. This is particularly true for commercial fishing operations based in Gulf Coast ports north of Monroe County; some depend on species, such as spiny lobster, pink shrimp, and stone crab, reared in Florida Bay nursery habitats. However, without more substantive research on the relationship between finfish and shellfish landings in these counties and the Florida Bay habitats, quantitative estimates of the potential economic losses outside Monroe County resulting from the degraded habitats of Florida Bay are infeasible. Suffice it to say that the estimated economic effects on Monroe County probably understate the total regional economic effects of the physical and biological changes in Florida Bay.

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[14]*Deterioration of Florida Bay*, p. 13.

[15]*NOAA Workshop on Florida Bay*, pp. 41-42.

[16]*NOAA Workshop on Florida Bay*, pp. 41-42.

The resident population of Monroe County was 79,000 people in 1991.[17] In addition to the year-round residents, seasonal residents (whose residence for Census purposes is elsewhere) may exceed 50,000.[18] The permanent residents had a total personal income in 1991 of more than $1.6 billion, an average of $20,332 per capita. This is 7 percent higher than average Florida per capita personal income ($18,985) and nationwide average per capita personal income ($19,091).[19]

Personal income has three components: net earnings; dividends, interest, and rent; and transfer payments. Net earnings -- wages and salaries, other labor income, and proprietors' income, adjusted for personal contributions for social insurance and for residence -- is the largest component, accounting for $782 million (49 percent) of 1991 Monroe County personal income. For comparison, net earnings accounted for 57 percent of all 1991 personal income in Florida, and 67 percent of all 1991 personal income in the United States.

Personal income from dividends, interest, and rent -- earnings from wealth, rather than from labor -- accounted for $628 million (39 percent) of Monroe County personal income in 1991. This is substantially higher than the 26 percent of Florida personal income and 17 percent of U.S. personal income generated from wealth in 1991, and is at least partly due to the relatively high seasonal population, many of whom rent temporary residences.

Transfer payments -- welfare, unemployment payments, and especially pensions and other retirement income -- provided only $197 million (12 percent) of Monroe County personal income in 1991. This was substantially lower than the 17 percent of 1991 Florida personal income and 16 percent of 1991 U.S. personal income from transfer payments, although retirement income for temporary residents is typically reported as occurring at their primary residence.

Table 1 presents gross earnings by economic sector for Monroe County in 1991. (Gross earnings differ from the net earnings discussed above, because sectoral earnings data include personal contributions for social insurance, but not certain residence benefits.) The table presents both gross earnings and the share of earnings from each sector, and compares them with average sectoral shares for Florida and for the United States. Table 2 presents 1991 sectoral employment data in a similar format.

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[17]U.S. Dept. of Commerce, Bureau of Economic Analysis, Regional Economic Measurement Division. *Personal Income by Major Source and Earnings by Industry*. Unpublished data. Washington, DC: April 26, 1994. (All data in the Overview are from this source, unless otherwise specified.)

[18]*Florida Keys Sanctuary Draft EIS*, p. 11.

[19]U.S. Dept. of Commerce, Bureau of Economic Analysis, Regional Economic Information System. *Bearfacts: Monroe, Florida, 1990-91*. Unpublished data. Washington, DC: n.d.

Table 1. Monroe County Gross Earnings in 1991
(in millions of dollars and percent)

	-- Monroe County -- Earnings	Percent	Florida	United States
Total	853.23	100.00%		
Agriculture	0.00	0.00%	1.83%	1.33%
Forestry/Fisheries [a]	20.20	2.37%	0.98%	0.67%
Mining	0.70	0.08%	0.20%	0.98%
Construction	50.47	5.92%	5.79%	5.33%
Manufacturing Sector				
Nondurable Goods	6.36	0.75%	3.89%	7.43%
Durable Goods	4.02	0.47%	6.35%	11.62%
Service Sector				
Transportation [b]	43.70	5.12%	6.42%	6.70%
Wholesale Trade	20.67	2.42%	6.38%	6.43%
Retail Trade	159.09	18.65%	12.25%	9.66%
F.I.R.E. [c]	11.47[d]	1.34%	6.47%	6.96%
Services	307.74	36.07%	32.04%	26.32%
Government				
Federal Civilian	40.62	4.76%	2.89%	3.35%
Federal Military	79.92	9.37%	2.02%	1.39%
State & Local	108.27	12.69%	12.50%	11.83%

[a]The full title is Agricultural Services, Forestry, Fisheries, and Other.
[b]The full title is Transportation and Public Utilities.
[c]The full title is Finance, Insurance, and Real Estate.
[d]The 1991 income in F.I.R.E. is abnormally low, because of 1991 net losses of $7.30 million in Real Estate and of $9.12 million in Holding & Other Investment Companies.

