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Tourism Dependence in Rural America: Estimates and Effects

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Recreation and tourism development continue to play an important role in reshaping rural America. Efforts to evaluate the effects of such development are complicated because residents and nonrecreation visitors also use the businesses that are affected by recreation and tourism visitors. We present a method for estimating in nonmetropolitan counties jobs and income that are generated by recreation and tourism visitors from outside the county. Several different techniques are used to (1) cluster similar counties, (2) account for the portion of tourism sector employment that serves local residents, and (3) account for the portion of export activity that serves nonrecreation visitors. Finally, we address the consequences of recreation dependence in rural counties. The counties most dependent on nonlocal tourism activity are compared to other rural counties on income, population, economic structure, and housing variables.

Keywords economic structure, minimum requirements, nonmetropolitan counties, recreation dependence, rural development, tourism dependence

Natural resources provide the amenity base for a rising level of tourism in rural America. Over the past 50 years, many amenity-based rural communities have shifted from an economy based on manufacturing to one driven by retail and service sectors. Tourists seeking natural resource–based settings, tranquility, and adventure have affected rural economies by injecting new dollars into local businesses, supporting local tax bases, and creating increased demands for locally available land, labor, and capital. With regard to recreational use of natural resources, tourist expenditures create local demands for traded goods and services, thus creating jobs

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and income for local residents (Johnson and Moore 1993; English and Bergstrom 1994).

However, the quality of life in such rural communities is often a point of contention between long-time residents and newcomers, especially as communities become very dependent on tourism (Rothman 1998; Green et al. 1996). Whether the change to increased dependence on recreation and tourism has been beneficial is a tricky empirical question. Many key socioeconomic issues related to tourism development remain unanswered. For example, what is the relation between recreational land use and local tourism business activity? How does tourism affect the level or distribution of residents' income in heavily impacted communities? Such questions are the basis for discussing public policy effectiveness in land management and community development.

Public agencies at all governmental levels are concerned with the answers to these and similar questions. An outgrowth of this concern is that the effects of land management decisions on resource-dependent rural communities are incorporated explicitly in the planning processes of these agencies (USDA–Forest Service 1995). Unfortunately, evaluating the rural development consequences of management efforts related to natural resource-based tourism can be somewhat difficult. Many of the businesses that cater to tourists also serve local residents, thus making it difficult to determine how much economic activity is directly due to nonresident visitors.

Although tourism is rather ill-defined from an industrial perspective (Leiper 1979, 1990; Smith 1987), geographers and regional economists have developed workable definitions that allow secondary data to be used in assessing tourism dependence (Johnson and Thomas 1990; Brown and Connelly 1986; Leatherman and Marcouiller 1996a). Most expenditures made by tourists fall into one of four economic sectors: lodging (including hotels, motels, campgrounds, and inns), eating/drinking (restaurants and bars), retail (grocery stores, gas stations, and gift shops), and recreation services (ski areas, golf courses, and amusement parks). In rural areas near large public land holdings, it is not uncommon for a large portion of the economic activity in these sectors to be caused by tourists and other visitors to the area. Given that recreation-based nonmetropolitan counties have experienced three times the rate of net migration as compared to nonmetropolitan areas as a whole (Beale and Johnson 1998), rural communities endowed with natural amenities will likely experience growing local demands on service and retail businesses.

A key difficulty with defining the level of dependence on resource-based tourism is that standard sector aggregates combine receipts from residents with those originating from nonlocal (or export-base) visitors. Certainly, some of the jobs and income in these sectors result from spending by local residents. Some also result from spending by visitors on trips for purposes other than resource-based tourism, such as for business, or for family matters. It is not always easy to determine what proportion is due to tourism, since visitation figures are typically unavailable or unreliable. Separating amenity-based (or recreational) travel from resident spending or business travel is a critical step in estimating usable causal relationships between local natural amenities and tourism dependence.

Also, the type of tourism in rural areas across the United States exhibits wide variation. Activities range from nature-based tourism characterized by guides and outfitters (such as that surrounding the Boundary Waters Canoe Area) to highly developed recreational services and amusements (such as around the Wisconsin Dells). The economic characteristics of tourism along this spectrum need to be incorporated into analyses of tourism dependence.

In this article, we test some sociodemographic hypotheses with respect to nonmetropolitan counties that are generally more dependent on resource-based tourism. We present estimates of the amount of economic activity caused by nonresident recreation and tourism visitors to rural counties in the United States, and compare counties that are most dependent on these visitors to counties that are not for several measures of income, economic structure, housing, and population characteristics. In defining recreation and tourism dependence, we extend traditional methods to focus only on the amount of economic activity in recreation and tourism sectors that is due to nonresident tourism demand. That is, we discount the economic activity generated both by local residents and by nonresidents who travel for purposes other than resource-based tourism. Further, we link this tourism dependence with components of economic structure relevant to discussions of local community development.

Defining Recreation Dependence

Researchers at the U.S. Department of Agriculture (USDA) Economic Research Service (ERS) developed a typology of nonmetropolitan counties in the United States for use in policy analysis, and described their economic dependencies (Bender et al. 1985; Hady and Ross 1990). Initially, the typology used included eight classes of rural policy counties: agriculture, federal lands, government, manufacturing, mining, poverty, recreation, and retirement. However, because only 63 counties were classified as recreation dependent, this category was dropped from further analysis (Ross and Green 1985). In these efforts, recreation dependence was defined as having at least 10% of total employment or labor/proprietor income in eating/drinking places, hotels and other lodging, and amusement establishments.

More recently, Beale and Johnson (1998) used another method to define recreation-dependent nonmetropolitan counties. This work confirmed earlier research (Johnson and Beale 1994) that suggested population growth was noticeably higher in areas with greater levels of recreation resources. Several indicators were used to define dependence. The first was if a county was at least two-thirds of a standard deviation above the national mean on any two of three measures: (1) percentage of employment in 1980 in entertainment, recreation, and personal services; (2) percentage of earnings income in 1980 in amusement, recreation, and lodging; or (3) percentage of housing units in 1980 that were vacant and held for recreation, seasonal, or occasional use. The second measure was if per capita spending on hotels, motels, trailer parks, and camps exceeded $100 in 1982. Individual examination of counties that qualified on either measure ensured that only those with documented recreation resources were retained. This process identified 285 counties as recreation dependent, with geographic concentrations in New England and upstate New York, near the Ozarks, the southern Appalachians, and in the West. Other concentrations occurred in nonmetropolitan coastal counties and the upper Great Lakes.

Beale and Johnson's approach improved on the ERS method by broadening the array of structural economic components, and including a more flexible set of criteria for determining the dependence threshold. However, neither method distinguished among various sources of demand that generated the levels of economic activity which classified a county as recreation dependent. Other USDA initiatives have attempted to develop local indices of amenity presence (Kusmin et al. 1996) and explain amenity migration (Nord and Cromartie 1997). In those two efforts, amenity indices were constructed based on climate, topography, water resources, and other amenities.

The approach reported in this article builds directly upon these previous efforts, but extends them to more closely estimate the effects of nonlocal recreational spending. Extensions include identifying like resource-based regions and applying an export-base estimator known as minimum requirements. Cluster analysis on primary resource-based factors allows more clear specification of tourism type. Applying minimum requirements leads to a more specific estimate of the nonresident component of service and retail sector activity than is found in either the Beale and Johnson or the Kusmin et al./Nord et al. approaches. To clarify the relation of our approach to previous work, it is useful to review the conceptual framework for this type of research.

Conceptual Model

Rural development research treats recreation and tourism as export activities (Dawson et al. 1993; English and Bergstrom 1994). That is, economic growth and development comes from increases in "exporting" goods and services to nonresident visitors. The effects of local demand are generally discounted as representing only transfers of money within the economy. Thus, tourism dependence should be defined with reference to export employment. Therefore, total employment (E) in a county in a tourism-related sector equals employment that serves local demand (E_L) plus employment that serves export demand (E_X). However, visitors to the county on nontourism trips also spend money in tourism-related businesses such as for hotels and food. Many such nontourism trips are for either family purposes or for business travel. Dwyer and Forsyth (1997) refer to travel for meetings, incentives, conventions, and exhibitions—or "MICE" travel. Thus, E_X can be subdivided into a tourism demand component (E_T), and a nontourism demand component (E_N).

Since E_T is employment that serves only tourism-related demand, we assume that E_T depends exclusively on the total number of nonresident tourist trips taken to the county. The number of tourist trips to a county or other destinations is explainable primarily by the set of natural and cultural amenities located there (Stynes and Peterson 1984). On the other hand, nontourism employment (E_N) depends solely on nontourism trips, and so must be explained by characteristics other than resource amenities. In this study, we assume that county population is the primary determinant of the volume of family-related trips. Some research has shown a direct link between population and employment for nonmetropolitan counties (Duffy-Deno 1998). We extend this link and posit a direct relationship between business-related trips and population. Measures of tourism dependence should be based on E_T. Removing the effects of both residents (E_L) and nontourism travel (E_N) allows the identification of the true relationship between tourism dependence and the social, economic, and quality-of-life issues that are important to policy makers and researchers.

Therefore our conceptual model is:

$$E = E_L + E_X$$
$$E_X = E_T + E_N$$
$$E_T = f(\text{REC})$$
$$E_N = g(\text{POP})$$

where POP is the county population and REC is a vector of recreation/tourism attributes for the county.

Methods

This study was limited to the 2261 nonmetropolitan counties in the contiguous United States. To account for structural differences in county size, climate, and other factors, some regional grouping for counties was desired. Because this research was designed to serve the Forest Service's Resource Planning Act (RPA) Assessment process, rural counties were divided into administrative regions used in the RPA Assessment reporting. Three regions were defined: South (VA to OK), North (MD, MN, and IA to New England), and West. Separate but identical analyses were carried out for each region to determine E_T. The South region contained 955 rural counties, the North region contained 686, and the West region contained 620.

Total employment and income data for four tourism-related sectors were extracted from sectoral data in the 1993 Micro-IMPLAN data set, developed by the Minnesota IMPLAN Group. These sectors included (1) hotels and other lodging, (2) eating and drinking places, (3) recreation and amusement services, and (4) other retail trade. Visitor spending in these sectors typically accounts for the majority of expenditures used in studies of the impacts of recreation and tourism (Dawson et al. 1993; Johnson and Moore 1993).

Estimating Export Employment in Tourism-Sensitive Sectors

The minimum requirements technique was used to separate E_L from E_X for each sector. Minimum requirements assume that local production serving local demands occurs prior to producing for exports (Pratt 1968; Isserman 1980), so a sector develops first to meet the needs of the local populace. Other assumptions are that counties can be divided into homogeneous groups, and that counties in the same group will have similar economic structures, in that the proportion of activity that serves local demand will be fairly constant within the group.

Cluster analysis was used to group counties in each region that were similar with respect to population density, distance from metropolitan areas, and the proportion of county acres in each cropland, forests, pasture/range, and mountains. Eight clusters were retained for each region. Within each cluster of counties, the minimum percentage of economic activity in each tourism-related sector was identified. Under minimum requirements, it was assumed that this is the percentage of employment needed to meet local demand. Thus, in the county with the minimum employment percentage, there is no "export" to support demand by nonresidents. In all other counties in the cluster, the excess above the minimum percentage serves export (out-of-county) demand. The calculation to determine export employment[1] for county i and sector j was:

$$\mathrm{EX}_{ij} = \left[\frac{\mathrm{ec}_{ij}}{\mathrm{ec}_{iT}} - \min\left(\frac{\mathrm{ec}_{ij}}{\mathrm{ec}_{iT}}\right)\right]\mathrm{ec}_{iT}$$

where EX_{ij} is the export employment share for county i and sector j; ec_{ij} is economic activity (employment or income) for sector j in county i; ec_{iT} is economic activity for county i, summed over all sectors; and min(·) is the minimum function, identifying the minimum value for all counties in the cluster of county i.

