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Boating Uses, Economic Significance, and Information Inventory for North Carolina's Offshore Area, "The Point"

Volume II: Economic Analysis of "The Point" and Adjacent Counties – Baseline Information, Valuation, and Potential Impacts

U.S. Department of the Interior
Minerals Management Service
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Cover photo courtesy of Dr. William Lang, Minerals Management Service.

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INTRODUCTION

The Chevron Corporation had planned to drill one or more exploratory wells in the Atlantic Ocean northeast of Cape Hatteras near an area known as "The Point." The State of North Carolina and particularly many coastal North Carolina residents were concerned about negative environmental effects and the increased possibility of oil spills in the area due to both production and increased tanker traffic in the area. Tourism and commercial fishing are key industries in the local economy that could potentially be damaged by off-shore oil and gas production. There might also be significant impacts on recreational fishing.

The purpose of this study is to generate baseline economic information for the counties that might be affected, explore the potential economic impacts of an oil spill off the Outer Banks, provide information on the value of recreational fishing at "The Point," and estimate the potential losses to recreational fishing at "The Point" if there were an oil spill. This study also presents information on the effects of coastal oil releases elsewhere to guide the scenarios used here. First, the report describes the economies of affected coastal counties and the role of tourism and commercial fishing in these areas. Next, the report describes the impact of several significant oil spill cases in the U.S. that will be used to develop possible spill scenarios for North Carolina. Following that, the appropriateness of economic base and input-output analysis to this case is discussed, and the techniques are used to describe the baseline economies and to analyze the potential impacts on the coastal economy of an oil spill.

The other major area studied in this research is recreational fishing. Using data on individual's fishing, we model how decisions are made about where to fish. Such decisions are affected by the expected catch of the various species and by the cost of getting to the fishing site. Using statistical models, we are able to estimate the role that these and other factors play in the decisions. Using the results, we are able to run scenarios about the losses to recreational fishermen if fishing at "The Point" is closed for various periods. These scenarios are again based on experiences elsewhere around the country.

ECONOMIC ANALYSIS OF COASTAL COUNTIES NEAR "THE POINT"

THE ROLE OF TOURISM AND FISHING IN THE ECONOMY OF THE OUTER BANKS

The counties of the central and northern outer banks are most likely to be impacted by Chevron's oil exploration activities. Hyde County, encompassing Ocracoke Island and a portion of the mainland across Pamlico Sound, is at the southern end of the area, but it is probably unlikely to be affected except through the fishing activities that may use "The Point." Dare County, stretching along 85 miles of the outer banks from Hatteras to north of Kitty Hawk, is at the greatest risk from oil exploration. A short stretch of Currituck County, mostly encompassing the town of Corolla, completes the outer banks to the Virginia border, but it would also be less affected than Dare County. Fishing has been an economic staple of this region for generations, but tourism has been the source of most of the recent growth. Travel expenditures by tourists in Dare County increased from $232 million in 1990 to $395 million in 1997, an increase of 70% in seven years. These numbers have not been adjusted for inflation, but even after adjusting for inflation, travel expenditures grew by 42 percent over this period. Travel dependent employment in Dare County increased from 6,660 to 8,440 (27%) over the same period (Office of State Planning, State of North Carolina, 1997).

According to the Office of State Planning, tourism is more important to the economy of Dare County than any other county in the state. As shown in Table 1, about half of the jobs in Dare County are directly dependent on tourist spending, and tourism expenditures were sixteen times greater than the value of the county's commercial fishing landings in 1997. Hyde County's economy is more balanced between fishing and tourism. Tourism dominates fishing in importance to the Currituck County economy, although the importance of both of these sectors is less than in Dare and Hyde counties, as most of Currituck County's population reside on the mainland.

Table 1. Selected Economic Statistics for Outer Banks, 1997

	Dare County	Currituck County	Hyde County
Populationa	27,279	16,664	5,040
Per Capita Income ($)[a]	19,271	17,873	14,976
Total Employment[a]	17,689	7,919	2,663
Value of Commercial Fishing Landings ($)[b]	24,221,987	1,638,396	11,381,112
Commercial Fishing Employment*[c]	1,594	43	225
Tourism, Direct Expenditures ($)[c]	395,520,000	40,810,000	16,560,000
Tourism Employment*[c]	8,440	650	310
Gross Sales Hotels, Motels, Cottages ($)[c]	163,530,523	9,447,897	5,524,572
Importance of Tourism (Rank of 100 NC counties)[d]	First	Sixth	Tenth

* Employment includes both full-time and part-time jobs.

Sources: [a] Department of Sociology & Anthropology, North Carolina State University, 1998.
[b] Diaby, S., 1998.
[c] Department of Parks and Recreation, North Carolina State University, 1998.
[d] Office of State Planning, State of North Carolina, 1997.

It is important to consider the seasonal nature of the tourism sector, because the economic impact of an oil spill in the busy summer season would be much greater than in the off season. The table below shows that nearly half of all lodging sales in Dare County occur during June, July and August, whereas only ten percent of lodging sales occur during the winter months. These statistics understate the seasonal nature of the tourist sector because lodging sales include a non-tourism component, which is more constant over the course of the year. Thus, the three summer months probably account for well over half of tourist related lodging sales. On the other hand, prices for other tourist purchases (food, gasoline, souvenirs, etc.) are probably higher during the summer, but are not likely to increase by the 70% margin for lodging. This price discrepancy would cause total lodging sales to vary more by the seasons than overall tourist spending. Due to these offsetting effects, it is impossible to determine whether total tourism expenditures are more or less seasonal than the lodging sales in Table 2. As lodging sales make up the largest portion of tourist expenditures, the figures in Table 2 can be thought of as a close approximation of the seasonal breakdown of overall tourist expenditures in the area.

Table 2. Seasonal Statistics for Dare County Hotels, Motels, and Cottages, 1996-1997

Season	Occupancy rate (%)	Avg. Daily Rate ($)	Total sales ($)	% of Annual Sales
Winter	25.6	46.00	17,617,407.16	10.8
Spring	43.7	56.67	37,985,358.12	23.2
Summer	64.0	78.00	74,587,983.54	45.6
Fall	39.7	54.67	33,339,774.19	20.4

Winter includes December, January, and February, Spring includes March-May, Summer is June-August, and Fall is September-November.

Source: Brothers and Mitchell, 1998.

The information presented in this section is used in developing the impact scenarios later in the report.

Economic Impacts of Notable U.S. Oil Spills

Although North Carolina has never experienced a major oil spill, about 100 oil tankers dock in Wilmington and Morehead City every year. In a typical year, the Coast Guard reports one oil spill in North Carolina usually involving only a few gallons of oil (Perko, 1989). Offshore drilling would increase the risk of a release from the drilling rig and, depending on how and where the oil was transported, the risk of a spill due to more tanker traffic. Between 1978 and 1996, the United States averaged 25 barge or tanker oil spills over 10,000 gallons, ranging from a high of 42 spills in 1990 to a low of 10 spills in 1996 (Etkin, 1996). In addition, there are 2-3 spills (releases) per year from production wells or oil rigs like Chevron has proposed off the coast of North Carolina. Most of these spills are quickly contained and cause little harm to commercial fishing and tourism. This section reviews some selected spills for which there has been documented tourism and fishing losses. It is by no means a complete list. The purpose of discussing them is to spell out some plausible analysis scenarios for a significant spill near Cape Hatteras. These considerations were used to develop the range of scenarios used elsewhere in the report.

The potential impacts of an oil spill on the coastal tourism industry has been the greatest concern of local residents opposed to offshore drilling in North Carolina (Raleigh News and Observer, 1998). However, other areas of the U.S. that have experienced oil spills have observed relatively small impacts on the overall tourism industry. Some individual sectors such as charter fishing boat operators are severely hurt by oil spills, whereas the largest tourism sectors, hotels and restaurants, are only mildly affected (Freeman et al., 1985). This is generally attributed to two effects. First, any reduction of tourists due to beach closings or other oil spill impacts is offset by the influx of individuals working on the spill cleanup who fill local hotels and restaurants during the period of beach closings. Second, many tourists still vacation at other nearby beaches and coastal areas. For example, an oil spill that closes Wrightsville Beach could be a windfall for hotel operators at Atlantic Beach. Thus, a spill may have minimal tourism impacts from a regional perspective.