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, Regional Economic Measurement Division. *Personal Income by Major Source and Earnings by Industry*. Unpublished data. Washington, DC: April 26, 1994.

As is true for the U.S. economy, the Monroe County economy is dominated by businesses in the service sectors. The local economy is particularly dominated by retail trade and services, suggesting a dependence on tourism. (The service sector includes health care, hotels and other lodging, legal and business services, and other such activities.) Commercial fishing is also a foundation of the Monroe County economy. The agricultural services/forestry/fisheries sector in Monroe County is relatively large, and is dominated by commercial fisheries. (Agricultural services dominates this sector in the rest of Florida and nationwide.) Finally, the county has a substantial Federal military presence, but this is unrelated to the existence or condition of Florida Bay, and will therefore not be addressed further in this report.

Table 2. Monroe County Employment in 1991

	-- Monroe County -- Jobs	Percent	Florida	United States
Total	48,477	100.00%		
Agriculture	0	0.00%	1.31%	2.24%
Forestry/Fisheries [a]	3,187	6.57%	1.91%	1.07%
Mining	44	0.09%	0.19%	0.72%
Construction	2,680	5.53%	5.79%	4.86%
Manufacturing Sector	717	1.48%	7.45%	13.87%
Service Sector				
Transportation [b]	2,009	4.14%	4.59%	4.76%
Wholesale Trade	848	1.75%	4.80%	4.78%
Retail Trade	11,058	22.81%	18.69%	16.45%
F.I.R.E. [c]	4,376	9.03%	9.55%	7.69%
Services	14,978	30.90%	31.35%	28.11%
Government				
Federal Civilian	1,315	2.71%	1.77%	2.31%
Federal Military	3,174	6.55%	2.00%	1.89%
State & Local	4,091	8.44%	10.61%	11.25%

[a]The full title is Agricultural Services, Forestry, Fisheries, and Other.
[b]The full title is Transportation and Public Utilities.
[c]The full title is Finance, Insurance, and Real Estate.

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, Regional Economic Measurement Division. *Full-Time and Part-Time Employees by Major Industry*. Unpublished data. Washington, DC: April 26, 1994.

COMMERCIAL FISHING

Gross earnings from commercial fishing in Monroe County exceeded $17 million in 1991, accounting for more than 2 percent of gross earnings in the county.[20] Monroe County contributes significantly to gross earnings from commercial fishing in the State, accounting for more than 20 percent of Florida's gross earnings from commercial fishing in 1991.

Despite the importance of this sector in 1991, gross earnings from commercial fishing in Monroe County have declined substantially since the seagrass dieoff began in 1987. In 1986, Monroe County gross earnings from commercial

[20]Commercial fishing includes those activities associated with harvesting and landing commercial fishery products. Onshore processing is included in food and kindred products (a manufacturing sector), while subsequent sales are included in wholesale and/or retail trade (service sectors).

fishing were more than $31 million, accounting for more than 5 percent of the county's gross earnings that year. Thus, in 5 years, gross earnings in Monroe County from commercial fishing have declined by more than $14 million (45 percent); because inflation makes 1991 dollars less valuable than 1986 dollars, the effective decline has been even greater -- more than 50 percent.

It is unclear whether the decline in gross earnings from commercial fishing in Monroe County is related to the environmental changes in Florida Bay, because total gross earnings from commercial fishing in Florida declined by a slightly greater amount. Florida gross earnings from commercial fishing in 1991 were $82.3 million, only 52 percent of 1986 gross earnings ($158.2 million). It is unclear what has caused this precipitous decline in earnings from commercial fishing in Monroe County and throughout Florida.