Estimating the Recreation Component of Tourism-Sector Exports

Results from minimum requirements calculations yielded estimates of E_X. Established techniques do not exist to separate E_T from E_N. Nor are data on the volumes of tourism and non-tourism trips to rural counties readily available. Consequently, we used results from a regression analysis to separate tourism-related export employment from nontourism export employment. The model estimated was:

$$EX_{ij} = \alpha_j + \beta_{POPj} POP_i + \beta_{RECj} REC_i$$

where POP is the population of county i; REC_i the vector of recreation/tourism attributes for county i; and α_j, β_{POPj}, and β_{RECj} the parameters to be estimated for sector j.

The equation represents the position that total export employment in tourism-related sectors is a function of tourism and nontourism (family and MICE) visitation. County population served as a proxy for the amount of nonresident nontourism trips. A wide array of recreation and tourism attributes was identified as having the potential to explain tourism visitation and hence employment.

There were too many resource attributes to include all of them in the regression analysis, and it was not known a priori which attributes would be most important. We used principal components analysis (PCA) to reduce the resource array into a smaller set of resource factors. To impose an initial structure on the array of resource attributes, each was assigned to one of four groups that represent specific types of opportunities for recreation and tourism (Table 1). Urban resources include developed opportunities that grow with population, such as golf courses, museums, and amusement parks. Land resources include resources that support traditional outdoor recreation activities, such as hiking or camping. Water resources are those that support water-based activities, such as boating, fishing, and swimming. Winter resources are those that support winter activities such as skiing and snowmobiling. PCA factors with eigenvalues greater than 1.0 were retained. In each region, 16 factors were retained, 4 that described urban resources, 6 for land resources, 4 for water resources, and 2 for winter resources.[2] Factors were nearly identical across the three regions.

The principal component factor scores served as the vector of recreation/tourism variables for the regression model. In turn, these scores would be used to predict the level of tourism-dependent employment in each nonmetropolitan county. A log-linear specification for the regression model had the conceptual advantage that predicted values would all be positive. It turned out to provide superior fit to the data as well.

Results of the regression model were used to estimate the amount of export employment that was due to recreation and tourism. The total expected amount of export employment, E_X, was given by:

$$E[E_X] = \exp(\hat{\alpha} + \hat{\beta}_{POP} POP + \hat{\beta}_{REC} REC)$$

That is, the total expected amount of export employment in a tourism-related sector was assumed to be a function of the population and recreation resources in a county and of the estimated parameters. All of the recreation resource factors were assumed to contribute only to tourism-related trips, and therefore tourism-dependent employment. Population was used to account for nontourism trips.

Hence, the expected amount of employment caused by nontourism trips was given by:

$$E[E_N] = \exp(\hat{\alpha} + \hat{\beta}_{POP}\,\mathrm{POP})$$

The proportion of export employment due to nontourism-generated trips would be $E[E_N]/E[E_X]$. Therefore, $1 - (E[E_N]/E[E_X])$ would be the proportion of export employment that is dependent on recreation and tourism. That is,

$$E[E_T] = E_X\left(1 - \frac{E[E_N]}{E[E_X]}\right)$$

Characteristics of Counties Dependent on Resource-Based Tourism

How do the rural counties that are most dependent on tourism compare with other rural counties? This question was examined through a series of simple (OLS) regression models. Independent variables in the models included an indicator variable for dependence on recreation, one for adjacency to a metropolitan area, and two more that indicated location in either the Southern or Western portions of the country. Initially, region-dependence interactions were included, but these were nonsignificant and were therefore deleted. Several variables related to population, income, age, education, housing, and economic structure were examined to evaluate the effect of tourism dependence on local residents and their quality of life.

Empirical Results

Regression Results

In total, 12 regression models (4 sectors for 3 regions) were estimated. Table 2 summarizes the results and indicates which resource factors had significant coefficients in predicting export employment by region and economic sector. All of the resource factors were significant in at least 2 of the 12 models. In the West region, at least 3 of the urban-related resource factors were significantly related to export employment in each of the 4 sector models. At least 2 urban resource factors were significant for each sector in the North region models, and for all but the lodging sector in the South region. Most of the land resource factors were tied to export employment in the lodging and retail trade sectors in the North and to the eating/drinking sector in the South and West. Water resource factors were significant in all 4 sectors in the North, all but lodging in the South, but to none of the sectors in the West. Both winter resource factors were significantly related all 4 sectors in the North, and to eating/drinking and recreation services in the West.

Local Jobs and Income Dependent on Resource-Based Tourism

Across all four tourism-related sectors, we estimated that 767,000 jobs result from nonresident recreation and tourism trips to nonmetropolitan counties (Table 2). These jobs account for $11.8 billion in income to employees and business owners. Over $4 billion in income accrues to people in rural counties in both the North and West regions, and about $2.6 billion in the South. Across all rural counties, about

TABLE 1 Definitions of Variables Used in Principal Components Analysis

Urban facilities:
Number of parks and recreation departments
Number of tour operators + sightseeing tour operators
Number of playgrounds + number of recreation centers
Number of private + public swimming pools
Number of private + public tennis courts
Number of organized camps
Number of tourist attractions + number of historical places
Number of amusement places
Number of fairgrounds
Number of local or county parks
Number of private + public golf courses
Number of ISTEA funded greenway trails
Estimate of acres of urban/built up land from 1995 National Resources Inventory (NRI)

Land resources:
Number of guides services
Number of hunting/fishing preserves, clubs, lodges
BLM public domain acres
Acres of mountains
Acres of cropland, pasture, rangeland
USDA–Forest Service National Forest and Grassland acres
FWS refuge acres open for recreation
Woodalls number of private campground sites
Woodalls number of public campground sites
NPS federal acres
NRI estimate of forest acres

Water resources:
Number of marinas
Number of canoe outfitters + rental firms + raft trip firms
Number of diving instruction or tours + snorkel outfitters
Number of guides services
Number of fish camps + private/fish lakes, piers, ponds
American Whitewater Association total whitewater river miles
Designated Wild and Scenic River miles: total 1993
National Resources Inventory (NRI) acres in water bodies 2–40 acres, <2 acres, ≥ 40 acres (lake or reservoir)
NRI acres in streams <66 ft wide + 66–660 ft wide + $\geq 1/8$ mi wide
NRI water body ≥ 40 acres (bay, gulf, estuary)
NRI wetland acres
Nationwide Rivers Inventory total river miles, any outstanding value

Winter resources:
Cross-country Ski Areas Association number of XC ski firms + public XC centers
International Ski Service skiable acreage
Federal land acres in counties with >24 in snowfall
Agricultural acres in counties with >24 in annual snowfall

TABLE 1 Continued

Acres managed by Bureau of Reclamation, Tennessee Valley Authority, Corps of Engineers	Acres of mountains in counties with >24 in annual snowfall
Total rail-trail miles	Acres of forestland in counties with >24 in annual snowfall
State park acres	
The Nature Conservancy acres with public access	
National Wilderness Preservation System acreage: total 1993	

Note. BLM, Bureau of Land Management; FWS, Fish and Wildlife Service; NPS, National Parks Service; NRI, National Resources Inventory; XC, cross-country. From USDA–Forest Service (1997).

TABLE 2 Summary of Regression Results Predicting Export Employment in Tourism-Related Sectors: Resource Factors With Significant Unstandardized Regression Coefficients, by Region and Economic Sector

General resource factor description	Sector			
	Lodging	Eat/drink	Retail trade	Recreation services
Urban:				
1. Tennis, golf, museums		N, S, W	S	S, W
2. Amusement parks, cultural attractions	N, W	N, W	N, W	N, W
3. Swimming pools, urban trails	W	N, W	W	S, W
4. Local parks, camps, fairgrounds	N, S, W	S, W	N, S, W	N, S, W
Land:				
1. Forest Service lands, wilderness	N, S	S, W	N, S, W	N, S
2. Private forest land	N	S	N	N
3. National Park Service, Fish and Wildlife Service	N	S, W	N	
4. Public campgrounds, other federal lands	S	S, W	S	
5. State parks and forests	W	W		
6. Hunting clubs, agricultural lands	N	W	N	N
Water:				
1. Fishing opportunities, river guides			S	N, S
2. Whitewater rivers	N	N	N	N, S
3. Marinas, lakes		N, S		
4. Ocean, wetlands		S	N	
Winter:				
1. Downhill and cross-country skiing	N	N, W	N	N, W
2. Forest and agricultural land with snow	N	N, S, W	N, W	N, W

Note. N, coefficient significantly different from zero for regression model for the Northern region. S, coefficient significantly different from zero for regression model for the Southern region. W, coefficient significantly different from zero for regression model for the Western region.

300,000 jobs and $3.455 billion in income in the eating/drinking sector are attributable to resource-based tourism. That equals about one-fourth of the total economic activity in that sector in nonmetropolitan counties. Likewise, the 171,000 jobs and $2.366 billion in income in retail trade caused by resource-based tourism comprise about 25% of all jobs in that sector in nonmetropolitan counties. Clearly, resource-based recreation is important to these sectors. For these two sectors, each job generates about $12,000 in income. The level of income per job is low most likely because a significant proportion of these types of jobs are part-time. In the accommodation and recreation services sectors, tourism "exports" account for almost twice as high a proportion of the total activity, over 40%. In addition, income per job is over $20,000 in these sectors.

In some rural counties, there was no economic effect from nonresident recreation. In others, over half of all jobs and income are tied to the tourist industry. Across the country, jobs and income generated by recreation "exports" make up about 3.1% and 1.5%, respectively, of all jobs and income in nonmetropolitan counties. However, these percentages are not the same for all regions. In the South, less than 2% of all jobs and under 1% of income in nonmetropolitan counties are due to nonresident tourism. Rural counties in the West are far more dependent on tourism. Jobs serving nonresident recreation and tourism visitors make up over 5% of all jobs in rural counties in this region. That is nearly twice the national percentage, and three times the proportion for the South. Over 3% of income comes from serving these visitors, also more than twice the national average and over 4 times the proportion found in the South.

Relative Importance of Resource-Based Tourism

There were 472 rural counties (about 21% of the total) wherein over 6% (double the national average) of the total number of jobs were due to nonresident recreation visitation. In 372 counties (about 16% of the total) the percentage of income due to nonresident recreation visitation was at least 3% of the total income, or at least double the national average. In total, 338 counties had more than double the national percentage for both jobs and income. These are the counties that we define as most dependent on tourism. The majority of these dependent counties are located in mountainous portions of the West. Other concentrations occur in coastal areas, and near Forest Service, National Park Service, or other large public land holdings in the eastern half of the country.

Our estimates reflect only the jobs and income directly related to nonresident tourism visitation in the sectors most closely tied to that activity. Visitors may also affect other types of businesses, such as gas stations, travel agents, real estate services, and grocery stores. In addition, some other businesses are indirectly linked to recreation by supporting those businesses directly tied to recreation. Examples could include laundry or cleaning services for hotels or restaurants, insurance services, or wholesale suppliers. Some of these jobs could also be partly due to recreation visitors. As a result, the figures presented here may be a slightly conservative estimate of the economic effects of recreation in rural counties in the United States.