The timing of an oil spill is critical in determining its tourism impact. For example, the 1996 Rhode Island oil spill occurred in January, the slowest time of year for the tourism industry. Hotel and restaurant operators in Rhode Island actually reported an increase in their usual winter business due to the cleanup effort. By spring, most lodging establishments were reporting their summer reservations ahead of the previous year's pace, indicating that a winter oil spill had little impact on their summer business (Providence Journal, 1996). A winter spill off the coast of

Massachusetts in 1976 also had no impact on the summer tourist season (Freeman et al., 1985). In January and February of 1969, a 3 million gallons of oil were released from an off shore well near Santa Barbara, California soiled beaches for weeks. However, expected hotel receipts in Santa Barbara only dropped 3% during the 1st quarter of the year, and there was no effect over the rest of the year (Mead and Sorenson, 1970).

Oil spills are more costly during the tourist season. Oil from a Mexican spill washed up on Texas beaches for 4 weeks in August 1979 causing direct economic losses of $3.1 million and $3.8 million in recreation and tourism-related gross business receipts, respectively (Freeman et. al., 1985).

For many U.S. oil spills, the losses to commercial fishing have been much greater than the losses to the local tourism industry. The table below shows the duration of closure for commercial fishing areas affected by a few significant U.S. oil spills. The two and half month closure of commercial fishing grounds near Block Island, Rhode Island in 1996 is the longest for any oil spill in the lower 48 states, and was widely criticized for being overly cautious (Providence Journal, 1996). The 1969 Santa Barbara spill was a blowout of an offshore oil well that produced a continuous flow of oil for weeks until crews were finally able to successfully cap it. A blowout of an offshore well produces a steady flow of oil for several days or weeks whereas tanker accidents can be very large but can be controlled more quickly. Commercial fishing is generally closed for only a few weeks after a major oil tanker spill (Freeman et. al. 1985).

Table 3. Commercial Fishery Closures for Selected U.S. Oil Spills

Date and Location of Oil Spill	Gallons Spilled	Length of Fishery Closure
1969 Santa Barbara, California	3,250,000	2 months
1989 Wilmington, Delaware	306,000	1 week
1990 Galveston, Texas	700,000	1 week
1996 Block Island, Rhode Island	828,000	2 ½ months

In addition to the lost revenues during fishery closures, commercial fisherman can be damaged after fishing resumes through mortality to the fish stock and lower prices for their catch because some of concerns about contamination. The state of Rhode Island spent hundreds of thousands of dollars advertising that the beaches were open and the seafood was safe (Providence Journal, 1996). The Governor of Maine found himself eating lots of lobster in public following a 1996 spill in Portland Harbor that affected consumer confidence in the safety of Maine lobsters (Portland Press Herald, 1996). These effects are much more difficult to quantify and there have been few detailed studies of such effects with previous spills. A study of Alaskan Salmon prices after the Valdez spill found that prices were reduced by 50% for as long as three years after the spill (Mendelsohn, 1993). Price effects from most oil spills are probably much less dramatic than for the Valdez, the largest and most notorious oil spill in U.S. history.

Economic Impact Analysis: Techniques and Criticisms

Determining the economic impact of changes to industries such as commercial fishing and tourism begins with estimating the change in final demand for the industry's output. For tourism, estimates of final demand are complex because it does not occur within the framework of a single industrial sector, nor does it encompass all of the output of any one sector. This report uses county level tourism expenditures estimated by the Department of Parks and Recreation Management at North Carolina State University with data from the U.S. Travel Data Center and the State of North Carolina. The total (direct, indirect and induced) economic impacts of the changes in final demand are estimated with input-output analysis (Fletcher, 1989; Johnson and Moore, 1993). The projected changes in final fishing and tourism sales would be the direct impacts of an oil spill. A decrease in final demand in one sector causes the demand for other sectors' output to increase, because of purchases between the sectors. These secondary effects in the local economy determine the indirect impact. The induced impact is calculated by treating the household sector as one of the productive sectors in the input-output framework. The induced impact is the decrease in economic activity resulting from the decrease in household incomes generated by the direct and indirect impacts. The total economic impact may be summarized by presenting multipliers for output, income, or employment.

Type I multipliers give the direct and indirect effects only — that is, the original expenditures resulting from the impacts plus the indirect effects of industries buying from industries. Household expenditures effects (induced effects) are not estimated. Type II multipliers are the direct, indirect, and induced effects where the induced effect is based on income. In Type III multipliers the induced effect is based on population, driven by an assumption that there is a linear relationship between per capita expenditures and the number of jobs. Most researchers are more comfortable with the assumption that there is a linear relationship between income and household expenditures than the number of jobs and household expenditures. Thus, only Type I and Type II multipliers are reported here.

Input-output analysis has several well-known weaknesses (Isard, 1975; Armstrong and Taylor, 1985; Nijkamp et al., 1986). First, it assumes that production in each sector is characterized by fixed, constant returns to scale technology. This is a significant restriction if one is analyzing impacts over very long periods of time. A restriction for short-run analysis is y the use of average cost data for firms when economic theory suggests that forms' decisions are based on marginal costs. Also, input-output analysis requires very detailed data that is costly and difficult to obtain for local economies such as coastal North Carolina. Frequently, national data are used to model industry linkages which may not be a very a good approximation of the local economy. Finally, input-output models ignore the existence of supply constraints, so that all economic adjustments are made through changes in quantities rather than prices. Rapid expansion of output in many sectors may not be possible because of input shortages. Thus short-run input-output analysis is probably more accurate for decreases in final demand when capacity constraints are not an issue. Many economists believe that prices are "sticky downward" in the short-run, thus the pure quantity adjustment assumptions of input-output analysis may be less problematic for the analysis of short-run, negative impacts.

The economic impact of an oil spill has several advantages for input-output analysis. An oil spill is a short-run negative impact on the local economy. Thus, the problematic assumptions of fixed, constant returns technology and pure quantity adjustments (no capacity constraints) are less damaging to the input-output results. Nevertheless, multipliers representing the indirect and induced impacts of the commercial fishing and tourism sectors should still be considered only as rough approximations of the true impacts.

Economic Impact Analysis of Dare County

Multipliers for commercial fishing and tourism sectors in Dare County were generated with the IMPLAN input-output model. IMPLAN was developed for the USDA Forest Service as a tool for analyzing economic impacts and is widely used in studies of this type (Alward et al., 1989). IMPLAN has over 500 sectors in the model. Commercial fishing is one of these sectors. For tourism there are a number of sectors which form this aggregate. The tourism sector consists of the following: automobile (451-gas stations, 477-car rental, 478-car wash, parking, 479-auto repairs & service), eating and drinking (454), lodging (463), tourist-related retail (449 general merchandise, 450 food stores, 452 apparel stores, 455 miscellaneous retail). Pooling them implicitly assumes that tourist expenditures are distributed between these categories in approximately the same proportions as total expenditures. This assumption is not likely to be too damaging for two reasons. The tourism industry dominates Dare County, so the tourist expenditures are actually a large part of the total expenditure data. Also, the multipliers in these individual sectors are very similar. Output multipliers range from 1.65 to 1.7, with only the auto sector being an outlier at about 1.5.

Output, personal income, and employment multipliers are reported in Table 4. Employment multipliers are not particularly useful here because of the temporary nature of an oil spill event. It is doubtful that employment would fully adjust for a temporary negative shock in the way it would for a permanent decrease. The same critique can be leveled against income multipliers but a large portion of income in these sectors are tip and proprietor's income that are more closely linked to total sales than employment. Output multipliers are likely to be the most accurate and appropriate in this case.