In contrast to the decline in earnings, commercial fishing employment in Monroe County has been relatively stable. In 1991, employment in the agricultural services/forestry/fisheries sector totalled 3,187 people, more than 6.5 percent of total Monroe County employment.[21] In 1986, the sector employed 3,408 people, accounting for 8 percent of county employment. Sectoral employment thus declined by 221, only 6.5 percent, while gross earnings declined by about half. Therefore, average earnings per employee (for the whole sector) declined by a third, from $9,780 per employee in 1986 to only $6,528 in 1991, excluding additional effective declines due to inflation.

The earnings data are fully consistent with data on finfish and shellfish landings in Monroe County.[22] Nearly 20 million pounds of finfish and shellfish were landed in Monroe County in 1990, about 11 percent of the commercial landings in Florida. However, because of higher values for the shellfish that dominate Monroe County landings, and because of higher average values in Monroe County, the $48.4 million in dockside value accounted for nearly 25 percent of the value of commercial landings in Florida. Of this, $16.7 million (34.5 percent) were distributed as earnings to the workers, while the remainder went for supplies, insurance, interest, and boatowner profit (if any).

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[21]Separate data on fisheries employment were not included in the Commerce Department data. However, from 1986 through 1991, commercial fisheries accounted for about 90 percent (plus-or-minus 5 percent) of gross earnings from the agricultural services/forestry/fisheries sector in Monroe County. Thus, employment data for the entire sector are strongly indicative of employment in commercial fishing. In contrast, sectoral employment data for Florida are probably not indicative of commercial fisheries employment, because commercial fishing accounted for only 8 percent (ranging from 5 to 15 percent) of sectoral gross earnings from 1986 through 1991.

[22] Unless otherwise specified, data on commercial fisheries landings are from: Chuck Adams. *Economic Activities Associated with the Commercial Fishing Industry in Monroe County, Florida*. Staff Paper SP92-27. Gainesville, FL: Univ. of Florida, Inst. of Food and Agricultural Sciences, Dec. 1992. 20 pp.

Several finfish species are important Monroe County commercial fisheries. In 1990, snappers, especially yellowtail snapper, accounted for 28 percent of the weight and 49 percent of the value of commercial finfish landings in the county. Monroe County accounted for more than 90 percent of Florida's 1990 commercial landings of yellowtail snapper, and more than half of Florida's commercial landings of two other snapper species. Other important finfish landings in Monroe County include groupers and grunts -- 7 percent of the weight and 9 percent of the value landed in 1990 -- and Spanish mackerel -- 15 percent of the weight and 6 percent of the value landed in 1990.

Finfish landings in Monroe County peaked in the mid-1970s, with nearly 10 million pounds landed annually from 1974-1977. The landings fell sharply in the late 1970s, to less than 6 million pounds annually from 1978-1980, but have recovered since. From 1981 through 1990, finfish landings have averaged 8 million pounds annually, with no discernible trend. Thus, through 1990, changes in the condition of Florida Bay have apparently not affected commercial finfish landings in Monroe County. However, some have suggested that future harvests of snappers and groupers might decline, because the Bay provides important habitat for several life stages for these species, while others have reported declining populations of these and other finfish species.[23]

Shellfish dominate the commercial landings in Monroe County, accounting for 61 percent of the weight and 84 percent of the value of commercial landings in the county in 1990. (In contrast, shellfish accounted for 30 percent of the weight and 56 percent of the value of commercial landings in Florida in 1990.) Spiny lobster, pink shrimp, and stone crab rank first, second, and third in both pounds and value landed in the county in 1990, and sponges (included with shellfish for commercial fisheries reporting purposes) ranked fifth in value. Monroe County accounted for more than 90 percent of Florida's commercial spiny lobster landings, and more than 40 percent of the landings for the other shellfish species, in 1990.

In contrast to finfish landings, shellfish landings have clearly declined in conjunction with the change in condition of Florida Bay. Shellfish landings averaged 17.6 million pounds annually from 1971-1985, with a peak of 22.8 million pounds in 1981. From 1986-1990, however, shellfish landings averaged only 12.2 million pounds annually, with a low of 10.2 million pounds in 1989. Thus, the average decline is more than 30 percent, with a distinct downward trend suggesting even lower commercial shellfish landings in the future. Shellfish landings began declining prior to the 1987 seagrass dieoff, although the landings were still at or above the 15-year average in 1984 and 1985. Studies have noted that pink shrimp harvests began declining after the appearance of the diatom blooms in the western portion of Florida Bay, and seem correlated with the declining freshwater inflows.[24]

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[23]*NOAA Workshop on Florida Bay*, pp. 35-36, 78.