Characteristics of Counties Dependent on Resource-Based Tourism

Income

Counties dependent on tourism had significantly higher per capita income levels in 1990 than did nondependent counties (Table 3). Dependent counties also showed greater percentage increases in per capita income between 1980 and 1990 than did nondependent counties. However, the average household income in tourism dependent counties was not significantly greater than in nondependent counties. Despite differences in income level and growth, there was no difference in the proportion of

TABLE 3 Jobs and Income Attributable to Resource-Based Tourism, by Region and Sector

Sector	North	South	West	U.S. total
Eating/drinking				
Jobs (1000s)	126	78	96	300
Income (million $)	1333	981	1041	3455
Accommodations				
Jobs (1000s)	61	24	86	171
Income (million $)	1098	484	1896	3478
Retail trade				
Jobs (1000s)	65	53	53	171
Income (million $)	944	781	641	2366
Recreation services				
Jobs (1000s)	51	23	51	125
Income (million $)	833	404	1274	2511
Total				
Jobs (1000s)	303	178	286	767
Income (million $)	4208	2650	4952	11810
Importance of resource-based tourism[a]				
Jobs (in percent)	3.0%	1.8%	5.4%	3.1%
Income (in percent)	1.3%	0.8%	3.0%	1.5%

[a] This is simply the proportion of all jobs and income (from all sectors) that is attributable to resource-based tourism (from the three identified sectors) in selected nonmetropolitan counties.

the population that live in poverty. Other studies have uncovered empirical evidence identifying inequities and distributional issues tied to tourism development (Smith 1986; Leatherman and Marcouiller 1996b). Although inconclusive, our results do not indicate statistical differences between tourism-dependent and other rural counties with respect to income distribution as measured by Gini coefficients. Further work is required to more closely examine potential equity disparities in counties with significant tourism development.

Economic Structure

In general, the economic structure in tourism dependent rural counties was less diverse than in nondependent rural counties (Table 4). This indicates that tourism-dependent rural counties have less activity in manufacturing and production sectors, and a higher concentration in services and related sectors. In particular, there was significantly less economic activity in both the forestry and wood products manufacturing sectors in dependent counties. However, this pattern may be changing. From 1980 to 1990, dependent counties had a greater proportional increase in economic diversity than did nondependent counties.

Housing

Housing in tourism-dependent areas was more expensive than in other rural areas. The average house value was nearly $13,000 higher in 1990 in tourism-

TABLE 4 Regression Results (Unstandardized Regression Coefficients, *t*-Values in Parentheses) for Models Comparing Recreation and Other Rural Counties on Income-Related Dependent Variables

Independent variable	1990 Per capita income	1990 Average household income	Gini coefficient	1990 Percent poor	Percent PCI change, 1980–1990
Constant	10,366	26,826	.4021	15.44	3.80
	(134.90)	(142.21)	(365.9)	(50.03)	(7.55)
Recreation	477.74	480.16	.0019	−0.260	2.43
dependent	(4.56)	(1.87)	(1.25)	(−0.61)	(3.53)
West	−102.02	−3.19	.0006	1.03	−2.05
	(−1.05)	(−0.01)	(0.46)	(2.64)	(−3.20)
South	−1153.47	−2418.40	.0342	8.00	2.15
	(−13.47)	(−11.51)	(28.16)	(23.26)	(3.83)
Metro	691.41	2375.80	−.0101	−2.75	2.46
adjacent	(9.25)	(12.97)	(−9.39)	(−9.15)	(5.03)
Model *F*	81.67	79.50	268.31	176.15	22.99
R^2	.13	.12	.32	.24	.04

Note. PCI, per capita income.

dependent rural counties, compared to nondependent counties (Table 5). Proximity to metropolitan areas accounted for a difference in house value of about $8700. As could be expected, the proportion of housing units that were seasonally vacant was much higher (12.6%) in dependent counties. The proportion that were rented was nearly 4% lower compared to nonmetropolitan counties that were not dependent.

TABLE 5 Regression Results (Unstandardized Regression Coefficients, *t*-Values in Parentheses) for Models Comparing Recreation and Other Rural Counties on Housing-Related Dependent Variables

Independent variable	1990 Mean value	1990 Percent seasonally vacant	Percent change in value, 1980–1990	1990 Percent rented	Change in units, 1980–1990
Constant	46,005	16.16	−15.67	21.23	1006.8
	(45.41)	(36.25)	(−19.70)	(50.03)	(176.68)
Recreation	12,797	12.63	7.43	−3.67	58.8
dependent	(9.25)	(20.76)	(6.84)	(−9.91)	(3.53)
West	271.7	0.15	−8.01	3.05	4.6
	(0.21)	(0.27)	(−7.92)	(8.84)	(0.52)
South	−2604	−0.64	8.43	0.35	47.1
	(−2.37)	(−1.28)	(9.51)	(1.17)	(7.41)
Metro	8672	−2.04	6.20	0.07	59.4
adjacent	(8.80)	(−4.71)	(8.00)	(0.27)	(10.72)
Model *F*	41.62	136.68	108.51	39.07	57.53
R^2	.07	.20	.16	.06	.09

TABLE 6 Regression Results (Unstandardized Regression Coefficients, *t*-Values in Parentheses) for Models Comparing Recreation and Other Rural Counties on Economic Structure-Dependent Variables

Independent variable	1990 Diversity index	1990 Forestry value added	1990 Wood products value added	Percent diversity index change, 1982–1992
Constant	0.6053	392.1	4833.7	115.81
	(290.91)	(1.73)	(7.97)	(208.39)
Recreation	−0.0127	−781.2	−3433.7	2.07
dependent	(−4.47)	(−2.54)	(−4.14)	(2.73)
West	−0.0352	1972.3	1027.5	5.40
	(−13.33)	(6.84)	(1.33)	(7.67)
South	−0.0353	736.2	−670.0	2.40
	(−15.23)	(2.92)	(−0.99)	(3.86)
Metro	0.0133	219.33	1787.7	−0.45
adjacent	(6.57)	(3.18)	(3.03)	(−0.82)
Model *F*	94.35	13.47	7.16	20.75
R^2	.14	.02	.02	.04

From 1980 to 1990, tourism-dependent counties had higher growth in number of housing units and in the percentage increase in average housing value. That is, in these counties both the quantity and price of housing increased faster than in counties that are not so dependent on recreation.

Population

Our results confirm the findings of Beale and Johnson (1998) regarding population growth. The counties we defined as dependent on tourism are growing faster than other rural counties. From 1980 to 1990, after accounting for regional differences and proximity to metropolitan areas, population in recreation dependent counties grew about 5.36% more than did other rural counties (Table 6). From 1990 to 1995, these counties' population grew another 3.81% faster, compared to nondependent rural counties (Table 7). The populace in the recreation/tourism dependent counties tends to be better educated, and less tied to farming than in other rural counties. Nearly 1.5% more of the population members in the dependent counties have college degrees, and almost 3% fewer live on farms.

Discussion

Dependence on recreation and tourism in rural areas is clearly tied to proximity to certain types of natural resources, including beaches, large lakes, forests, and mountainous terrain. In areas where these resources are owned by public agencies, recreation and tourism seem to be especially important parts of the rural economy. Because of the link between public recreation resources and local economic structure, our results would seem to affirm the prominence that public land-managing agencies place on the local economic consequences of their policy decisions.

Resource-based tourism-dependent rural counties are experiencing greater increases in population growth and housing construction than are other rural

TABLE 7 Regression Results (Unstandardized Regression Coefficients, *t*-Values in Parentheses) for Models Comparing Recreation and Other Rural Counties on Selected Population-Dependent Variables

Independent variable	Percent increase in total population		1990 Percent college educated	1990 Percent female-headed households	1990 Percent living on farms
	1980–1990	1990–1995			
Constant	−5.352	1.101	7.490	10.44	10.063
	(−9.40)	(330.76)	(55.92)	(48.66)	(30.92)
Recreation dependent	5.355	3.813	1.442	−0.180	−2.846
	(6.90)	(9.14)	(7.89)	(−0.62)	(−6.41)
West	1.674	1.817	2.480	−1.379	3.260
	(2.31)	(4.68)	(14.57)	(−4.18)	(7.89)
South	3.822	1.698	−0.916	4.686	−3.856
	(6.03)	(4.99)	(−6.14)	(19.60)	(−10.63)
Metro adjacent	6.356	2.900	−0.071	0.261	−1.618
	(11.48)	(9.77)	(−0.55)	(1.25)	(−5.11)
Model *F*	51.18	48.12	170.24	177.15	103.53
R^2	.08	.08	.23	.24	.15

counties. Higher housing prices may reflect greater housing demand or more valuable private land close to recreation infrastructure. Such findings lend some support to observations made by Howe et al. (1997) that Americans are moving to rural areas for natural resource amenities and improved quality of life.

In-migration can lead to pivotal changes in the social structure and patterns in rural areas and communities, particularly if migrants are noticeably different from residents. Differences in education level, income level, regional background, and age structure may be among the salient characteristics of demographic structure in rural amenity-rich communities. We echo the concerns voiced by Beale and Johnson (1998) that new residents may demand different levels of social and community services, altering traditional patterns of local government spending. Although some evidence suggests that recreational homeowners are positive net contributors to local fiscal conditions (Deller et al. 1997), more work is needed to assess the effect of aging among in-migrating residents on locally available public services. Recent studies (Green et al. 1996) suggest that it also seems likely that such migrants would hold different values for the natural resource base and development options than do long-time residents, particularly in the desired mix of amenity and commodity outputs.

Our findings do not seem to support contentions that recreation and tourism jobs are necessarily lower with respect to aggregate local income generation, since mean incomes were higher in the more recreation-dependent counties. However, other phenomena may cloud the issue. For example, it is possible that mean incomes could be influenced by amenity-seeking migrants who bring with them higher incomes. That might explain why average incomes are higher in dependent counties, but the percent of population in poverty is not different from nondependent counties. Further research is needed to track changes in the tourism-sensitive sectors in the more dependent counties and control for the effect of migration, to examine how workers in those businesses are faring. In addition, research can concurrently track changes in income distribution in the dependent counties and can compare these to analogous changes in nondependent counties.

Clearly, identification of tourism-dependence counties depends on the methods used. Our choices in defining regions, clustering variables, and tourism resource variables were driven by a combination of administrative needs, previous research, and our own intuition. Further research is needed to develop guidelines for these types of decisions and to tie such guidelines to existing theoretical and conceptual models. For example, most research has noted that part of the difficulty in establishing the level of dependence on tourism is that the sectors affected by tourists are also affected by local residents and by visitors on nonrecreation trips. Our work has focused on highlighting one means to separate export employment that serves recreation and tourism visitation from export employment that serves visitors who come for other reasons. Future research is needed to examine the effect of assumptions inherent in our methods. For example, although we examined each of the four sectors independently, the nature of demand for these types of service may indicate the need for simultaneous equations. In addition, alternatives to minimum requirements could lead to different results on the overall level of export employment in tourism-related sectors.

Methods used by other researchers have led to a different set of counties being identified as tourism dependent. Beale and Johnson (1998) identified 285 nonmetropolitan recreational counties. We identified 338 such counties. Although the classification procedures and the thresholds for dependency differ between the two methods, there are 156 counties that both methods define as tourism dependent. According to our estimates, about 10% of all income and about 15% of jobs in these counties are due to nonresident tourism activity. Selection of those 156 counties is robust to divergent methods, so it seems that those counties might well be the ones most dependent on recreation and tourism. Other rural counties that have been classified by only one method or the other might represent a second and somewhat lower tier of tourism dependency.