Table 4. Output, Employment and Personal Income Multipliers

Output Multipliers:		
Sector	Type I Multiplier	Type II Multiplier
Commercial Fishing	1.26278	1.81927
Tourism Sectors	1.25268	1.66580
Employment Multipliers:		
Sector	Type I Multiplier	Type II Multiplier
Commercial Fishing	1.027512	1.094780
Tourism Sectors	1.153266	1.435373
Personal Income Multipliers:		
Sector	Type I Multiplier	Type II Multiplier
Commercial Fishing	1.15555	1.48450
Tourism Sectors	1.20589	1.55265

The Type II output multiplier is somewhat higher for commercial fishing than for tourism. Fishing has a higher induced effect. This is because the wages, salaries, and proprietors' income form a larger fraction of the costs in the industry. Most of the value of the catch is retained as income within the county. In contrast, the tourism sector imports many of its inputs from other regions (e.g. retail merchandise, gasoline) and pays comparatively less of the revenues as employee compensation. Other county level studies estimate tourism income multipliers between 0.44 and 0.78 with most studies estimating an income multiplier around .60 (Fletcher, 1989). Such results compare very well with the multipliers for tourist related sectors in Dare County shown above.

One can also generate information about the sectors most likely to be affected by the indirect and induced effects generated by losses in commercial fishing and tourism. The many sectors in IMPLAN can be aggregated to form ten sectors using 1-digit SIC codes. The names of these sectors are descriptive of the types of firms they contain with exception of two of them. TCPU represents the transportation, communication, and public utilities sectors, and FIRE is the finance, insurance, and real estate sectors. The examples given here are for a $1,000,000 impact in the commercial fishing sector (Tables 5) and tourism (Tables 6). As before, the output tables should provide the best representation of the impacts.

Possible Oil Spill Scenarios and Their Predicted Economic Impact

Based on the review of previous U.S. oil spills, an oil spill off Cape Hatteras might close beaches and/or the fishery for various durations up to two months. The effect of an oil spill will depend upon its location and size, weather conditions, effectiveness of the clean up effort, and the season of the year. A likely scenario would be that a spill that would not come very close to the shoreline due to the northeast flow of the gulfstream and local weather conditions. A spill of this nature could close fishing grounds for some time but would have only minimal impacts on the tourist economy (charter fishing boats excepted) if the oil stays out to sea. The tourism impacts of an oil spill will vary dramatically by season. To keep the number of scenarios to a reasonable number, the paper will look at plausible fishing and tourism impacts separately, and the impacts can be combined in various ways depending on the characteristics of a particular overall scenario.

There are many possible long-run impacts on the commercial fishing sector beyond the short-term loss in sales resulting from the closing of fishing grounds. Lower prices due to consumer perceptions of a tainted product could potentially last long after the fishery reopens. In addition, the oil spill could kill a portion of the fish stock and cause long-term changes in the fish population and catch rates. Alternatively, the temporary closure of the area to fishing might result in a larger stock of fish because of the reduction in commercial harvests. Additional considerations include differential effects by species (e.g. shellfish vs. finfish), the partial closure of certain fishing grounds causing increased fishing in the areas that remain open, and the effect of the mosaic of fishing regulations such as annual quotas on the catch of various species. Because of the difficulty in forecasting these complicating factors, the scenarios will mainly examine what is likely the most important effect, short-run closure of fishing grounds.

Table 5. Decrease in Output, Employment and Personal Income by Sector for Commercial Fishing

Decrease in Output by Sector ($)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Commercial Fishing	1,000,000	804	101	1,000,905
Agriculture	0	2,477	3,910	6,387
Mining	0	103	105	208
Construction	0	87,605	10,913	98,518
Manufacturing	0	10,630	13,952	24,582
TCPU	0	48,926	56,522	105,448
Trade	0	45,904	148,999	194,903
FIRE	0	15,572	125,625	141,197
Services	0	44,366	182,593	226,959
Government	0	6,390	13,773	20,163
ALL SECTORS	1,000,000	262,777	556,493	1,819,270
Decrease in Employment by Sector (# of jobs)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Commercial Fishing	157.3	0.1	0.0	157.4
Agriculture	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0
Construction	0.0	1.1	0.1	1.2
Manufacturing	0.0	0.0	0.0	0.0
TCPU	0.0	0.3	0.4	0.7
Trade	0.0	1.2	4.0	5.2
FIRE	0.0	0.1	0.9	1.0
Services	0.0	1.1	4.5	5.6
Government	0.0	0.2	0.4	0.6
ALL SECTORS	157.3	4.1	10.3	171.7
Decrease in Personal Income by Sector ($)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Commercial Fishing	567,843	457	57	568,357
Agriculture	0	437	690	1,127
Mining	0	40	41	81
Construction	0	28,563	3,558	32,121
Manufacturing	0	2,823	3,705	6,528
TCPU	0	10,372	11,983	22,355
Trade	0	19,879	64,523	84,402
FIRE	0	1,393	11,235	12,628
Services	0	19,628	80,780	100,408
Government	0	4,741	10,218	14,959
ALL SECTORS	567,843	88,333	186,790	842,966

Table 6. Decrease in Output, Employment and Personal Income by Sector for Tourism

Decrease in Output by Sector ($)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Tourism	1,000,000	21,038	92,229	1,113,267
Agriculture	0	3,229	3,004	6,233
Mining	0	78	80	158
Construction	0	15,416	8,221	23,637
Manufacturing	0	10,395	10,732	21,127
TCPU	0	40,895	43,063	83,958
Trade	0	25,324	34,858	60,182
FIRE	0	52,227	93,782	146,009
Services	0	74,231	119,642	193,873
Government	0	9,846	10,212	20,058
ALL SECTORS	1,000,000	252,679	415,823	1,668,502
Decrease in Employment by Sector (# of jobs)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Tourism	27.8	0.6	2.6	31.0
Agriculture	0.0	0.0	0.0	0.0
Mining	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0
Manufacturing	0.0	0.0	0.0	0.0
TCPU	0.0	0.3	0.3	0.6
Trade	0.0	0.4	0.6	1.0
FIRE	0.0	0.4	0.7	1.1
Services	0.0	2.0	3.2	5.2
Government	0.0	0.3	0.3	0.6
ALL SECTORS	27.8	4.0	7.7	39.5
Decrease in Personal Income by Sector ($)				
Sector	Direct Impact	Indirect Impact	Induced Impact	Total Impact
Tourism	411,833	8,664	37,983	458,480
Agriculture	0	587	546	1,133
Mining	0	30	31	61
Construction	0	5,026	2,680	7,706
Manufacturing	0	2,760	2,850	5,610
TCPU	0	8,670	9,129	17,799
Trade	0	10,251	14,111	24,362
FIRE	0	4,671	8,387	13,058
Services	0	36,827	59,356	96,183
Government	0	7,305	7,576	14,881
ALL SECTORS	411,833	84,791	142,649	639,273

COMMERCIAL FISHING SCENARIOS

A range of possible scenarios if there were a significant release of oil was used. The total value of commercial fishing landings in 1997 was $24,221,987. For commercial fishing these scenarios assumed closure of the fishing ground for two weeks, one month, or two months. A scenario was also run with a 50% reduction in the value of the catch for six months because of consumer concerns. The scenarios for species group one assumed that the catch of billfish (marlin, sailfish, etc.), dolphin, tuna, wahoo, and bonito by Dare County based fishing boats would be eliminated for the three durations. These are the fish that live in the warm waters of the Gulf Stream where the effects would be most likely to occur. Scenarios for species group two assumed that in addition to the temporary elimination of the above species, there would be a 50% reduction of the catch of sharks, mackerel, sea bass, grouper, bluefish, and tilefish. The latter effect would be less likely to result directly from the oil but the value of the catch might be reduced because of consumer concerns. The final set of scenarios assumed that all fish would be tainted in actuality or is consumers' minds for the various durations. The results for these scenarios are reported in Table 7.

Table 7. Commercial Fishing Scenarios (reductions in dollar value of catch)

Duration of Closure	Species Group 1[1]	Species Group 2[2]	All Fish Tainted
2 weeks	$76,392	$152,784	$931,230
1 month	$165,517	$331,034	$2,018,499
2 months	$331,034	$662,068	$4,036,998
½ of catch for six months after closure	$496,551	$993,101	$6,055,497

[1] Group 1 includes bill fish (marlin, sailfish, etc.), dolphin, tuna, wahoo, and bonito.
[2] Group 2 includes the species in group 1 plus 50% of the catch of sharks, mackeral, sea bass, grouper, bluefish, and tilefish.