[24]*Deterioration of Florida Bay*, p. 14; *NOAA Workshop on Florida Bay*, pp. 34-35.

While data are not available to examine details of the decline in shellfish landings, several studies have noted the sponge dieoff and the decline in pink shrimp harvests.[25] Thus, two important shellfish species appear to have been directly affected already. However, another source has reported that pink shrimp parent stocks have been rising slowly but steadily since 1960.[26] It may be that pink shrimp harvests have declined because of competition from low-priced shrimp imports, rather than because of reduced stocks, but the data are insufficient to evaluate these alternative explanations.

The most important shellfish species in Monroe County in 1990 -- spiny lobsters, with 27 percent of the weight and 44 percent of the value of all commercial fishery landings -- has apparently not been affected yet. Because of their dependence on sponges during their juvenile stages, however, and because of the sponge dieoff, future harvests of spiny lobsters are very likely to decline, perhaps substantially. When this will occur depends on the time required for spiny lobsters to grow to commercially harvestable size. Thus, the largest commercial fishery in Monroe County in 1990 is threatened by the changes in the environmental condition of Florida Bay, although the magnitude of the threat is unclear, and even an immediate return to pre-1987 conditions might not prevent this anticipated decline.

In summary, commercial fisheries landings and resulting personal income have declined in conjunction with the changes in condition of Florida Bay. The decline in real (deflated) income over the past 5 years has been more than 50 percent. However, the weight of commercial landings -- principally of pink shrimp -- has declined by only about 30 percent. The difference is probably due to the weak economy. (Shellfish is generally recognized as a "superior" good, with rising demand during economic recoveries and falling demand during recessions.) Assuming that the decline in pink shrimp landings is associated with changes in the condition of Florida Bay, as some have suggested, the 30 percent decline in landings is a loss of about $20 million in gross revenues, and about $7 million in personal income, from 1986 to 1990.

This decline in commercial fisheries landings only shows the loss to date. Further declines are very possible. The future of pink shrimp landings is uncertain, but the trend appears downward. The importance of Florida Bay for snappers and groupers has been noted, and declining commercial landings of these species are credible, although no quantitative projections have apparently been offered. Given the significant commercial landings of these species (2.7 million pounds worth $4.5 million -- 58 percent of the value of finfish landings in Monroe County in 1990), the decline in gross revenues and personal income could be significant. More important, however, is the anticipated decline in

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[25] *Deterioration of Florida Bay*, pp. i, 1; *NOAA Workshop on Florida Bay*, pp. 34-35, 72.

[26] U.S. Dept. of Commerce, National Marine Fisheries Service. *Our Living Oceans: The First Annual Report on the Status of U.S. Living Marine Resources*. NOAA Tech. Memo. NMFS-F/SPO-1. Washington, DC: Nov. 1991. pp. 52-53.

landings of spiny lobster due to the sponge dieoff. There appear to be no quantitative estimates of the extent of the sponge dieoff, in either acres or percent, and thus the likely decline in spiny lobster landings is unknown. Given the greater significance of spiny lobster landings (5.3 million pounds for $21.2 million -- 44 percent of the value of all commercial fisheries landings in Monroe County in 1990), and the stronger ecological linkage indicating a likely decline, the economic impact is likely to be substantial -- several million dollars in gross revenues and in personal income in the county.

TOURISM

The tourism "industry" is much more difficult to assess than is commercial fishing (or most other industries), because economic data are aggregated by type of establishment or organization, not by type of purchaser (tourist or resident). Tourist expenditures (and the resulting earnings and employment) on food and lodging, for example, are not distinguished from expenditures by residents.

The majority of the tourist economy occurs in two sectors: retail trade, including eating and drinking places, automotive dealers and service stations, food stores, general merchandise stores, and miscellaneous retail; and services, including hotels and other lodging places. These sectors are clearly more important in Monroe County than in Florida or nationwide. (See tables 1 and 2.) These sectors produced $467 million in gross earnings in 1991, nearly 55 percent of gross earnings in the county. They also employed 26,036 people, nearly 54 percent of total Monroe County employment in 1991. In Florida, these sectors were less important, accounting for 44 percent of gross earnings and 50 percent of employment; nationally, they accounted for only 36 percent of gross earnings and 45 percent of employment.