An economy's dependence on recreation and tourism is difficult to characterize, due to how that "industry" affects the local economy. Further research is needed on how to identify and address the relation between tourism activity and the economic or social structure in rural counties. Separating activity that serves local versus export demand is a critical component targeted here. Migration and housing demand is another, as shown by Beale and Johnson (1998). Because projections for outdoor recreation and tourism show increases for most activities, such research may well play a vital part in forming public land management and local development policies. Further, as demands for tourism-related uses of natural resources increase, there will be trade-offs with commodity production. Thus, it will be important to coordinate research on commodity dependencies with tourism dependency, to accurately evaluate the effects of various options that face rural areas in the United States.

Notes

1. Pratt (1968) has criticized the minimum requirements approach on its assumption that each region within the peer set, except for the minimum peer, produces for export. In this critique, Pratt was looking at manufacturing sectors. Tourism, however, is a unique case of the export base concept. Nonresident visitors that provide tourism demands can be considered as purely basic. Unlike manufacturing sectors, tourism has no contrasting "import" demands. Tourism represents a purely export-driven activity. Thus the minimum requirements approach is conceptually a more valid approach to apply to tourism-sensitive sectors. In our case, we assume that all counties within a peer group have some level of tourism activity (except the minimum peer, which is assumed to have no export tourism demand) and that the minimum peer represents the basis for assessment. We further extend this to account for local population to control for nonrecreational tourism demands.
2. Factor score tables and tabular results from cluster analyses are available upon request from the primary author.

References

Beale, C. L., and K. M. Johnson. 1998. The identification of recreational counties in nonmetropolitan areas of the United States. *Population Res. Policy Rev.* 17:37–53.

Bender, L. D., B. L. Green, T. F. Hady, J. A. Kuehn, M. K. Nelson, L. B. Perkinson, and P. J. Ross. 1985. *The diverse social and economic structure of nonmetropolitan America.* Washington, DC: USDA–Economic Research Service, Report RDRR-49.

Brown, T. L. and N. A. Connelly. 1986. Tourism and employment in the Adirondack Park. *Ann. of Tourism Res.* 13(3):481–489.

Dawson, S. A., D. J. Blahna, and J. E. Keith. 1993. Expected and actual regional economic impacts of Great Basin National Park. *J. Park Recreation Admin.* 11:45–59.

Deller, S. C., D. W. Marcouiller, and G. P. Green. 1997. Recreational housing and local government finance. *Ann. of Tourism Res.* 24(3):687–705.

Duffy-Deno, K. 1998. The effect of federal wilderness on county growth in the intermountain western United States. *J. Regional Sci.* 38:109–136.

Dwyer, L., and P. Forsyth. 1997. Impacts and benefits of MICE tourism: A framework for analysis. *Tourism Econ.* 3(1):21–38.

English, D. B. K., and J. C. Bergstrom. 1994. The conceptual links between recreation site development and regional economic impacts. *J. Regional Sci.* 34:599–611.

Green, G. P., D. W. Marcouiller, S. C. Deller, D. K. Erkkila, and N. R. Sumathi. 1996. Local dependency, land use attitudes, and economic development: Comparisons between seasonal and permanent residents. *Rural Sociol.* 61(3):427–445.

Hady, T. H., and P. J. Ross. 1990. *An update: The diverse social and economic structure of nonmetropolitan America.* Washington, DC: Agriculture and Rural Economy Division, USDA–Economic Research Service, Staff Report AGES 9036.

Howe, J., E. McMahon, and L. Propst. 1997. *Balancing nature and commerce in gateway communities.* Washington, DC: Island Press.

Isserman, A. 1980. Estimating export activity in a regional economy: A theoretical and empirical analysis of alternative methods. *International Regional Science Review.* 5:655–667.

Johnson, K. M., and C. L. Beale. 1994. The recent revival of widespread population growth in nonmetropolitan areas of the United States. *Rural Sociol.* 59:655–667.

Johnson, P., and B. Thomas. 1990. Employment in tourism: A review. *Ind. Relations J.* 21:36–48.

Johnson, R. L., and E. Moore. 1993. Tourism impact estimation. *Ann. Tourism Res.* 20:279–288.

Kusmin, L., J. M. Redman, and D. W. Sears. 1996. *Factors associated with rural economic growth.* Washington, DC: USDA Economic Research Service, Tech. Bull. 1850.

Leatherman, J. C. and D. W. Marcouiller. 1996a. Estimating tourism's share of local income from secondary data sources. *Rev. Regional Stud.* 26:317–341.

Leatherman, J. C. and D. W. Marcouiller. 1996b. Income distribution characteristics of rural economic sectors: Implications on local development policy. *Growth and Change* 27(4):434–459.

Leiper, N. 1979. The framework of tourism: Toward a definition of tourism, tourist, and the tourist industry. *Ann. Tourism Res.* 6(4):398.

Leiper, N. 1990. Partial industrialization of tourism systems. *Ann. Tourism Res.* 17(4):600–605.

Nord, M., and J. B. Cromartie. 1997. Migration: The increasing importance of rural natural amenities. *Choices* 3:22–23.

Pratt, R. 1968. An appraisal of the minimum requirements technique. *Econ. Geogr.* 44:177–224.

Ross, P. J., and B. L. Green. 1985. *Procedures for developing a policy-oriented classification of nonmetropolitan counties.* Washington, DC: USDA Economic Research Service, Staff Report AGES850308, August.

Rothman, H. K. 1998. *Devil's bargains: Tourism in the twentieth century American West.* Lawrence: University Press of Kansas.

Smith, M. 1986. *Behind the glitter: The impact of tourism on rural women in the Southeast.* Lexington, KY: Southeast Women's Employment Coalition.

Smith, S. L. J. 1987. Defining tourism: A supply-side view. *Ann. Tourism Res.* 14(1):179–190.

Stynes, D. J., and G. L. Peterson. 1984. A review of logit models with implications for modeling recreation choice. *J. Leisure Res.* 16:295–310.

USDA–Forest Service. 1995. *The Forest Service Program for Forest and Rangeland Resources: A long-term strategic plan.* Draft 1995 RPA Program. Washington, DC.

USDA–Forest Service. 1997. *National Outdoor Recreation Supply Information System (NORSIS).* Resource data set compiled by USDA–Forest Service, Recreation, Wilderness, and Urban/Wildland Research Unit (SRS-4901), Athens, GA.

Walter, Hanspeter

From: Sherrie Thrall <sherrie.thrall@gmail.com>
Sent: Wednesday, March 25, 2015 11:36 AM
To: Walter, Hanspeter
Subject: Fwd: Coldwell Banker Revenues from Lake Fishing

Sharon (Sherrie) Thrall
Plumas County Supervisor, District 3
P.O. Box 368
Chester, CA 96020
530-258-3656
website: almanorpost.com

---------- Forwarded message ----------
From: **Susan Bryner** <susan.bryner@gmail.com>
Date: Wed, Mar 25, 2015 at 10:57 AM
Subject: Coldwell Banker Revenues from Lake Fishing
To: Sherrie Thrall <sherrie.thrall@gmail.com>

Hello Sherrie,

Sorry for late reply. I was out of town. Talked to Wendy and decided to pull similar numbers for our Vacation Rental Revenues related to fishing on our lake, 80% during shoulder season and 20% during season.

Given that, the potential loss of Vacation Rental revenue from our homes, should the lake be "un-fishable" would be between $95,000 and $125,000 annually.

Hope this helps!

Susan Bryner
BRE#01751530

Coldwell Banker Kehr/O'Brien
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Economic Impacts of Recreational Spending on Rural Areas: A Case Study

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H. Ken Cordell
Gregory A. Ashley
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Researchers, planners, and policymakers are becoming increasingly interested in the rural economic development potentials of outdoor recreation. Empirical evidence evaluating this economic development potential, however, is almost nonexistent. In this article, results of a study that examined local economic effects of spending associated with outdoor recreation in selected rural areas are reported. Recreational expenditures were collected as part of the Public Area Recreation Visitors Study (PARVS). Economic impacts of these expenditures were estimated using regional input-output models developed from the USDA Forest Service input-output model and data base system (IMPLAN). Results indicated that recreational spending contributed substantially to gross output, income, employment, and value added in the studied rural areas. These results suggest that outdoor recreation may be a viable rural economic development strategy.

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Severe poverty and unemployment persists in many rural areas, particularly in the South. Federal, state, and local governments are increasingly interested in economic improvement programs for these rural areas.[1] The purpose of this article is to present the results of a study that examined local economic development effects of recreational spending on selected rural areas. The economic development potential of outdoor recreation has been almost completely ignored in the literature. Results reported in this article suggest that recreational spending stimulates a considerable amount of economic activity in rural economies. Hence, outdoor recreation may provide a viable development strategy for some rural communities.

Methodology for measuring the economic impacts of recreational spending on rural areas is discussed in the following section. The study used data from the Public Area Recreation Visitors

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Study (PARVS) and an input-output modeling system developed by the U.S. Forest Service (IMPLAN). After the methodology discussion, empirical results are presented and discussed. A summary, policy implications, and conclusions are offered in the final section.

METHODOLOGY

Background Concepts

The economic effects of outdoor recreation spending on rural areas may be measured in terms of direct, indirect, and induced effects. Recreation is a basic exporting industry as defined in standard export base theory. The "exports" of a park, for instance, are recreational services provided to people who live outside of the local area near the park, usually viewed as the surrounding counties. Exports of recreational services bring outside dollars into an economy and stimulate economic activity. The process by which this economic activity leads to growth is perhaps best explained through a simplified, hypothetical example.

Assume a rural area has a number of petroleum-related firms (e.g., service stations, wholesale gasoline distributors), as well as a state park. Nonresident visitors to the park spend money on a variety of items. Major expenditure categories include transportation, lodging, food and beverages, fees, and miscellaneous supplies. While visiting the park, for example, visitors may purchase gasoline for automobiles, recreational vehicles, and boats at local service stations. In order to meet the increased demand for gasoline, local service stations must increase purchases of gasoline and other products from other industries. These first-round purchases are the inputs for the local service stations and represent the *direct effects* of recreational spending on the local rural economy.

In order to increase sales of inputs to service stations, input suppliers must in turn increase their purchases of inputs from other industries. For example, gasoline wholesalers must increase purchases of gasoline from oil refineries. These purchases would result in even more economic activity, because, in order to meet increased input demand from gasoline wholesalers, input suppliers (e.g., oil refineries) would also have to purchase more inputs. Thus the increase in input purchases made by service stations in order to meet increased demand for gasoline from park visitors initiates a "chain reaction" of additional purchases in the local rural economy. The economic activity stimulated by these multiple-round input purchases are the *indirect effects* of recreational spending on the rural area economy.

The direct and indirect effects of recreational spending result in an overall increase in the production and distribution of goods and services in a rural area. This increase in economic activity results in increased employment and household income. Increases in household income, in turn, increase consumer demand for goods and services. For example, as a result of increased demand for gasoline caused by park visitors, local service stations may hire additional employees and/or increase employee wages. Given additional income, the service station employees will increase purchases of consumer goods such as clothes, food, and gasoline for their automobiles. In order to meet this increased demand, even more multiple-round purchases of inputs will be stimulated. Economic activity stimulated by increased consumer purchases are the *induced effects* of recreational spending on the rural area economy.