TOURISM SCENARIOS

Tourism impacts will vary by season. Winter oil spills have been shown to have no impact on summer tourist visitation. Furthermore, the spending from the clean-up effort should offset a small decrease in winter visitation. Thus, negative economic impacts are expected to be minor for a winter oil spill of any size. In constructing the summer scenarios, it is important to consider that although the beaches may be closed due to oil pollution, most of the hotels and cottages would remain open. It is unlikely that the islands would be evacuated as they would be during a hurricane. Not all of the popular recreational activities in the area would be precluded by the oil spill (e.g. hang gliding, aquariums, golf, visiting historic sites, shopping, dining out, etc.), although the beach certainly is central to the decision to visit an area. People who are unable to visit the beach may spend their time in ways that cause them to spend more money than they would at the beach. Many people who have already placed deposits on lodging may or may not be allowed to get a refund on their reservations on short notice. It is difficult to predict how many tourists would choose to stay home.

Nevertheless, some illustrative scenarios are presented below. Representative losses vary by season due to the variation in total expenditures by season. The duration of the effects is given for two weeks, one month, and two months, as it was for the commercial fishing impacts. Also a residual impact for an additional six months at one-half the original reduction is provided to allow for negative perceptions after the spill is corrected. Visitation reductions of 25%, 50%, and 100% are presented. Obviously, the losses would be greatest if the spill occurred in the summer. The spring and fall only differ significantly when the residual effects are included, since the residual after the spring is in the summer while the residual after the fall is in the winter. As discussed above, the visitation loss in the winter may be relatively less than in the summer, so this should be considered in interpreting the tables. In 1997 total direct tourism expenditures were $395,520,000. This is broken down by season in Table 8.

Table 8. Tourism Scenarios by Season (dollar value of tourist spending reductions)

Winter Season: Total expenditures = $40,343,040			
Duration of Impact	25% Visitation Loss	50% Visitation Loss	Total Loss
2 weeks	$1,551,655	$3,103,311	$6,206,622
1 month	$3,361,920	$6,723,840	$13,447,680
2 months	$6,723,840	$13,447,680	$26,895,360
½ of reduction for 6 months after spill	$22,940,160	$45,880,320	$91,760,640
Spring Season: Total Expenditures = $91,760,640			
Duration of Impact	25% Visitation Loss	50% Visitation Loss	Total Loss
2 weeks	$3,529,255	$7,058,511	$14,117,022
1 month	$7,646,720	$15,293,440	$30,586,880
2 months	$15,293,440	$30,586,880	$61,173,760
½ of reduction for 6 months after spill	$45,089,280	$90,178,560	$180,357,120
Summer Season: Total Expenditures = $180,357,120			
Duration of Impact	25% Visitation Loss	50% Visitation Loss	Total Loss
2 weeks	$6,936,812	$13,873,624	$27,747,249
1 month	$15,029,760	$30,059,520	$60,119,040
2 months	$30,059,520	$60,119,040	$120,238,080
½ of reduction for 6 months after spill	$20,171,520	$40,343,040	$80,686,080
Fall Season: Total Expenditures = $80,686,080			
Duration of Impact	25% Visitation Loss	50% Visitation Loss	Total Loss
2 weeks	$3,103,311	$6,206,622	$12,413,243
1 month	$6,723,840	$13,447,680	$26,895,360
2 months	$13,447,680	$26,895,360	$53,790,720
½ of reduction for 6 months after spill	$10,085,760	$20,171,520	$40,343,040

CONCLUSIONS ON POTENTIAL IMPACTS

This section has examined the potential economic impacts of an oil spill resulting from Chevron's proposed oil exploration about forty miles off shore from Cape Hatteras. Tourism dominates the local economy and the impacts to this sector are potentially large. As a comparison, the tourism losses from a hurricane are much greater. Hurricane Fran in September 1996 was estimated to reduce direct tourism expenditures in coastal North Carolina by $211 million, much more than the estimated tourism losses from a large, summer oil spill (Brothers, 1998). However, the effects of the oil spill would be more concentrated than the effects of a major hurricane.

Although it has a smaller role in the economy, the impacts to the commercial fishing sector may be just as important for two reasons. First, the northeast flowing gulfstream currents and the distance from shore make it very likely that an oil spill would not reach the shore before being contained. In this case, the tourism impacts would be minimal while the commercial fishing impacts could still be substantial. Second, the multiplier effects of a dollar loss in fishing sales are higher than those in the tourism sector. The larger multipliers are because most fishing sales are retained as personal income, and relatively few inputs are imported from outside the region. While this study has concentrated on Dare County, the potential fishing impacts are particularly important to tiny Hyde County, where the local economy is equally based in fishing and tourism.

Tourists who avoid the Outer Banks because of an oil spill are likely to choose alternate locations rather than forgo their vacations altogether. An oil spill near Cape Hatteras would probably be good for the tourism business in Wrightsville Beach or Myrtle Beach. Thus, as one broadens the region of analysis, the economic impact of tourism losses diminishes although there may be substantial redistribution between areas.

THE ECONOMIC VALUE OF RECREATIONAL FISHING FOR BIG GAME SPECIES AT "THE POINT"

The primary goal of this portion of the study is to derive the economic losses to recreational anglers that might result from a closure of the large game fisheries at "The Point" off the coast of North Carolina.[1] The dollar value of these losses to recreational anglers will be measured using the concept of "consumer surplus" or more precisely "compensating surplus." This represents the amount of money that would be necessary to compensate the angler for reductions in the expected catch or the temporary loss of a fishing site. In the current case, this concept can also be referred to as "willingness to accept," the amount of money that the angler would have to receive to be willing to accept the reduction in the expected catch or the temporary loss of a fishing site.

This portion of the study involves three steps. First, we use historical creel survey data from the Marine Recreational Fisheries Statistics Survey (MRFSS) to estimate the expected catch of each recreational angler. Second, we use a random utility model of recreation demand to

[1] "The Point" is an area of approximately 35 square miles of open ocean located approximately 30 miles east of Salvo, North Carolina. The region is characterized by dynamic oceanographic and biological factors mixed with geological contours that serve to attract a wide variety of marine life, including several popular sport fish species (Currin and Ross, 1999).

estimate the effect of expected catch on the recreationists' site choice decisions. Finally, we derive measures of the willingness to accept compensation for decreases in expected catch rates.

INTRODUCTION

The extensive literature on the valuation of recreational experiences was developed principally as a means of valuing the reduction in services to user groups that resulted from damages to natural resources.[2] Recreation demand models are based on the idea that the price of a recreational experience is represented at least in part by the costs incurred in accessing the recreation site. The random utility model is one type of model contained within the larger recreation demand framework, and views the choice of a recreation site as a function of the satisfaction or utility derived from each of the available sites. The recreationist chooses the site that provides the most satisfaction or utility. A function describing how trip utility is related to site attributes is estimated using data on individual trips and site characteristics. The results can be used to measure the compensating surplus from a change in one of the site attributes. As recreation site decisions are made prior to the realization of quality, the relevant site characteristics in a random utility model are expected quality measures. For recreational fishing trips, a characteristic likely to influence site choice is the expected catch rate of different species. As there are dozens of different species that potentially can be caught on a given fishing trip, so having the expected catch of each species as a site characteristic is not a realistic option for deriving species-specific measures. However, we can value the benefits of an improvement in individual species catch by separating the relevant species from the other aggregates.

We estimate the lost benefits from decreasing the recreational catch of three species and one species aggregate commonly targeted and caught at "The Point" offshore North Carolina. These are the dolphin, tuna, wahoo and a bill fish aggregate, which is composed of marlin, sailfish, swordfish and spearfish[3]. The expected catches of these species and of other species treated in aggregate form are modeled as following a Poisson process. Poisson regressions are a statistical technique appropriate for data taking non-negative, integer values. A random utility model of site choice is then estimated as a function of these expected catch rates, travel costs, and other site characteristics.

THE RANDOM UTILITY MODEL OF SITE CHOICE

Discrete choice or random utility models of recreation behavior are well established in the literature.[4] Their primary focus is on the choice among alternative mutually exclusive sites for a given recreational trip. The site choice decision is assumed to be a function of the utility derived from the alternative sites, where the site that is chosen yields the maximum utility to the

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[2] For example, the losses incurred by recreationists following oil spills.