While it is impossible to know precisely how large the tourist industry in Monroe County is, the millions of tourists[27] and tens of thousands of seasonal residents suggest that the "tourist economy" could directly account for half the expenditures, earnings, and employment in the retail trade and services sectors, and thus could account for a quarter of the Monroe County economy -- more than $200 million in gross earnings and 12,000 employees. These gross estimates are reasonably consistent with data reported from other sources.[28]

Evaluating the possible effects of changes in Florida Bay conditions on the tourist industry is further complicated by the indirect linkage between tourism and the quality of the environment. Populations and commercial landings of pink shrimp and spiny lobster, for example, can be correlated with environmen-

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[27]According to the *Monroe County Statistical Abstract*, more than 6 million tourists visited the Florida Keys in 1990. Cited in: Water Quality Joint Action Group. *Florida Bay and the Monroe County Economy*. Unpublished report. Key West, FL: Mar. 8, 1994.

[28] Water Quality Joint Action Group. *Florida Bay and the Monroe County Economy*. Unpublished report, citing "Bureau of Economical Analysis." Key West, FL: Mar. 8, 1994.

tal conditions, because their growth and development depend on the condition of their habitats. However, subtle changes in environmental conditions are only one factor, albeit an important one, in people's choices of when and where to recreate. Changing environmental conditions influence recreation choices, but there is not a direct correlation between environmental conditions and recreation use of an area.

The most direct linkages between Florida Bay and tourism in the county are through recreational fishing and diving. Both activities occur on both sides of the Keys -- in Florida Bay and along the reefs on the ocean-side of the Keys. However, the coral reefs depend on water flows from the Bay, and changes in Florida Bay's conditions, or in the ability of water to flow from the Bay between the Keys, may damage the reefs.[29] Thus, many major recreational activities at least partly depend on the condition of the aquatic resources of Florida Bay.

The influence of environmental conditions on recreation use also depends on the tourist perceptions. Changes that might damage commercial fishing, for example, might not affect recreation and tourism until the effects of the changes are widely recognized -- through persistent and substantial declines in recreational fish catches, substantial environmental changes that affect water clarity (*e.g.*, widespread algae blooms), and extensive media coverage of the changed conditions (*e.g.*, news magazine stories). Thus, tourism response to changed environmental conditions may be delayed, perhaps by several years.

To date, there is no direct evidence of a decline in the tourism industry of Monroe County. Since 1986, earnings in the retail trade and services sectors that account for most of the tourism economy have grown at rates substantially above the growth rate of the general economy. Employment has also grown, although employment in services declined slightly (0.2 percent) from 1990 to 1991, perhaps due to the economic recession.

Nonetheless, because of the possible delay between changed environmental conditions and recreational activities, a decline in the tourism industry due to changes in the condition of Florida Bay is quite possible. As with potential declines in commercial finfish and spiny lobster landings, there appear to be no estimates of the possible timing or magnitude of a decline in tourism. However, an unknown, but potentially substantial fraction of the industry's roughly $200 million in gross personal income and 12,000 jobs may be at risk. Furthermore, because of delays between changed conditions and tourism, any decline could persist for perhaps several years even if conditions in Florida Bay improved.

SECONDARY EFFECTS

Secondary economic effects are the indirect and induced effects of a change in the direct (or primary) industry; this is also called the "multiplier" effect. Indirect effects are the changes in demand for supplies and thus the impact on

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[29] *Florida Keys Sanctuary Draft EIS*, p. 11.

suppliers. If commercial fishing declines, for example, the firms that supply and repair gear and boats and that sell diesel fuel and other operating supplies will likely see a decline in demand for their goods and services; declining sales and profits, in turn, often force reductions in the workforce, thus reducing earnings and employment. Induced effects are the changes in the demand for goods and services that result from changes in earnings and employment in the direct and indirect industries. Thus, a decline in a primary industry may precipitate a decline in secondary industries.