The total economic effects of outdoor recreation on a rural area are measured by the sum of direct, indirect, and induced effects of recreational spending. The direct and indirect effects account for the first and subsequent rounds of input purchases made in order to support firms that directly provide recreational visitors with goods and services. The induced effects account for increased input purchases made in order to meet increased demand for goods and services caused by increased household income in the local rural economy. The direct, indirect, and induced effects of recreational spending are referred to as secondary economic benefits.[2]

Secondary economic benefits do not necessarily increase economic efficiency or contribute to national economic development. Gains caused by increased recreational spending in one region may be offset by losses in another region. This assumption however, is usually valid only if the economy is at full employment, and it usually is not. Also, people within a region who never used state parks may be enticed to do so by their proximity to a park or improvement of recreational services offered. Secondary economic benefits, however, do contribute to regional economic

TABLE 1
Representative Georgia State Parks and Adjacent Counties Forming the Local Impact Regions

State Park	*Adjacent Local Counties*
Unicoi	White Lumpkin Hall Banks Habersham Towns Union
Red Top	Bartow Gordon Pickens Cherokee Paulding Polk Floyd
F. D. Roosevelt	Harris Troup Meriwether Talbot Chattahoochee
Little Ocmulgee	Tel Fair Wheller Jeff Davis Coffee Ben Hill Wilcox Dodge
Dahlonega Gold Museum	Lumpkin White Hall Dawson Fannin Union

development and may meet welfare distributional objectives related to redistribution of income and employment to economically depressed rural areas.[3]

Data Collection

The secondary benefits of outdoor recreation were empirically estimated for five representative state parks in Georgia. These parks, selected with the assistance of the Georgia Department of Natural Resources, were Unicoi State Park, Red Top State Park, Dahlonega Gold Museum State Park, F. D. Roosevelt State Park, and Little Ocmulgee State Park. Unicoi, Red Top, and Dahlonega Gold Museum State Parks are located in the north Georgia mountain region. F. D. Roosevelt State Park is located in the central Georgia Piedmont region, and Little Ocmulgee State Park is located in the south Georgia coastal plain region. All parks are located in predominantly rural areas. For each park, a local impact region was defined as the county where the park is located, plus all counties contiguous to that county. Counties included in these local regions are listed in Table 1.

Estimation of the economic effects of state parks requires data on park visitors' spending in the local region. Visitor expenditure data were collected as part of the Public Area Recreation Visitor Study (PARVS). PARVS is a nationwide cooperative effort to collect data on the economic benefits of outdoor recreation and tourism. Six federal agencies, 16 states, four national associations, and six universities have cooperated to implement PARVS. Since 1985, continuing data collection efforts have resulted in about 52,000 interviews at about 320 sites across the country.[4]

. . . the Public Area Recreation Visitor Study . . . is a nationwide cooperative effort to collect data on the economic benefits of outdoor recreation and tourism. Six federal agencies, 16 states, four national associations, and six universities have cooperated to implement PARVS.

Survey Procedures

At the five study parks in Georgia, PARVS enumerators conducted on-site interviews of visitors as they exited the park. Interviews were coordinated by the Georgia Department of Natural Resources. Data were collected on travel patterns, on-site activity, participation and participant characteristics, and recreation patterns throughout the year. Interviewed visitors were also asked to provide their names, addresses, and phone numbers for a follow-up mail survey. From this list of names and addresses, the sample of visitors was sent a survey questionnaire through the mail.

The mail survey questionnaire asked respondents detailed questions on equipment usage, year-long recreation-related spending, and expenditures related to their trip to the Georgia state parks. Respondents were asked first to report trip-related expenditures made at their residence, either before the trip (e.g., purchase of film) and after the trip (e.g., payment for developing exposed film). Respondents were then asked to report expenditures made while en route from their residence to the park (e.g., gasoline and food purchases). Next, respondents were asked to report expenditures made while at the park before leaving to return home or to travel on to other sites (e.g., food and lodging, souvenirs, fees, ice). Finally, respondents were asked to report annual expenditures made on outdoor recreation in general (e.g., purchase or repairs of recreational equipment).

Pilot testing of sampling procedures for on-site interviews and for the mail survey follow-ups, within the constraints of a limited budget, led to adoption of selective sampling of exiting park visitors at intervals dictated by the time required to complete the rather lengthy PARVS survey form. Because of this length, interview numbers were maximized using a strategy of intercepting the next available exiting park user after an interview had been completed. This strategy was used throughout the daily interview period. The number of exiting vehicles was recorded while each interview was in progress, and the ratio of recreational and nonrecreational vehicles encountered through interview contacts were maintained. These data, plus existing visitor count records from the state parks, were used to postsample weight interview records to account for disproportionate sampling among park user strata, especially day versus overnight visitors.

Follow-up mail questionnaires were sent to each on-site interviewee. The equipment usage and year-long and trip expenditure data gained from the mail survey was central to this economic study. For this reason, special care was taken in postsample weighting of each mail follow-up respondent's record because the on-site selective samples were further diluted by mail survey response rates of less than 100%. This weighting emphasized four strata; day versus overnight developed-site users and day versus overnight dispersed-area users. Such weighting, of course, only partially corrected for possible sample bias, that is, that potentially caused by disproportionate representation among strata. Possible representation of a population's expenditures within a strata could not be corrected by post sample weighting given the limited preexisting data describing user's characteristics.

Relatively low response rates to the mail follow-up survey further contributed to the resulting low numbers of cases. Given the relatively small number of cases per study park (Table 2), sample numbers were increased by pooling interview records obtained at the other Georgia state parks on which PARVS was implemented. Pooling occurred only across parks of similar purposes facilities and attractions, for example, historic parks. These pooled data increased sample sizes sufficiently to engender statistical stability in the expenditure data. The authors acknowledge, however, that larger sample sizes, which included only cases explicit to the studied representative parks, would likely have provided a superior data set. Within these data constraints, however, the objective of this study is still well served for several reasons. The expenditure data used reflect actual recreational spending; mean expenditures were weighted to reproportion samples among represented strata; and comparisons with expenditure means from similar state and federal areas showed highly comparable results.

IMPLAN Analysis

The expenditure items included in the PARVS mail survey questionnaire were developed specifically to provide visitor expenditure profiles compatible with IMPLAN, a computer-based input-output data base and model developed by the Land Management Planning Division of the USDA Forest Service. The IMPLAN software system consists of (1) an input-output data base,

TABLE 2
Recreation Trip Expenditure Profiles for Samples of Visitors to Representative Georgia State Parks

	Mean Expenditures Per Person Per Trip (1986 dollars)				
Category	*Unicoi*	*Red Top*	*F.D. Roosevelt*	*Dahlonega Gold Museum*	*Little Ocmulgee*
Transportation	$ 6.18	$0.49	$ 1.91	$ 1.01	$13.26
Food and Beverages	16.38	6.07	11.82	9.96	25.69
Lodging	6.81	0.73	4.20	0.00	4.07
Activities	0.59	0.09	0.56	0.07	1.05
Miscellaneous	2.46	0.04	0.28	1.29	1.49
Total	32.42	7.42	18.77	12.33	45.58
Number of Observations	52	34	23	29	20

(2) several program modules for constructing interindustry models for the user designated impact region, and (3) a model that calculates the direct, indirect, and induced effects of changes in final demand.[5] The IMPLAN input-output data is composed of a national-level technology matrix and county-level estimates of final demand, final payments, gross output, and employment for economic sectors. The national technology matrix denotes fixed coefficient production functions for economic sectors. The matrix was derived from the 1972 national input-output model updated to 1982.

The county-level estimates of final demand, final payments, gross output, and employment were derived from a number of secondary sources. These sources included the U.S. Department of Commerce, County Business Patterns, Dunn and Bradstreet Corporation employment data, and various censuses conducted by the U.S. Department of Commerce (e.g., Agriculture, Manufacturing, and Population and Housing). All data were adjusted to the IMPLAN base year of 1982.[6]

Input-output accounts for a region are developed within the IMPLAN system using nonsurvey techniques. In particular, regional accounts are derived by a "downward movement" approach by which national input-output data are disaggregated to state and county levels. The county-level estimates of final demand, final payments, gross output, and employment serve as "control totals" at the state and local levels. The national technology matrix is then applied to derive interindustry purchases (inputs) and sales (outputs) for a region. The end result of this process is a complete, nonsurvey based input-output account for a region.[7]

IMPLAN is subject to commonly recognized limitations of national, nonsurvey-based input-output models. The general concern is whether such highly aggregated nonsurvey techniques generate accurate "pictures" of a local economy. First, secondary data sources used to derive county-level estimates of final demand, final payments, gross output, and employment may be incomplete, inconsistent, and inaccurate.[8] It is therefore advisable, when feasible, to compare county-level estimates of final demand, final payments, gross output, and employment provided in IMPLAN with other local data bases such as state government labor statistics.[9] In addition, all data in IMPLAN are adjusted to 1982. Economic activity in a region may change considerably over time, especially in rural areas experiencing rapid expansion or contraction. Thus there is a need periodically to evaluate and update county-level estimates of final demand, gross output, and employment provided in IMPLAN.

Another major limitation of IMPLAN resulting from its nonsurvey-based framework is the application of national technical coefficients (or production functions) to every disaggregated region. This procedure ignores geographical differences in production processes, and production variations between firms in an industry.[10] If the user has more and/or better information on production processes for industries in a region (e.g., farming practices in a rural area), IMPLAN provides the capability for the user to adjust regional technical coefficients.[11] Even assuming that the national technical coefficients are appropriate for a region, production technology may change over time. Hence, it would be desirable periodically to evaluate and adjust the national technical coefficients, which are already over 10 years old.[12]

Another potential problem in the application of IMPLAN are changes in the structure of the regional economy. IMPLAN assumes that the industries within a regional economy remain stable over time. However, especially in certain, unstable rural areas, industries may both enter and leave the region over time. In a rural economy, the addition or subtraction of only one industry (e.g., manufacturer) may cause a major "shock" to the economy. Thus it may also be important periodically to evaluate and update the structure of county-level industries contained in IMPLAN.[13]

Despite its limitations, IMPLAN is widely applied and professionally accepted both within and outside the U.S. Forest Service. A recent cross-check of IMPLAN using more recent and detailed county-level control data indicated that impact results generated by IMPLAN appear reasonably accurate.[14] Thus, although caution should be exercised in applying IMPLAN, it appears to be a useful, valid, and powerful tool for economic impact analysis. IMPLAN is especially amenable to assessing the economic impacts of outdoor recreation.[15]

In this study, the IMPLAN modules were employed to construct regional input-output models for each of the local impact regions listed in Table 1. The models then were used to calculate the direct, indirect, and induced effects of recreational spending. Recreational expenditures and the input-output data describing the local impact regions (e.g., sales, population) were for the year 1986.

The first step in the economic impact estimation process was to determine the allocation of recreational expenditures among IMPLAN sectors. This allocation was made using an algorithm (or "bridge" table) developed by a number of cooperating PARVS researchers.[16] This allocation algorithm was based upon producer price and marketing margin data provided by the Bureau of Economic Analysis (BEA). For example, on visits to Georgia state parks, visitors may spend money on gasoline for automobiles, recreational vehicles, and boats. Using the BEA data, recreational spending on gasoline was allocated to the following IMPLAN sectors through increased input purchases: petroleum refining; lubricating oils and greases; petroleum and coal production; rail, motor freight, water, air, and pipe transportation; other wholesale trade; and other retail trade.