[3] These are species that are found in the warm waters of the Gulf Stream. Boats leaving from Dare County are usually heading for the vicinity of "The Point" if these fish are targeted. (The one exception would be white marlin generally caught north of "The Point", but this species was not in the data set.) If these species were targeted and/or caught and the boat launch was in Dare County, it was assumed the fishing was at "The Point". This decision was based on conversations with representatives of the Division of Marine Fisheries, the Oregon Inlet Fishing Center, charter boat captains, and a recreational fishing instructor.

[4] See Bockstael et al. (1987and 1989) and Kaoru et al. (1995) for good examples

individual. Some of the site and individual characteristics that influence the utility and hence the site decision are observable while others are known only to the individual, so that from the perspective of the researcher, there is a random component to utility. Hanemann (1999) has shown that by assuming that utility is linear, and that the error term is distributed as a type 1 extreme value random variable, the utility function can be estimated using a simple logit model. Given an estimate of the indirect utility function, the benefits or losses from a change in the quality of one of the site characteristics can be estimated as the per trip compensating surplus:

$$[1] \qquad CS_k = (1/\beta)(\ln \textstyle\sum_i \exp(V_{ik}^0) — \ln \sum_i \exp(V_{ik}^1))$$

where β is the coefficient on access price in the indirect utility function, and V0 and V1 represent expected utility before and after the quality change respectively. Because of the structure of the model, β estimates the marginal utility of income, so 1/β converts the difference in expected utility into a dollar measure, compensating surplus.

North Carolina Models and Data

This portion of the study uses data from the Marine Recreational Fisheries Statistics Survey (MRFSS) intercept data for North Carolina for 1990. Recreational anglers were intercepted and interviewed at 261 different public access locations across 11 coastal counties.[5] Information was collected about aspects of the trip such as mode of fishing, species targeted, and quantity and type of fish caught. Angler characteristics such as county of residence, age, sex, and fishing experience were also collected. For this study, intercept points are aggregated to the county level. Two pairs of counties (Tyrell and Dare, and Craven and Pamlico) are aggregated together due to limited data availability for one site in each pair.[6] We thus have nine "sites" over which choice will be modeled (Table 9).

In order to estimate the model outlined above, we must specify a form for the indirect utility function. This requires identifying observable variables that are likely to influence site choice, such as access costs and measures of site quality. Access costs can be measured by the sum of direct travel costs and the opportunity cost of travel time. The quality of a each site can be a composed of an estimate of the expected catch rate of different species groups, as well as other site-specific characteristics which are likely to influence choice.

The geography of the North Carolina coast is such that different types of fishing opportunities are available in different counties. Counties that include the barrier island chain known as the Outer Banks (Dare, Hyde, and Carteret) offer both ocean fishing and sound fishing opportunities. Craven/Pamlico and Beaufort counties offer only sound fishing opportunities, and the remaining four sites (Onslow, Pender, New Hanover, and Brunswick counties) offer only ocean fishing opportunities. To account for these differences, we will employ two dummy variables in the site choice model, so that the utility derived from a site will be a function of the type of fishing opportunities available at that site. To account for differences in size of sites, we follow the suggestion made by Ben-Akiva and Lerman (1985) and use the log of the number of intercept

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5 Anglers originating from private points of access, such as personally owned docks, were not included in the survey.

6 Tyrell County and Craven County each had less than 5 observations. The counties aggregated together border one another, and offer similar fishing opportunities.

points as an additional quality variable. As we are dealing with boat fishing, this is the number of launch points identified in the NMFS data.

Table 9. Coastal North Carolina Angler Intercept Sites

Site Number	Location
1	Dare County and Tyrell County
2	Hyde County
3	Beaufort County
4	Pamlico County and Craven County
5	Carteret County
6	Onslow County
7	Pender County
8	New Hanover County
9	Brunswick County

In addition to these variables, we hypothesize that anglers make site choice decisions based on expectations. Anglers are likely to be concerned with total numbers of fish expected to be caught or, in the case of larger fish that are caught infrequently, the probability that at least one fish will be caught. By including these quality measures in our specification for utility, we have a means for deriving the value of changes in stocks. We assume that each angler forms an expectation of the catch of different types of fish when making the decision of where to go fishing. We wish to ascertain the value attributable to different game species. Because there are dozens of species that are regularly caught by recreational anglers in North Carolina, employing a model with such a large number of catch rates as choice variables would be very difficult to successfully model and is probably an unrealistic view of the way site choice decisions are made. It may be more realistic to assume that anglers view potential catch in broad categories of fish according to where, when, and how they can be caught. We will therefore aggregate most species into two broad species groups and consider the species of interest for policy analysis (the big game species available at “The Point”) separately (Table 10).

Table 10. Species Groups Used in Random Utility Model

Species Group	Species Included
Bill Fish	Sailfish, Blue Marlin, White Marlin, Longbill Spearfish, Sailfish, Swordfish
Dolphin	Dolphinfish
Tuna	Skipjack Tuna, Little Tunny, Albacore, Bluefin Tuna, Yellowfin Tuna, Blackfin Tuna, Bigeye Tuna
Wahoo	Wahoo
Bonito	Atlantic Bonito, Striped Bonito
Other Surface fish	Bluefish, Barracuda, Cobia, , Mackerel Family (excluding tuna), Tarpon Family
Other Bottom Fish	Flounder Family, Cod Family, Snappers, Groupers, Jacks, Grunts, Seabass, Porgy, Wreckfish, Croakers, Chubbyu, Drum Family, Sharks, Skates, Rays, Dogfish

Modeling Expected Catch as a Poisson Process

Since anglers are intercepted after their trip has taken place, information about the catch expected prior to the trip is not obtained. As actual or realized catch is endogenous, and may not bear any relation to expected catch (Bockstael et al., 1989), we must form a proxy for expected catch. We will assume that different anglers will have different expectations about the catch of different species. It is also likely that individual characteristics such as fishing experience, age, familiarity with the site, choice of target, and gear used will influence expected catch. To incorporate these assumptions into a model of catch expectations, we model catch to be an expectation formed by a Poisson process (see McConnell et al., 1995; Smith et al., 1993; Kaoru et al., 1995; and Schuhmann, 1998).

The catch rate of a specific species or species group is likely to be influenced by factors such as the age and experience of the angler, type of gear and bait, season, species being targeted, and availability of stock. By modeling actual catch as a function of these variables, we will form a reasonable proxy for expected catch. Actual catch on a given trip must take on integer values greater than or equal to zero, hence modeling catch per trip with a Poisson process will allow for a better fit of the data than continuous specifications such as OLS.

Given observations on the catch per trip of different species, and variables that will influence catch, we can estimate the Poisson model via maximum likelihood. For each species group, the equation we will estimate is:

$$[2] \quad Q^a = \exp\,[\beta_0 + \beta_1(\text{bill fish target}) + \beta_2(\text{dolphin target}) + \beta_3(\text{tuna target}) + \beta_4(\text{wahoo target}) + \beta_5(\text{other surface fish target}) + \beta_6(\text{other bottom fish target}) + \beta_7(\text{site 1}) + \beta_8(\text{site 2}) + \beta_9(\text{site 3}) + \beta_{10}(\text{site 4}) + \beta_{11}(\text{site 5}) + \beta_{12}(\text{site 6}) + \beta_{13}(\text{site 7}) + \beta_{14}(\text{site 8}) + \beta_{15}(\text{number of NC fishing trips in past 12 months}) + \beta_{16}(\text{private boat}) + \beta_{17}(\text{male}) + \beta_{18}(\text{age}) + \beta_{19}(\text{age}^2) + \beta_{20}(\text{predicted hours fished})\,]$$

where Q^a_{ik} = the number of fish of species group *a* caught by angler *k* at site *i*, target variables = 1 if the angler is targeting that species and = 0 otherwise, site variables = 1 if the angler is fishing at that site and = 0 otherwise, private boat = 1 if the angler is fishing from a privatly owned boat (as opposed to a charter boat) and 0 otherewise, male = 1 if the angler is a male and = 0 otherwise, and predicted hours fished = length of trip in hours as predicted by an OLS regression using these same independent variables plus a dummy variable for whether or not the individual was employed.[7]

The results of these regressions are reported in Table 11, and can be interpreted as logarithmic elasticities. That is, each coefficient indicates the percentage change in expected catch per trip given a one-unit change in the independent variable. The signs of the estimated coefficients in the 12 equations are mostly as expected. Notice that the site dummy variables are generally significant. The signs of the target dummy variables conform with expectations — the sign for a particular dummy is always positive and significant in the equation for that species — indicating that anglers targeting a particular species are much more likely to catch that species. It appears that anglers fishing from private boats can expect to catch fewer fish than anglers in charter boats, all other things equal. An unexpected result is the generally negative signs on the "predicted hours" variable. This may be an indication of fishing quality on particular days combined with the presence of explicit or implicit limits on catch. If quality of fishing is good on a particular day, an angler may need only a short trip to realize his or her allowable catch. Alternatively, the additional satisfaction derived from catch an additional fish probably diminishes as more fish are caught, so a successful trip may be shortened. In either case, short trips and good fishing quality may be positively correlated.