Secondary effects are typically estimated using "multipliers" to calculate total changes in demand, earnings, and employment associated with a change in demand in the primary industry. Multipliers that estimate the secondary effect of a change in a primary industry vary widely by industry and region, but generally range from about 0.5 to 2; *i.e.*, for $1 of lost demand or earnings (or each lost job) in the primary industry, the secondary loss is between $0.50 and $2 (.5 and 2 jobs). (Thus, the total economic loss is between $1.50 and $3 of demand or earnings -- or between 1.5 and 3 jobs -- counting both primary and secondary effects.)

Multipliers are commonly calculated using an input-output model of the regional economy. Input-output models are quite useful in assessing possible regional economic changes, but also have serious limitations. First, they are static representations of the economy, but economies are dynamic. Secondary impacts are smaller when a regional economy is growing, because the losses (at least the induced impacts) associated with a decline in a primary industry are absorbed by growth in other industries. Second, input-output models assess the existing interdependencies, but the induced effects of lower earnings and employment may be less than calculated by the models because of unemployment insurance, use of savings, and part-time and temporary employment. Because of these problems, multipliers for a given industry and region can differ; for example, the employment multipliers used in studies of the impacts of spotted owl protection ranged from 1.4 to 2.3 total jobs per direct timber industry job (as well as ranging from 4.2 to 16.2 direct jobs per million board feet of timber not harvested).[30]

Relevant economic multipliers for commercial fishing and for tourism in Monroe County are virtually nonexistent. One study[31] calculated multipliers for fishery products exported from the county: $1.49 in total sales for each $1 of export sales; $0.59 in total earnings for each $1 of export sales; and 41 total jobs for each $1 million of export sales. These multipliers are based on

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[30]U.S. Library of Congress, Congressional Research Service. *Economic Impacts of Protecting Spotted Owls: A Comparison and Analysis of Existing Studies*. [by Ross W. Gorte.] CRS Report for Congress No. 92-922 ENR. Washington, DC: Dec. 7, 1992. pp. 49-60.

[31]Chuck Adams. *Economic Activities Associated with the Commercial Fishing Industry in Monroe County, Florida*. Staff Paper SP92-27. Gainesville, FL: Univ. of Florida, Inst. of Food and Agricultural Sciences, Dec. 1992.

wholesale values, which are calculated from markups on the dockside value of each fishery product; the average markup is 32 percent. If one shifts the wholesale markup to secondary effects (making dockside value the direct output measure of the commercial fishing industry), the total sales is $1.96 for each $1 of dockside landings. Earnings would thus be $0.79 per $1 of dockside landings and employment would by 54 jobs per $1 million of landings. Since gross commercial fisheries earnings in Monroe County in 1990 ($16.7 million) averaged $0.35 earnings per $1 of dockside landings ($48.4 million), total earnings would be $2.27 per $1 of earnings in commercial fishing. The employment estimate shows no secondary employment effects; the ratio of commercial fisheries employment (2,666 jobs)[32] to dockside landings ($48.4 million) in Monroe County in 1990 is 55 primary industry jobs per $1 million of dockside landings. Thus, since the sales and earnings multipliers are consistent with other data, one would expect secondary effects (deducting effects on the primary industry) from declines in commercial fishing to be $0.96 in sales and $1.27 in earnings. However, there would likely be some secondary employment effects, as well -- most likely about 1 secondary job per commercial fishing job.

Estimates of comparable multipliers for tourism in Monroe County, or elsewhere, apparently do not exist. Nonetheless, if tourism in Monroe County declined, the effects would undoubtedly ripple throughout the economy. Because of the relatively low wages in the retail trade and services sectors, the induced impacts might be lower than is typical of primary producing industries. However, supplies account for a relatively high proportion of total sales, and thus the indirect impacts might be relatively higher. Thus, it seems reasonable to assume that the secondary effects of changes in tourism are similar to the secondary effects of changes in other industries -- secondary effects would probably be at least equal to the effects on the primary industry.