Once it was determined how recreational expenditures should be allocated across IMPLAN sectors, it was necessary to estimate the appropriate portion of total trip expenditures to allocate for economic impact analysis. This allocation was also based on procedures developed by cooperating PARVS researchers.[17] First, only expenditures made by visitors living outside of the local impact region were considered. The following assumptions were then made for allocating a portion of trip-related expenditures for each specific IMPLAN sector to a local impact region. Allocation procedures were performed for each local impact region separately.

As discussed previously, four basic categories of trip-related expenditures were collected. The first category was expenditures made at home, before or after the trip. Because these expenditures all occur outside the local impact region, they were not included in the economic impact analysis. The second category of expenditures was money spent on the trip to and from the park. Some of these expenditures (e.g., gasoline purchases) likely occurred within the local impact region. The probability that en route expenditures occurred within the local impact region was estimated by dividing the average radius of the local impact region by the total one-way miles traveled. For example, if a visitor traveled 100 one-way miles to a park and the local impact region had a radius of 25 miles, this probability would be equal to 0.25 = 25/100. The estimated probability weight was then multiplied by total en route expenditures to give the portion of en route expenditures which occurred in the local impact region. In the forgoing example, if the visitor spent a total of $40 en route to and from the park, $10 = 0.25 × $40 was allocated to the local impact region.

The third, and most important, expenditure category was spending at the park or in the immediate vicinity of the park. It is assumed that all of these expenditures were made within the local impact region. Hence, all expenditures reported in this category were allocated across the IMPLAN sectors.

The fourth expenditure category was annual purchases of recreational supplies, gear, and equipment (e.g., fishing gear). Purchases of these items for use at a Georgia state park made within the local impact region will also stimulate economic activity in the region. Only expenditures on equipment or other goods that the respondents had with them on the trip during which they were interviewed were considered. Annual expenditures were first multiplied by the ratio of days of use at the interview site to total days of use elsewhere. The resulting number was then divided by annual trips to the interview site. The result was an estimate of annual expenditures per trip. This portion was further reduced by multiplying it by the probability of the annual expenditures occurring within the local impact region. This probability was estimated and applied following similar procedures used for allocating a portion of en route expenditures to the local impact region.

After determining the portion of total trip expenditures to assign to the local impact region, mean expenditures per person per trip were calculated. Mean expenditures per person per trip were then multiplied by annual visitation estimates provided by the Georgia Department of Natural Resources to calculate annual recreational expenditures attributable to a particular park. These total expenditures were then allocated across the appropriately affected IMPLAN sectors. The economic impact module in IMPLAN was then run to estimate total gross output, personal and property income, total income, employment, and value added which result from recreational spending in the local impact region.

RESULTS

The overall response rate for the PARVS mail questionnaire designed to collect recreational trip-related expenditures was 22%. In all, 200 usable questionnaires were returned. The basic profiles of expenditures made within each local impact region are shown in Table 2. As indicated in the table, most expenditures are for transportation, lodging, and food.

The direct, indirect, and induced effects of recreational spending on local impact regions are summarized in Table 3. Total gross output measures the value of all outputs produced in a local impact region; thus, it is an overall indicator of economic activity analogous to the gross national product (GNP) for the United States. Employee compensation is wages and salaries paid to employees of firms and businesses located in the local region. Property income is profits, rents, royalties, interest, and related payments that accrue to owners of property, firms, and businesses located in the local region. Total income is the sum of the employee compensation and property income. Value added is the sum of employee compensation, indirect business taxes, and property income. Basically, value added accounts for the income accruing to a local impact region when an output is produced and sold. Employee compensation and property income are paid directly to region residents, and indirect business taxes indirectly benefit residents through their local government. Employment refers to numbers of people employed by firms and businesses located in the local impact region.[18]

The numbers in Table 3 indicate that recreational expenditures at state parks stimulate a proportionately large amount of economic activity in surrounding rural areas of Georgia. Annual visits to Unicoi State Park, for example, supported over 1,400 jobs and over $14 million of total income in the local region in 1986. For each economic indicator reported in Table 3, about 50% of the total effects of recreational spending, in general, is accounted for by direct effects. Induced effects generally account for the next largest portion of the total effects of recreational spending, followed by indirect effects. The fact that induced effects are proportionately important signifies that local workers benefit as do the local businesses with which they trade.

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The economic effects of spending stimulated by state parks varies considerably across the five parks analyzed in this study. The greatest effects are associated with Unicoi State Park, the most heavily visited. Unicoi State Park is the largest of the five parks with numerous hiking trails, camping facilities, a recreational lake, tennis courts, and a state operated convention center. The park attracts a large number of both day and overnight visitors. The smallest economic effects are associated with F. D. Roosevelt, Little Ocmulgee, and Dahlonega Gold Museum state parks. These state parks are rather modest, attracting relatively small numbers of primarily day use visitors. Red Top State Park generates moderate economic effects. Attractions at Red Top State Park, which are perhaps more typical of state parks, include camping, hiking, swimming, and picnicking. Red Top State Park attracts a greater number of day and overnight users, as compared to F. D. Roosevelt, Little Ocmulgee, and Dahlonega Gold Museum state parks.

The rural economic development potential of outdoor recreation is summarized by the regional economic multipliers shown in Table 4. Regional multipliers show the total effects of recreational spending (direct, indirect, and induced effects) per unit of direct effect.[19] The employment multiplier for Red Top State Park, for example, is 1.5. This means that 1.5 jobs will be created in the local economy per each job created by the direct effects of recreation spending. Thus if 10 new jobs resulted from the direct effects of recreational spending, 15 total jobs would eventually be

TABLE 3
Economic Effects of Recreational Spending at Representative Georgia State Parks

	Economic Effects (millions of dollars)					
Source of Effect by Park	Total Gross Output	Employee Compensation	Property Income	Total Income	Value Added	Employment (actual number)
Unicoi State Park						
Direct Effects	$21.1937	$6.1129	$2.4287	$8.5416	$9.7100	$1185.19
Indirect Effects	4.3877	1.3261	0.5975	1.9236	2.0331	76.83
Induced Effects	7.5634	2.3087	1.5926	3.9013	4.4320	173.25
Total Effects	33.1448	9.7478	4.6187	14.3665	16.1752	1435.26
Red Top State Park						
Direct Effects	13.3089	4.1409	0.6600	4.8008	5.4711	414.75
Indirect Effects	2.7197	0.7536	0.4816	1.2352	1.3288	47.90
Induced Effects	7.7550	2.2108	1.7286	3.9395	4.4750	166.91
Total Effects	23.7835	7.1054	2.8702	9.9755	11.2749	629.56
F. D. Roosevelt State Park						
Direct Effects	1.4924	0.4414	0.1381	0.5795	0.6603	74.99
Indirect Effects	0.2381	0.0762	0.0341	0.1103	0.1170	4.70
Induced Effects	0.5278	0.1665	0.1163	0.2829	0.3221	12.68
Total Effects	2.2583	0.6841	2.2886	0.9727	1.0993	92.37
Dahlonega Gold Museum State Park						
Direct Effects	0.4881	0.1515	0.0507	0.2022	0.2268	23.18
Indirect Effects	0.0905	0.0257	0.0133	0.0390	0.0416	1.63
Induced Effects	0.1420	0.0431	0.0298	0.0729	0.0828	3.28
Total Effects	0.7206	0.2202	0.0939	0.3141	0.3512	28.09
Little Ocmulgee State Park						
Direct Effects	2.8517	0.8985	0.2781	1.1766	1.3415	199.00
Indirect Effects	0.5900	0.1518	0.0813	0.2331	0.2470	9.93
Induced Effects	2.1648	0.6486	0.4564	1.1049	1.2583	54.30
Total Effects	5.6065	1.6989	0.8158	2.5146	2.8468	263.23

added to the local region — 10 resulting from the direct effects of recreational spending and five more from the indirect and induced effects.

The larger the regional economic multiplier, the greater is the potential for recreational spending to stimulate increased economic activity in a rural area. As indicated in Table 4, recreational spending appears to be associated with relatively large multipliers. Hence, new or expanded outdoor recreational facilities and attractions may bring new dollars into a rural area, which, through multiplier effects, stimulate considerable economic growth. The magnitude of the multipliers estimated for Georgia is consistent with previous studies. A review of previous studies, for example, showed total gross output multipliers ranging from 1.46 to 2.60.[20]

LOCAL DEVELOPMENT POLICY IMPLICATIONS

Poverty and joblessness exist in many rural areas. Local governments in such rural areas are becoming increasingly interested in implementing economic development programs. In the past, local economic development efforts have focused on attempting to attract new manufacturing plants, factories, and related industrial development. New industrial development, however, may fail to meet local economic development expectations. A new industry, for instance, may import specialized employees and not employ large numbers of local workers, and multiplier effects may turn out to be smaller than anticipated. New industrial development may also create new problems for rural areas such as environmental pollution, strains on natural resources (e.g., water supplies), conflicts with established rural enterprises (e.g., farmers), and strains on local utilities.

The results of this study suggest that outdoor recreation may provide a viable economic development alternative for rural areas.

The results of this study suggest that outdoor recreation may provide a viable economic development alternative for rural areas. Recreation-related multipliers estimated for gross output,

TABLE 4
Local Economic Multipliers for Recreational Spending at Representative Georgia State Parks

	Local Multipliers				
Economic Indicator	*Unicoi*	*Red Top*	*F. D. Roosevelt*	*Dahlonega Gold Museum*	*Little Ocmulgee*
Total Gross Output	1.56	1.79	1.51	1.48	1.97
Employee Compensation	1.59	1.72	1.55	1.45	1.89
Property Income	1.90	4.35	1.66	1.85	2.93
Total Income	1.68	2.08	1.68	1.55	2.14
Value Added	1.67	2.06	1.66	1.55	2.12
Employment	1.21	1.52	1.23	1.21	1.32

employment, and income are relatively large, which suggests that the direct, indirect, and induced effects of recreational expenditures stimulate a considerable amount of economic activity in rural economies. In addition, outdoor recreation development, for example, park development, can be undertaken in such a way that natural resources are conserved and environmental quality improved. Outdoor recreation development may also be complementary with established rural enterprises such as agriculture.

Local leaders in rural areas can facilitate outdoor recreation development in several ways. First, suppose a rural area is already endowed with land or water resources open to the public for outdoor recreational use (e.g., national or state park, national or state forest, large private tracts, reservoirs, or rivers). Economic growth in a rural area results from local expenditures by visitors who live outside of the rural area where these resource opportunities exist. Thus local economic development can be facilitated by encouraging increased out-of-region visitation through promotion of local recreational opportunities, improving access to local recreational attractions, and by raising the level and quality of services and attractions. Advertising, for example, may consist of travel brochures, maps, and newspaper and magazine advertisements. Improved access, for example, may involve the construction of new roads and airport facilities. Local leaders may need actively to solicit funding for such projects from federal, state, and local sources. But more important, by doing the kind of analysis demonstrated in this study, the benefiting businesses and industries can be identified, contacted, and asked to contribute.

Local leaders may also be able to encourage and facilitate the development of new or additional outdoor recreational facilities in rural areas. There may be opportunities, for example, for local agencies to cost-share or enter into partnership arrangements with federal or state agencies on outdoor recreational facility development. It is also feasible for local agencies to develop and operate outdoor recreational facilities on their own. Developing facilities for people to visit unique local attractions (e.g., historical structure, natural scenic attractions) is a distinct opportunity for local agencies.