[7] Because of the potential for endogeneity between hours fished and catch per trip, we use predicted hours fished as an instrument for the hours fished for each angler.

Table 11. Results of Poisson Regressions for Numbers of Fish Caught

	Bill fish Catch	Dolphin Catch	Tuna Catch	Wahoo Catch	Bonito Catch	Other Surface Fish Catch	Other Bottom Fish Catch
	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)	Coefficient (Std. Error)
Bill target	4.50 (1.32)	-2.49 (0.59)	2.70 (0.65)	-1.75 (7242.35)	-16.38 (7669.47)	-3.11 (0.71)	-14.28 (126.98)
Dolphin Target	-15.57 (7164.93)	1.80 (0.13)	1.56 (0.74)	1.35 (0.86)	-15.54 (4730.73)	-2.05 (0.08)	-0.60 (0.15)
Tuna Target	2.69 (1.44)	-1.31 (0.20)	2.05 (0.58)	-2.11 (4105.39)	0.76 (1.61)	-0.86 (0.13)	-14.50 (71.47)
Wahoo Target	4.06 (51386.26)	4.57 (1.07)	-15.79 (18893.51)	6.80 (2.74)	-16.27 (31150.13)	1.19 (0.72)	-15.18 (570.53)
Other Surface Fish Target	-14.06 (1852.80)	0.27 (0.19)	-15.72 (745.05)	1.00 (0.91)	0.23 (1.21)	1.01 (0.06)	-0.99 (0.07)
Other Bottom Fish Target	-14.84 (1969.43)	-14.82 (167.80)	-15.58 (779.69)	-14.18 (1117.32)	-15.71 (1291.91)	0.25 (0.06)	0.24 (0.04)
Site 1	16.73 (4124.54)	16.28 (333.32)	15.95 (1542.95)	-0.58 (2728.19)	16.12 (2684.53)	0.57 (0.08)	-0.61 (0.08)
Site 2	2.36 (5883.54)	13.38 (333.32)	-0.12 (2193.15)	2.02 (3566.45)	0.46 (3713.29)	-0.44 (0.16)	-0.13 (0.10)
Site 3	11.29 (19230.74)	14.43 (1594.89)	14.44 (7226.45)	16.04 (11929.72)	15.54 (11647.96)	-1.69 (0.72)	-1.29 (0.51)
Site 4	-0.43 (6715.88)	0.57 (579.24)	0.16 (2542.68)	1.96 (4215.27)	0.29 (4298.99)	-0.88 (0.19)	0.00 (0.10)
Site 5	-0.27 (4463.91)	14.06 (333.32)	15.20 (1542.95)	16.68 (2447.40)	15.91 (2684.53)	-0.28 (0.08)	-0.46 (0.07)
Site 6	0.11 (4810.15)	12.21 (333.32)	-0.20 (1803.08)	-0.12 (2860.92)	0.21 (3118.38)	-0.52 (0.10)	-0.02 (0.07)
Site 7	0.45 (7483.15)	0.52 (663.17)	0.71 (2823.37)	1.52 (4813.49)	0.07 (4903.12)	0.10 (0.13)	0.05 (0.11)
Site 8	-0.62 (5086.57)	12.05 (333.32)	0.47 (1891.90)	-0.19 (2927.31)	15.77 (2684.53)	-0.28 (0.10)	-0.72 (0.09)
Trips in Past 12 Months	-0.02 (0.03)	0.00 (0.00)	0.00 (0.00)	0.01 (0.01)	0.01 (0.00)	0.00 (0.00)	0.00 (0.00)
Private Boat Dummy	-9.64 (6.01)	-4.25 (0.65)	-2.22 (2.13)	-5.07 (4.55)	-0.07 (5.57)	-1.50 (0.26)	0.93 (0.25)
Male Dummy	18.01 (2313.88)	0.34 (0.20)	0.58 (0.67)	0.15 (1.34)	15.68 (1588.20)	0.36 (0.08)	0.73 (0.08)
Age	0.14 (0.16)	-0.06 (0.01)	0.16 (0.09)	0.19 (0.13)	0.15 (0.21)	0.07 (0.01)	0.08 (0.01)
Age Squared	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Predicted Hours Fished	-3.18 (1.95)	-0.35 (0.21)	-0.07 (0.73)	-0.09 (1.51)	-0.09 (1.87)	-0.15 (0.09)	0.49 (0.08)
Constant	-18.37 (4729.27)	-11.50 (333.32)	-22.79 (1542.96)	-21.97 (2447.42)	-38.77 (3119.17)	0.12 (0.55)	-4.53 (0.53)
Log Likelihood	-23.50	-127.00	-15.00	-7.00	-7.00	-644.00	-703.00
Pseudo R2	0.50	0.52	0.52	0.45	0.45	0.12	0.12

ESTIMATING THE RANDOM UTILITY MODEL

Using the expected catch results we estimate the following indirect utility function for 1990 boat mode recreational fishing trips:

$$[3] \quad V_{ik} = \alpha_1(\textit{travel cost}_{ik}) + \alpha_2(\textit{expected catch Bill fish}_{ik}) + \alpha_3(\textit{expected catch Dolphin}_{ik}) + \alpha_4(\textit{expected catch Tuna}_{ik}) + \alpha_5(\textit{expected catch Wahoo}_{ik}) + \alpha_6(\textit{expected catch Bonito}_{ik}) + \alpha_7(\textit{expected catch other surface fish}_{ik}) + \alpha_8(\textit{expected catch other bottom fish}_{ik}) + \alpha_9(\textit{outerbanks dummy}_i) + \alpha_{10}(\textit{sound site dummy}_i) + \alpha_{11}(\textit{log of intercept points}_i)$$

where:

$\textit{travel cost}_{ik}$ = (.41) (round-trip distance in miles to site i by angler k) + (.66)(hourly wage)(hours driving time),[8]

$\textit{outerbanks dummy}_i$ = 1 for Dare, Hyde, and Carteret counties (sites 1,2, and 5)
= 0 otherwise,

$\textit{sound site dummy}_i$ = 1 for Craven/Pamlico and Beaufort counties (sites 3 and 4)
= 0 otherwise,

$\textit{log of intercept points}_i$ = log of the number of intercept points at site i as reported in the MRFSS data set.

The coefficients in Table 11 are used to generate proxies for expected catch, and the expected probability that catch will be greater than one fish for each of the species groups in Table 10 for each angler at each site for all single-day fishing trips in our sample. These values, along with the other site quality characteristics, were used to estimate the per-trip indirect utility function detailed in equation [3].

Preliminary estimates of equation [3] were problematic for two reasons. First, the coefficients on the catch rates of billfish and dolphin in equation [3] were not significantly different than zero. This is likely due to a lack of significant variation in the (generally low) catch rates of these species across the sites in our model. Hence, this result should not be interpreted as meaning that catch of billfish and dolphin do not enhance the satisfaction realized on a recreational fishing trip. Rather, we should assume that because these species are specifically targeted, the catch of these species does contribute to trip utility, but lack of variation for species that are infrequently caught may prevent the site choice model from revealing their contribution to trip utility. Second, the coefficient on bonito was negative and significant at the 5 percent level. This would seem to indicate that increasing the catch of bonito would detract from trip utility. Despite the

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[8] The explicit travel costs were estimated at \$0.41 per mile, which was the cost of operating a motor vehicle in 1990 (Bureau of the Census, 1991). Driving time was calculated assuming 45 miles per hour average speed. County level income data were used to estimate the hourly wage (Bureau of the Census, 1991). Two-thirds of the wage is used as an approximation of the opportunity cost of time. We lack information on boat related travel costs such as those associated with accessing fishing grounds far offshore. Because the RUM uses travel costs as the “price” of a recreation opportunity, omitting these other costs may bias the welfare results downwards.

fact that no anglers in our sample were specifically targeting bonito, we find this unlikely to be the case, as bonito are generally regarded as an enjoyable fish to catch.