ADDITIONAL IMPACTS

Secondary effects document the indirect and induced economic changes that result from changes in a primary industry, and are typically estimated using an input-output (I/O) model. However, as our understanding of the economic impacts of environmental changes expands, the limitations of I/O analyses for estimating economic impacts are becoming clearer. I/O models estimate the primary and secondary economic losses when production in a primary industry is constrained, such as for environmental protection or recovery; I/O models do not estimate the economic benefits of environmental protection (or losses from continued environmental degradation) unless deterioration reaches a finite level

[32]The Commerce Department employment data are for the agricultural services/forestry/fisheries sector. The fisheries employment has been assumed to be the same proportion of total sectoral employment that fisheries earnings are a proportion of total sectoral earnings -- 86 percent of the sector in 1990.

from which static comparisons can be made.[33] Three categories of economic impacts have been identified: (a) the indirect costs imposed by environmental degradation on other industries; (b) the aesthetic and health costs imposed on residents by environmental degradation; and (c) the declining existence and bequest values from environmental degradation.

The situation in Monroe County poses special challenges for traditional economic analyses of environmental degradation/protection. Production in the primary industries -- tourism and commercial fishing -- is being constrained by the environmental changes in Florida Bay. To the extent that constrained production can be quantified, the externalities noted above can be captured within the I/O analysis of primary and secondary effects. Nonetheless, the environmental changes in Florida Bay affect the aesthetic and other values. A method for estimating such impacts has been proposed,[34] but the method is very data-intensive and site-specific. Thus, while the changes in Florida Bay may have degraded these values in Monroe County, no estimates of such losses are currently feasible.

One particular local change that may be of profound consequence is the possible effect of environmental changes, and the related economic changes, on real estate values. For many Americans, property is their principal source of savings, and declining property values therefore have a substantial effect on their wealth. One study of the economic effects of spotted owl protection[35] estimated that house prices (and therefore homeowner investment values) decline by 2 percent for each percentage point rise in unemployment; if such a relationship holds true in Monroe County, then residential property values would be expected to decline by 2 percent for each additional 500 jobs lost due to changes in environmental quality (or for any other reason).[36] Furthermore, in areas that depend heavily on tourism and recreation, one might expect that a decline in tourism might reduce property values by a larger share. The negative gross earnings (gross losses) in the real estate industry in Monroe County in 1990 ($0.5 million) and 1991 ($7.3 million) certainly indicate weak real estate

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[33]ECO Northwest. *A Method for Estimating the Economic Effects of Habitat Protection*. Prepared for the U.S. Fish and Wildlife Service. Eugene, OR: Jan 1994. 50 p. (Hereafter referred to as ECO Northwest, *Method for Estimating Economic Effects*.)

[34]ECO Northwest, *Method for Estimating Economic Effects*.

[35]Bruce R. Lippke, J. Keith Gilless, Robert G. Lee, and Paul E. Sommers. *Three-State Impact of Spotted Owl Conservation and Other Timber Harvest Reductions: A Cooperative Evaluation of the Economic and Social Impacts*. Contribution No. 69. Seattle, WA: Univ. of Washington, Inst. of Forest Resources, Sept. 1990.

[36]This impact is in addition to the secondary, "multiplier" effect discussed above. The I/O model captures the decline in real estate transactions due to reduced economic activity. However, the estimate with respect to spotted owls, and that may be relevant in Monroe County, was a decline in personal wealth, which is not measured in an I/O analysis until the property is sold.

markets that could, in part, reflect public perceptions of the environmental degradation of Florida Bay. However, specific estimates of declines in homeowner investment values due to environmental changes in the Bay apparently do not exist.

Finally, changes in primary industries is of particular importance to State and local governments because of the potential effect on revenues. The State of Florida collects a sales tax of 7 percent; thus, declining sales to tourists in the retail trade and services sectors would reduce State sales tax collections. Of more importance to Monroe County is the 4 percent tourist development tax on all temporary lodging (hotels, motels, guesthouses, and rentals of less than 6 months). A decline in tourism would probably reduce development tax collections proportionally. In addition, much of the local government revenue base is property taxes, with millages ranging from less than 12.5 to more than 17. If, as noted above, real estate values decline due to environmental changes in Florida Bay, then local property tax collections might also decline.

SUMMARY AND CONCLUSIONS

There is concern about the environmental quality of Florida Bay and its impact on the region's economy. A partial dieoff of the mangroves ringing the islands in the Bay has occurred. A seagrass dieoff in the Bay began in 1987, and has continued to expand. The seagrass dieoff has been linked to blue-green algae blooms in the eastern and central portions of the Bay, and these blooms are blamed for the sponge dieoff. Finally, diatom blooms have become increasingly common in the western portions of the Bay since 1979.