The results of this study suggest that some of the largest economic impacts are associated with highly developed outdoor recreational facilities (e.g., resort facilities). Such facilities are often developed and operated by private firms. Thus, using the same techniques for attracting industrial development, local agencies can attempt to attract private development of outdoor recreational and tourism facilities. Major resorts, however, are expensive and bring negative externalities to a rural area, including pollution, congestion, and increased strains on local public services and facilities.

Local agencies should carefully evaluate all proposals for outdoor recreational development, whether publicly or privately supported. The potential economic benefits of outdoor recreation development can be assessed using economic impact analysis techniques, such as described in this article. These benefits must be compared to the potential costs of outdoor recreational development. Out-of-pocket development and operation costs may be relatively straightforward to measure. Environmental and other costs caused by intensively developed outdoor recreational facilities (e.g., major resorts) are important to consider, but difficult to quantify. The opportunity costs of devoting local resources to outdoor recreational development, instead of some other form of economic development, are also important to consider, but difficult to quantify.

Local leaders should also carefully assess the local business infrastructure to determine whether the types and diversity of extant businesses and services can effectively support growth. Programs to attract and stimulate recreation-related or support industries can further increase multipliers and economic growth effects. Attracting more and higher quality recreation and tourism attractions along with stimulating business growth in the economic sectors affected by recreation are highly important tandem strategies for local economic growth.

SUMMARY AND CONCLUSIONS

Economic impact analysis measures economic growth stimulated by increases in final demand for products produced in a regional economy. In the case of outdoor recreation, recreational services are produced and "exported" from a region. An increase in demand for these recreational services, measured by an increase in visits or trips to the local area, results in increased recreational spending and increased economic growth.

In this article, the economic effects of recreational spending on selected rural areas in Georgia were estimated. Recreational expenditures associated with visits to state parks were estimated from data provided by the Public Area Recreation Visitor Study (PARVS). The direct, indirect, and induced effects of these expenditures on the local region surrounding a particular state park were estimated using IMPLAN. IMPLAN is an input-output modeling system developed by the USDA Forest Service. IMPLAN results indicated that recreational spending can stimulate a considerable amount of economic activity in rural areas.

The magnitude of economic activity stimulated depends on the attractiveness of parks to out-of-region visitors and on the structure and diversity of the local economy. Currently, many state parks in rural areas of Georgia and other states have not yet achieved major destination status for out-of-region visitors. Improved management, however, may be able to change this status.

The results suggest that for some rural areas, outdoor recreation will likely provide a viable economic development alternative. This potential viability is supported by the relatively large multipliers estimated for employment, income, and other economic indicators. In addition to creating new jobs and economic activity, outdoor recreation is generally compatible with existing rural enterprises such as tourism and agriculture, and helps to enhance the overall quality of life by providing recreational opportunities to local residents. Of course, new recreational development should not proceed if the total costs (e.g., tax expenditures, negative externalities) exceed the total benefits of development.

More focused research is needed on the economic impact of outdoor recreation on regional economies. Input-output analysis, although widely used and accepted, is limited by strict analytical assumptions and the structure of existing computer routines. It would be useful to compare the results reported in this article to those obtained using alternative economic impact analysis techniques, such as econometric models. Also, the sensitivity of results reported in this article to assumptions regarding the allocation of recreational expenditures to local impact regions and specific IMPLAN sectors is unknown.

Future research efforts should examine these assumptions, modifying them as needed to generate alternative economic impact results. Additional research is also needed to improve procedures for collecting expenditure data. Although limited, the combination of the PARVS data base and the IMPLAN model represents a credible system for estimating the economic impacts of outdoor recreational spending on regional economies. Thus the results reported in this article may provide useful inputs into resource management and rural development policy decisions.

NOTES

1. Lionel J. Beaulieu, ed., *The Rural South in Crisis Challenges for the Future* (Boulder, CO: Westview, 1988).
2. J. R. Stoll, J. B. Loomis, and J. C. Bergstrom, "A Framework for Identifying Economic Benefits and Beneficiaries

of Outdoor Recreation," *Policy Studies Review* 7 (1987): 443-452; R. G. Walsh, *Recreation Economic Decisions: Comparing Benefits and Costs* (State College, PA: Venture Publishing, 1986).

3. E. J. Mishan, *Cost-Benefit Analysis* (New York: Praeger, 1976); P. G. Sassone and W. A. Schaffer, *Cost-Benefit Analysis: A Handbook* (New York: Academic Press, 1978); Stoll et al., "Framework."

4. H. K. Cordell, L. A. Hartman, A. E. Watson, J. Fretschen, O. B. Propst, and E. L. Siverts, "The Background and Status of an Interagency Research Effort: The PARVS," in *1986 Southeastern Recreation Research Conference*, ed. B. M. Cordell (Athens: Recreation Technical Assistance Office, Institute of Community and Area Development, University of Georgia, 1987).

5. C. J. Palmer and E. L. Siverts, *IMPLAN Analysis Guide*, Land Management Planning Systems Section (USDA Forest Service, Fort Collins, CO, 1985).

6. G. S. Alward, "Extending the IMPLAN I/O System: The Social Accounting Matrix" (Paper delivered at the Midwest Forest Economist's Meeting, Iowa State University, Ames, IA, May 1985); G. S. Alward, H. G. Davis, K. A. Despotakis, and E. M. Lofting, "Regional Non-Survey Input-Output Analysis with IMPLAN" (Paper delivered at the Southern Regional Science Association Annual Meetings, Washington, DC, 1985); G. S. Alward and C. J. Palmer, "IMPLAN: An Input-Output Analysis System for Forest Service Planning," in *Proceedings of the First Forest Sector Models* (Williamsburg, VA: AB Academic Publishing Oxford 1981); Palmer and Siverts, *IMPLAN Analysis Guide.*

7. Alward and Palmer, "IMPLAN;" Alward et al., "Regional Non-Survey."

8. Alward et al., "Regional Non-Survey;" J. E. Hotvedt, R. L. Busby, and R. E. Jacob, "Use of IMPLAN for Regional Input-Output Studies" (Paper, delivered at the Southern Forest Economic Annual Meeting, Buena Vista, Florida, 1988).

9. Palmer and Siverts, *IMPLAN Analysis Guide*; Hotvedt et al., "Use of IMPLAN."

10. Alward et al., "Regional Non-Survey."

11. Ibid.; E. L. Siverts, "Analytical Opportunities Using IMPLAN" (Paper delivered at the Midwest Forest Economist's Meeting, Iowa State University, Ames, IA, May 1985.)

12. Siverts, "Analytical Opportunities."

13. Ibid.

14. Hotvedt et al., "Use of IMPLAN."

15. G. S. Alward and E. M. Lofting, "Opportunities for Analyzing the Economic Impacts of Recreation and Tourism Expenditures Using IMPLAN" (Paper delvered at the Annual meetings of the Regional Science Association, Philadelphia, PA, 1985); D. B. Propst and D. G. Gavrilis, "Role of Economic Impact Assessment Procedures in Recreational Fisheries Management," *Transactions of the American Fisheries Society* 116 (1987): 450-460.

16. Alward and Lofting, "Opportunities for Analyzing"; D. Propst, "Use of IMPLAN with the Public Area Recreation Visitor Survey (PARVS) Pretest Data: Findings and Recommendations" (East Lansing: Michigan State University, November 1985); D. B. Propst, D. G. Gavrilis, H. K. Cordell, and W. J. Hansen, "Assessing the Economic Impacts of Recreation and Tourism: Work Team Recommendations," in D. B. Propst, (compiler), *Assessing the Economic Impacts of Recreation and Tourism: Conference and Workshop* (Asheville, NC: Southeastern Forest Experiment Station, USDA Forest Service); A. E. Watson and L. Bratcher, *Public Area Recreation Visitor Study: Phase III Reporting* (Final cooperative research agreement report to the Southeastern Forest Experiment Station, Athens, Georgia, 1987).

17. Alward and Lofting, "Opportunities for Analyzing"; Propst, "Use of IMPLAN"; Propst et al., "Assessing the Economic Impacts"; Watson and Bratcher, *Public Area Recreation Visitor Study.*

18. Palmer and Siverts, *IMPLAN Analysis Guide.*

19. Walsh, "Recreation Economic Decisions."

20. Ibid.

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Estimating the Economic Impacts of a Trophy Largemouth Bass Fishery: Issues and Applications

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Abstract.—We sought to apply economic impact assessment methodology to better understand the local and state-level economic impacts associated with a trophy largemouth bass *Micropterus salmoides* fishery at Lake Fork, Texas. A sample of 848 anglers encountered during creel surveys were sent follow-up mail surveys and asked about their trip expenditures. Creel surveys indicated 74% of anglers were nonlocal state residents, 11% were residents of the three adjacent counties, 10% were from adjacent states, and 5% were other out-of-state anglers. An estimated 204,739 one-person, multiple-day fishing trips were made to Lake Fork between June 1, 1994, and May 31, 1995. We estimate that US$27,487,000 was spent on fishing trips during the study period: $15,783,000 in the local area, $10,637,000 elsewhere in Texas, and $1,067,000 out-of-state. Local residents spent the least per angler/trip ($44) and out-of-state anglers from nonbordering states spent the most per angler/trip ($474). Anglers residing outside of the local area (nonlocal residents and border state and other out-of-state residents) made about $14,540,000 (92%) of the total expenditures in the Lake Fork area. These direct expenditures for local goods and services generated an additional $4,019,871 in economic output, resulting in a total output of $18,559,871 and 367 full- and part-time jobs. The total value-added generated by this increased level of output was estimated at $9,355,999. The total output associated with the fishery at the state level was $9,585,057, and nonresident angler expenditures created 163 jobs in Texas. Besides showing the extent of positive economic impacts of nonlocal fishing activity, these results reveal the extent to which private sector stakeholders benefited from recreational fishing at Lake Fork.

Human dimensions researchers have stressed that anglers seek a diversity of fishing experiences (Driver and Cooksey 1977; Fedler and Ditton 1994). Typically, fishery managers have provided for this diversity through variations in the types of settings they manage (i.e., ponds, lakes, rivers, and streams) and by focusing on managerially relevant species that flourish in those settings. With the increases in fishing pressure that have accompanied human population growth over the past 30 years, however, anglers are demanding even more diversity in their fishing opportunities. No longer satisfied with just a change in fishing locale, anglers want greater variety in the size and number of fish from their desired species that they can catch (fishing quality). This is particularly the case with largemouth bass *Micropterus salmoides* fishing. Even though managers recognize this trend, implementing regimes that provide for this diversity is a difficult task because managing similar water bodies differently will ultimately result in directly or indirectly excluding some anglers at each location. However, this is what must be done if agencies are to enhance fishing quality and maintain high levels of satisfaction within the overall angler population. For many years, trout fisheries management has utilized various rules and regulations to reduce or manipulate angling mortality to provide anglers with the particular fishing quality they seek (see, for example, Deinstadt 1987; Hunt 1987).

From statewide angler surveys, fishery managers in Texas knew that some anglers wanted to catch "a lot of fish" on fishing trips, while others preferred to catch "a few large fish" (Ditton and Hunt 1996). At public hearings in the mid-1970s,

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anglers indicated they wanted some relief from the statewide minimum length limits (304 mm) for largemouth bass. This coincided with researchers' acceptance of the idea that bass populations could be manipulated with variations in length limits. Coupled with a boom in reservoir development, Texas Parks and Wildlife Department (TPWD) personnel began to experiment with extended minimum and slot-length limits at the new reservoirs in an effort to develop trophy largemouth bass fisheries for anglers interested in this particular fishing "product" (as they are referred to by Driver 1985).