To attempt to address both of these problems, in the utility model we replace the expected catch with the expected probability that catch will be greater than one fish for the five species of interest. This specification can be justified by assuming that since these species are caught so infrequently, anglers do not make site choice decisions based on the number of fish they expect to catch, but rather on whether or not they expect to catch at least one fish. This model resulted in insignificant coefficients for billfish and bonito. Because the bonito did not perform well in either model, and because no anglers in our sample were targeting bonito, we added the expected catch of bonito to the expected catch of other surface fish to yield a new estimate of the expected catch of other species. This sum was then entered as a quality characteristic in both forms of the site choice model. By estimating this new model we are imposing the restriction that the coefficient on bonito, α_6 , is equal to the coefficient on other surface fish, α_7 , in the indirect utility function given by equation [2]. Using a likelihood ratio test for the restricted and unrestricted indirect utility functions, we cannot reject the hypothesis that the bonito and other surface fish coefficients are equal at the one-percent level for both the catch model and the success model. We therefore will use the restricted models and thus have six expected catch rates as quality variables in addition to the two dummy variables and the log of the number of intercept points. Despite the insignificance of the bill fish coefficient, we decided to leave it as a separate variable in the site choice models, reasoning that it was far less likely that these larger fish would have the same contribution to utility as any other species in the model. We therefore proceed with two models of the per trip indirect utility. Model 1 contains the expected catch in numbers of billfish, dolphin, tuna, wahoo, other surface fish (including bonito) and other bottom fish. Model 2 contains the expected probability that at least one fish will be caught for billfish, dolphin, tuna, and wahoo, plus the expected catch in numbers of other surface fish (including bonito) and other bottom fish.

The results for both site choice models are given in Table 12. These estimates were used to estimate the compensating surplus (CS) or per-trip willingness-to-accept for several different catch changes by estimating the compensating variation measure reported in equation [1]. As we are interested in the losses that might be realized by anglers not being able to fish at "The Point," we value 50 and 100 percent decreases in catch of the four big game species for trips originating from site 1 (Dare/Tyrell). The mean per-angler, per-trip compensating surplus measure was calculated for each angler. The means and standard deviations in 1990 dollars are reported in Table 13. Notice that Model 1 produces losses that are slightly higher than those found with Model 2. In both cases, because expected catch and hence losses depend on angler-specific variables, there is large variation in the estimates across the sample. These values can be interpreted as the mean per angler loss from a one-trip closure of the big game fisheries for boat trips launching from Dare County.

Table 12. Random Utility Model Coefficients

	Model 1 Catch Only	Model 2 Catch and Success
Variable		
Travel Cost	-0.0639**	-0.0636**
	(0.0019)	(0.0019)
Bill fish	55.5493	
Expected Catch	(57.0970)	
Dolphin	0.0522	
Expected Catch	(0.0656)	
Tuna	18.9363**	
Expected Catch	(5.2294)	
Wahoo	3.2207**	
Expected Catch	(0.9905)	
Other Surface	0.6610**	0.6130**
Expected Catch [1]	(0.1051)	(0.1125)
Other Bottom	0.5778**	0.5885**
Expected Catch	(0.0713)	(0.0715)
Bill fish		53.1466
Expected Success		(58.2419)
Dolphin		1.4940[+]
Expected Success		(0.8624)
Tuna		15.1976*
Expected Success		(5.9610)
Wahoo		4.5529*
Expected Success		(2.2532)
Outerbanks	5.018**	5.0101**
Dummy	(0.2279)	(0.2289)
Sound	-1.7987**	-1.8324**
Dummy	(0.1558)	(0.1573)
Log of Number of Launch Points	0.2134*	0.1890[+]
	(0.1074)	(0.1082)
Log likelihood function	-1121.768	-1119.629

[+] Significant at the 10% level

* Significant at the 5% level

** Significant at the 1% level

[1] The expected catch of other surface fish is found as the sum of the expected catch of a surface fish aggregate and the expected catch of bonito. Hence, this model represents a restricted form of a model where the expected catch of Bonito was entered as a separate argument in the utility function. Using a likelihood ratio test, we cannot reject the null hypothesis that the coefficients are equal at the 1percent level.

Table 13. Welfare Estimates (per trip) for 100% and 50% Reductions in Big Game Fish Catch at "The Point" (1990 dollars)

			Model 1	Model 2
	Mean	Std Dev	Mean	Std Dev
100%	-9.60	59.21	-7.29	36.82
50%	-5.04	31.36	-3.06	15.05

Deriving the Losses from Hypothetical Fishery Closures

The random utility model presented above allows us to derive the per-angler, per-trip willingness-to-accept for decreases in trip quality. In order to value longer fishery closures — such as those that would be caused by a spill of oil or other hazardous substance — we can expand these pre-trip values using estimates of total trips during a particular period of time.

In conjunction with the on-site creel survey, each year the National Marine Fisheries Service estimates annual recreational fishery participation in numbers of anglers and total trips for each coastal state. The trip estimates are categorized by wave and mode, where a wave is a two-month interval.[9] Modes are divided into man-made structure, beach/bank ocean, beach/bank inland, private/rental boat inland, charter boat inland, private/rental boat ocean ≤ 3 miles from shore, charter boat ocean ≤ 3 miles from shore, private/rental boat ocean > 3 miles from shore, and charter boat ocean > 3 miles from shore. The last two of these are of interest for this study, as "The Point" is far offshore. Using these data, we construct estimates of total trips by private/rental boat to ocean > 3 miles from shore from Dare county by multiplying the sample percentage of offshore trips that are from Dare (0.2734) from our intercept sample by the NMFS estimate of total 1990 trips > 3 miles. These values, along with the NMFS estimates of total trips by mode and wave, are reported in Table 14.

In order to derive the losses to recreational anglers from closure of the big game fisheries at "The Point," we combine the estimates of total trips reported in Table 6, with the per trip compensating variation measures reported in Table 5. We use these values to examine the following 6 closure scenarios: complete closure of Dare big game for 2 weeks, complete closure of Dare big game for 1 month, complete closure of Dare big game for 2 months, complete closure of Dare big game for 2 weeks and then a 50% reduction in the probability of success for the remainder of a 6 month period, complete closure of Dare big game for 1 month and then a 50% reduction in the probability of success for the remainder of a 6 month period, and complete closure of Dare big game for 2 months and then a 50% reduction in the probability of success for the remainder of a 6 month period. We use both a January 1 and a July 1 starting point for each of these scenarios, hence, we examine a total of 12 closure scenarios. The losses in dollars are reported in Table 15.

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9 For all years except 1989, there were no on-site MRFSS surveys during wave 1 (January-February) hence the corresponding estimate of total trips is zero. NOAA personnel indicate that either no anglers were intercepted who were fishing offshore, or due to low expected fishing pressure, no interviews were conducted during wave 1. We therefore construct an estimate of trips during wave 1 in 1990 by applying the proportion of 1989 total trips taken during wave 1 to the estimate of 1990 total trips.

Table 14. 1990 trips by Model and Wave

MONTHS	Private Boat Trips > 3 Miles	Charter BoatTrips > 3 Miles	Total Trips > 3 Miles	Estimate of Dare Trips > 3 Miles [2]
JAN-FEB[1]	2099	0	2099	574
MARCH-APRIL	64208	7133	71341	19505
MAY-JUNE	53384	21211	74595	20394
JULY-AUG	104912	38720	143632	39269
SEPT-OCT	43294	9661	52955	14478
NOV-DEC	9558	3586	13144	3594
TOTAL	277455	80311	357766	97813

[1] There were no interviews during wave 1 in 1990. This value is an estimate constructed by applying the proportion of 1989 total trips taken during wave 1 to the estimate of 1990 total trips.
[2] Found by multiplying sample percentage of Dare trips > 3 miles (0.2734) by total trips > 3 miles.