These changes in the vegetation of Florida Bay are, in turn, affecting the fauna of the Bay. The Bay contains resident and transient populations of bottlenose dolphins and provides habitat for the endangered manatee, several endangered sea turtle species, and along the north shore, the endangered American crocodile. The Bay provides feeding and nesting habitat for many bird species, but the number of ospreys and of wading bird colonies has declined. The Bay also provides nursery grounds for many species of finfish and shellfish, as well as habitat for other life stages for some species.

The Bay's finfish and shellfish are important foundations for the two major industries in Monroe County: commercial fishing and tourism. To date, the only measurable economic losses associated with the changed environmental conditions of the Bay are in commercial fishing, principally from the substantial decline in pink shrimp harvests. Since 1986, employment in commercial fishing has declined by about 10 percent, while personal income in the industry has declined by $14 million -- about 50 percent (net of inflation). However, some of the decline in income is probably due to the economic recession, and the decline in shrimp harvesting could be due to competition from imports, rather than from environmental degradation. Regardless of the cause, the losses have probably led to secondary (indirect and induced) losses of another 250 jobs and $18

million. In total, the losses to date amount to about one percent of the employment and two percent of the personal income in Monroe County.

A much larger portion of the Monroe County economy may be threatened by the continued vegetative changes in Florida Bay. The sponge dieoff (linked to the seagrass dieoff and blue-green algae blooms) is a serious threat to the spiny lobster fishery, since the sponges are critical habitat for juvenile lobsters. In 1990, spiny lobsters landings totalled $21.2 million, contributing nearly $7.5 million in personal income for the approximately 1,150 workers employed in the fishery. In addition, the Bay is important for life stages of several snappers and groupers (as well as for important sport finfish). Landings of these species totalled $4.5 million in 1990, contributing more than $1.5 million in personal income for the approximately 250 workers employed in this fishery. Thus, the continued vegetative changes in Florida Bay could pose a threat to about 1,400 jobs in commercial fishing and the resulting $9 million in personal income -- about half of the commercial fishing industry in Monroe County.

These possible losses in commercial fishing would also have significant indirect and induced effects. The secondary economic activity resulting from commercial fishing is about $25 million in gross output, about 1,400 jobs, and more than $11 million in personal income. These fisheries are unlikely to disappear entirely. However, a collapse comparable to the decline in pink shrimp landings (down 75 percent) would amount to nearly five percent of employment and nearly two percent of the gross earnings in Monroe County.

Tourism is also threatened by the environmental changes in Florida Bay. While precise estimates are impossible, it appears that tourism accounts for about a quarter of the Monroe County economy -- 12,000 jobs and $200 million in personal income. The threat is less direct than with commercial fishing, but is nonetheless real. The seagrass dieoff and algae blooms have reduced water clarity in an area favored by recreational divers because of its pristine waters. The Bay provides habitat for several important sport finfish, such as spotted seatrout and red drum. The changes in the Bay may also threaten the oceanside coral reefs that are important to sport divers.

The imprecision in estimating the magnitude of the tourism economy and in linking tourism with the environmental changes in Florida Bay makes a realistic estimate of the potential economic effects impossible. Nonetheless, the changes are apparent to tourists, and the changes are attracting substantial national media attention as an example of ecosystem degradation. Over time, a loss of a quarter of tourists and seasonal residents is possible, and would threaten thousands of jobs and tens of millions of dollars in personal income -- probably exceeding the potential primary and secondary losses associated with declining commercial fisheries. Furthermore, because changes in tourism are likely to lag behind changes in environmental quality, losses in the tourist economy are likely to persist, even if vegetation in the Bay were to recover quickly.

If such declines were to occur in tourism and commercial fishing, the losses would amount to about 5,000 jobs -- more than 10 percent of employment -- and about $75 million in personal income -- nearly 10 percent of gross earnings -- in the county. In addition, property values and local tax collections would probably decline, putting additional financial pressures on local governments when the demand for additional social services is rising. Finally, the area's aesthetics and the existence and bequest values of a functioning ecosystem are threatened by the changes in Florida Bay. crsphpgw