Table 15. Lost CV from Dare Trips (1990 dollars) [1]

	Start time = January 1		Start time = July 1	
Scenario	Model 1	Model 2	Model 1	Model 2
1	-1,377	-1,046	-94,246	-71,568
2	-2,755	-2,092	-188,491	-143,135
3	-5,509	-4,183	-376,982	-286,271
4	-204,637	-124,454	-333,763	-216,989
5	-205,291	-125,060	-378,529	-258,516
6	-206,600	-126,274	-468,062	-341,570

[1] Found by multiplying Dare trips by per trip CV measures over the length of the scenario.

Closure Scenarios:

1 = Complete closure of Dare big game for 2 weeks.
2 = Complete closure of Dare big game for 1 month.
3 = Complete closure of Dare big game for 2 months.
4 = Complete closure of Dare big game for 2 weeks and then a 50% reduction in the probability of success for the remainder of a 6-month period.
5 = Complete closure of Dare big game for 1 month and then a 50% reduction in the probability of success for the remainder of a 6-month period.
6 = Complete closure of Dare big game for 2 months and then a 50% reduction in the probability of success for the remainder of a 6-month period.

Estimated losses for closures during wave 1 are relatively low due to the low estimate for offshore fishing during January and February. Closure scenarios that begin in January and extend beyond wave 1 (scenarios 4, 5, and 6) affect fishing during more popular months and result in significantly larger losses. Because wave 4 is the most popular in terms of numbers of offshore trips, closures that include July and August have the largest effect on recreational angler welfare. As a result, the estimates of losses for all scenarios beginning in January are significantly lower that those beginning in July.

INTERPRETING THE RESULTS

In addition to generating baseline data, this study has presented the results for various scenarios in the unlikely event of the release of oil from the drilling operation. The various scenarios used for the impacts on Dare County and the impacts on recreational fishermen are almost identical. However, the nature of the numbers generated from the input-output model is quite different from the values estimated for the recreational fishing model. It is important to interpret them carefully.

One important difference is that the losses estimated for recreational fishing take into account the fact that anglers will substitute other locations if fishing around "The Point" is restricted. The losses estimated for recreational fishing are a net losses after all adjustments have been made. In a benefit-cost study, they are legitimate costs. On the other hand, the earlier section of this report concentrates on impacts on Dare County and does not consider effects in other counties that are potentially partially offsetting. The input-output analysis also does not consider the various substitutions and reactions that will take place in the event of a spill. Thus, the dollar values for the tourism and commercial fishing scenarios cannot be directly compared to those for recreational fishing. They will include impacts that would not be considered as losses in a benefit-cost study. This is not to say that the impact analysis results are not useful. Distributional questions are important. It is just that the numbers in the two parts of the study should not be directly compared.

It is also important to note the differences in the scenarios for commercial fishing and tourism. Both are impact analyses. However, the commercial fishing scenarios for species group 1 assume that the physical effects of the spill are only occurring in the vicinity of "The Point." The tourism impacts require that some of the spill makes landfall, news of the spill reduces visits even without physical effects, or at least part of the tourists are intending to fish at "The Point." Any or all of these may be true, but direct comparison of commercial fishing and tourism impacts must be approached with caution, and the assumptions must be made explicitly.

With these *caveats*, the results in this report have generated baseline information about the economies of the coastal counties and the value of recreational fishing. By examining the experiences elsewhere with offshore releases, we have generated a range of scenarios and estimated the effects on the coastal counties and recreational fishing should there be a release off "The Point."

REFERENCES

Alward, G., E. Siverts, D. Olson, J. Warner, D. Senf, and S. Lindall. 1989. Micro Implan Software Manual. Regents of the University of Minnesota. Minneapolis, MN.

Armstrong, H. and J. Taylor. 1985. Regional Economics and Policy. Philip Allan publishers. Oxford, England.Ben-Akiva, M., and S.R. Lerman. 1985. Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press.

Bockstael, N.E., Hanemann, M.W., and Kling, C.L. 1987. Estimating the Value of Water Quality Improvements in a Recreation Demand Framework. Water Resources Research 23:951-960.

Bockstael, N.E., McConnell, K.E., and Strand, I.E. 1989. A Random Utility Model for Sportfishing: Some Preliminary Results for Florida. Marine Resource Economics, 6:245-260.

Ben-Akiva, M. and S.R. Lerman. 1985. Discrete Choice Analysis. Cambridge: MIT Press.

Brothers, G. 1998. Personal Conversation about Estimates of the Economic Impact of Hurricane Fran on Coastal Tourism. Department of Parks and Recreation Management. Raleigh, NC.

Brothers, G. and S. Mitchell. 1998. North Carolina Accomodations Survey. North Carolina State University. Raleigh, NC.

Bureau of the Census. 1991. Statistical Abstract of the United States: 1991. (111th Edition.) Washington, DC.

Currin, M. and Ross, S. 1999. Characterization of Recreational and Commercial Fisheries at "The Point" — Offshore North Carolina." Contractor's report to NC-Division of Coastal Management, August 1999.

Diaby, S. 1998. An economic profile of the commercial fishing industry in coastal North Carolina. NC-DMF Report. 47 pp.

Department of Parks and Recreation Management, North Carolina State University. 1998. Travel and Tourism Facts: North Carolina Counties. Raleigh, NC.

Department of Sociology and Anthropology, North Carolina State University. 1998. Demographic Tables for North Carolina Counties. Raleigh, NC.

Etkin, D.S. 1996. International Oil Spill Statistics: 1996. Cutter Information Corporation. Arlington, MA. 54 pp.

Fletcher, J.E. 1989. Input-Output Analysis and Tourism Impact Studies. Annals of Tourism Research. 16:514-529.

Freeman, R., S. Holland, and R. Ditton. 1985. Measuring the Impact of the Ixtoc I Oil Spill on Visitation at Three Texas Public Coastal Parks. Coastal Zone Management Journal. 13(2):177-201.

Hanemann, W.M. 1999. Welfare Analysis with Discrete Choice Models in Herriges, J.A. and C.L. Kling, Valuing Recreation and the Environment: Revealed Preference Methods in Theory and in Practice, Edward Elgar.

Isard, W. 1975. Introduction to Regional Science. Prentice-Hall. Englewood Cliffs, New Jersey.

Johnson, R.L. and E. Moore. 1993. Tourism Impact Estimation. Annals of Tourism Research. 20:279-288.

Kaoru, Y., Smith, V.K., and Liu, J.L. 1995. Using Random Utility Models to Estimate the Recreational Value of Estuarine Resources. American Journal of Agricultural Economics, 1:141-151.

McConnell, K.E., Strand, I.E., and Blake-Hedges, L. 1995. Random Utility Models of Recreational Fishing: Catching Fish Using a Poisson Process. Marine Resource Economics, 10(3).

Mead, W.J. and P.E. Sorenson. 1970. The Economic Cost of the Santa Barbara Oil Spill. *Santa* Barbara Oil Spill Symposium. Santa Barbara, Marine Science Institute, University of California. Pp. 183-226.

Mendelsohn, R. 1993. The Effect of the *Valdez* Oil Spill On Alaskan Salmon Prices. Unpublished Manuscript.

Nijkamp, P., P. Rietveld, and F. Snickars. 1986. Regional and Multiregional Economic Models: A Survey. In Handbook of Regional and Urban Economics, P. Nijkamp, editor. North-Holland. New York.

Office of State Planning, State of North Carolina. 1997. LINC County Profiles. Raleigh, NC.

Perko, G.V. 1989. Survey of Developments in North Carolina Law, 1989 Environmental Law: Spillover from the *Exxon Valdez*: North Carolina's New Offshore Oil Spill Statute. North Carolina Law Review. 68(6):1214-1235.

Portland Press Herald. 1996. Various Issues.

Providence Journal. 1996. Various Issues.

Raleigh News and Observer. 1998. Various Issues.

Schuhmann, P.W. 1998. Deriving Species-Specific Benefits Measures for Expected Catch Improvements in a Random Utility Framework. Marine Resource Economics 13(1):1-21.

Smith, V.K., J.L. Liu, and R.B. Palmquist. 1993. Marine Pollution and Sport Fishing Quality. Economic Letters 42:111-116.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.