Accordingly, a lake developed for water supply purposes in northeastern Texas was designed as a fishery for trophy largemouth bass from the outset. In 1978, before impoundment, the Florida subspecies of largemouth bass *Micropterus salmoides floridanus* was stocked in local farm ponds that eventually would be inundated. The reservoir opened in 1980 with a 355-mm minimum length limit and 5 fish/d daily bag limit—both the most stringent limits in Texas at the time. The minimum length regulation was changed in 1985 to a slot-length limit of 355–457 mm and changed again in 1988 to 355–533 mm; the daily bag limit was reduced to three fish in 1992 (only one of which could be longer than 533 mm). In 1998, the slot-length limit was changed again, to 406–609 mm, but the bag limit was extended to five fish (only one of which could be longer than 609 mm) (Hunt and Ditton 1996b). These strategies were designed to initially protect small fish from harvest, then to protect mid-sized fish so they could reach a trophy size, and finally to protect trophy-sized fish and prohibit stunting of the largemouth bass population by encouraging anglers to retain subslot-size fish (Kurzawski 2001). These regulations, along with the bass habitat created by limited tree clearing before impoundment, were intended to produce a quality trophy bass fishery. To date, the 11,211-hectare surface-area reservoir has yielded 35 of the 50 heaviest largemouth bass ever taken from Texas waters, including the current state record of 8.25 kg.

The development of this product-oriented fishery had more farreaching effects than producing large fish and satisfying anglers. Since the first state record fish was caught there in 1986, increases in the numbers of nonlocal and out-of-state anglers at the reservoir were evident from creel surveys and inspection of vehicle license plates at public and private boat ramps (P. Durocher, Texas Parks and Wildlife Department, personal communication). Recognizing that fishing trips made to the reservoir were probably generating extensive economic activity, we initiated this study to better understand the extent of the (largely unintended) economic consequences of developing this recreational fishery.

In particular, we wanted to estimate the extent of local and state-level economic impacts associated with the development of a fishery intended to meet the wants and needs of a particular angler segment: those interested in catching trophy-size largemouth bass. The role of economic impact assessments in reservoir and fisheries development is well established (Weithman 1986; Reichers and Fedler 1996). Total angler expenditures and economic impacts have been quantified at the national level (e.g., U.S. Fish and Wildlife Service and U.S. Bureau of the Census 1997) and at the state level (e.g., Volk and Montgomery 1973; Storey and Allen 1993; Maharaj and Carpenter 1998). Economic impacts of recreational fisheries have been quantified at the local level (e.g., Strang 1970; Martin 1987) and even at the local level for a single species (Brown 1976; Schorr et al. 1995; Bohnsack et al. 2002) but such studies are rare. Likewise, few published studies have used the IMPLAN (IMpact analysis for PLANning) model for assessing the economic impacts of a recreational fishery (e.g., Schorr et al. 1995; Rhodes and Iverson 1998; Steinback 1999; Bohnsack et al. 2002), and all but Schorr et al. (1995) have dealt with marine fisheries. No published results from economic impact studies of local largemouth bass fisheries or, for that matter, of trophy largemouth bass fisheries have appeared previously in the journal literature. Therefore, an assessment of the local and statewide economic impacts of a local fishery at Lake Fork should be useful to fishery managers for project planning and for evaluating the effects of existing reservoir projects in light of project goals.

Study objectives were fourfold: (1) to understand the differential effects of fishing-related expenditures by in-state and out-of-state anglers, (2) to estimate the extent of total economic impacts associated with the development of a new fishery where none existed previously, (3) to identify which business sectors benefit the most from local fishery development efforts, and (4) to better understand the methods, issues, and limitations of economic impact assessments.

Methods

Survey data collection.—We used follow-up mail surveys of anglers encountered through creel surveys to obtain additional information about anglers using a particular water body (Ditton and Hunt 2001). This approach provides an opportunity to explore angler and trip characteristics, as well as expenditures incurred on trips, after the trip has been completed and in greater detail than possible during the creel survey.

Initiating a follow-up mail survey of Lake Fork anglers required a sampling frame. This was accomplished by collecting mailing addresses from anglers who were intercepted on TPWD creel surveys of the reservoir, in addition to standard catch and harvest information. The creel survey was designed as an access-point intercept survey which intercepted anglers at one of four randomly selected public boat ramps for 36 d (9 per quarter) between June 1, 1994, and May 31, 1995 (Lyons and Poarch 1993). Creel results from the previous year suggested that additional sampling days were necessary to ensure a sufficient number of out-of-state anglers were represented. To increase sample size, a creel clerk was randomly assigned to one of the four public boat ramps on every weekend day when TPWD was not conducting a creel survey to solicit additional names and addresses from anglers. A total of 2,200 angler names and addresses were collected from regular TPWD creel sampling and these additional efforts.

Most (N = 1,652) anglers intercepted were nonlocal Texas residents who lived outside of the three counties bordering the reservoir. Because nonlocal Texans would be combined with nonresidents for economic analysis, this number was more than adequate to achieve the desired precision level, that is, a 5% margin of error. Thus, a random sample of 300 nonlocal Texas anglers was selected from this group, which was then combined with the full listing of local Texas anglers (N = 199) and out-of-state anglers (N = 349) for a final sample size of 848 anglers. Oversampling of names and addresses was necessary to obtain a sufficient number of out-of-state anglers for economic analysis. After accounting for survey nonresponse (estimated at 35%), this sample size was considered adequate to be representative of all Lake Fork anglers with a 5% margin of error (Krecjie and Morgan 1970; McNamara 1994).

A self-administered mail questionnaire was developed to collect information from anglers. First, anglers were asked several questions about the fishing trip when they were intercepted by TPWD creel clerks (the date they were intercepted was added to the questionnaire to facilitate respondent recall). Anglers were asked to indicate how many miles they traveled (one-way) to get to the reservoir, whether this was the first time they visited the reservoir, how many days they spent fishing on their trip, the size of their fishing party, and what species they targeted. Next, anglers were asked to indicate how much money they spent within 35 mi of the reservoir or the local area (Hopkins, Rains, and Woods counties) and elsewhere in Texas on their trip for several trip-related items, including automobile transportation, other transportation (e.g., airplane), boat rental, boat operation, boat launch fees, entrance and parking fees, lodging, restaurant meals, groceries, bait and tackle, fishing guide fees, fishing licenses, and other miscellaneous expenses in Texas. Last, out-of-state anglers were asked how much they spent overall outside of Texas on their trip.

Questionnaires were mailed between September 1994 and June 1995 to selected anglers. The mail survey was conducted in four waves immediately after each creel quarter to reduce potential recall bias associated with expenditure items (Hiett and Worrall 1977; Chase and Harada 1984). The subsample of 300 nonlocal anglers was evenly distributed among the four quarters: 75 were included in each wave. Survey procedures were based partly on Dillman (1978) and partly on previous experience with data collection in Texas (Hunt and Ditton 1996a). The survey was personalized to enhance response rate. Three mailings were sent to each angler (as necessary) with a reminder postcard sent 10 d after the first mailing.

Response rates did not differ significantly among the four survey waves (range 72–78%; χ^2 = 2.88, df = 3, P = 0.41), so the results for all four were combined for purposes of reporting results. A total of 619 anglers responded to the mail survey. After excluding nondeliverables from consideration, the effective overall response rate was 74.6%. Returned questionnaires were checked for completeness of response; 10 surveys were returned but were not usable because respondents reported they no longer fished (N = 2), refused to answer (N = 6), or were reported as deceased (N = 2). Another 14 anglers did not provide any economic expenditure data and were removed from the analysis. This left a total of 595 usable questionnaires.

A telephone survey of nonrespondents was used to test for nonresponse bias in the survey results (Bethlehem and Kersten 1985; Fisher 1996). Telephone calling resulted in 39 completed surveys from a sample of 45 nonrespondents (i.e., 20% of nonrespondents). We found no significant differences between respondents and nonrespondents on trip-related items pertinent to the economic analysis: distance traveled on the trip on which they were intercepted by TPWD (t = 0.73, df = 643, P = 0.47), days spent fishing on their trip (t = 0.50, df = 631, P = 0.61), and total expenditures on their trip (t = 0.13, df = 643, P = 0.93).

Economic impact analysis.—This study used an input–output (I–O) IMPLAN modeling system to estimate the economic impacts of a trophy fishery on the Lake Fork region and the state of Texas. The analytical framework for IMPLAN is the I–O economic modeling approach as described by Leontief (1986). The traditional purpose of an I–O model is to provide the quantified interdependent relationships among industries in a regional economy (at local or state levels or both). Miller and Blair (1985) provide a detailed discussion of the advantages and disadvantages of the I–O modeling technique. In addition, for more information about the calculation and limitations of the I–O IMPLAN, readers are referred to the IMPLAN Professional User's Guide (1999).

To ascertain the economic impacts of various management alternatives in contiguous areas, IMPLAN was developed in 1976 by the U.S. Forest Service Land Management Planning Division and Rocky Mountain Forest and Range Experiment Station. The initial application of IMPLAN was designed to calculate the economic impacts of land planning and timber-related management (Chen et al. 2001). In 1997, IMPLAN was modified by the Minnesota IMPLAN Group for estimating economic impacts resulting from various events.

In IMPLAN, yearly data sets are assembled from various secondary sources and industries are categorized into 528 economic sectors based on Standard Industrial Classification codes. IMPLAN allows users to estimate regional economic impacts at the national, statewide, and county level (Chen et al. 2001). Two separate I–O models were used for this study to determine the economic impacts associated with anglers' expenditures. One model focused on the economic impacts of angler expenditures on the three-county local study area; the other estimated the impacts of expenditures on the Texas economy. Within each model, only expenditures by nonresident anglers were counted (those not residing in one of the three local counties for the Lake Fork model and out-of-state residents for the Texas model).

In this study, survey data were used under the IMPLAN models to calculate the economic impacts of a recreational fishery. Residence location was determined from TPWD creel surveys. Using total days of fishing effort estimates from TPWD creel surveys (one-person) and the percentages of anglers by residence location, the total number of days fishing (one-person) was calculated for each residence group. Using average trip lengths for local, nonlocal, border state, and nonborder state anglers as reported in the mail survey, and the total numbers of days fishing per residence group, we calculated the total number of one-person, multiple-day fishing trips for each residence group.

Initial direct expenditures of anglers in the Lake Fork area by nonresident anglers constitute the direct economic effects of the Lake Fork fishery on the local economy. However, direct effects are only one component of the full economic impact of the Lake Fork fishery. Other factors include indirect and induced effects. Indirect effects include economic activity generated among the businesses supplying goods and services to the firms that directly sold their products to visiting angling parties (e.g., additional food supplied to area restaurants for anglers' consumption). Induced effects include economic activity generated by increased local incomes as a result of anglers' expenditures. The sum of direct, indirect, and induced effects constitutes total economic impact. Type I, Type II, and Type III are three types of multipliers available with IMPLAN. Selection among these multiplier types has an important effect on the size of the impacts that are estimated. The Type I multipliers capture the interindustry effects and exclude the induced effects. The Type II multipliers give the direct, indirect, and induced effects in cases where the induced effect works by incorporating labor income and the household consumption into the multiplier. The Type III multipliers measure the direct and indirect and induced effects in cases where the induced effect is based on population. A fundamental problem with the Type III multipliers is that a change in the economy may have reflected a change in productivity or unemployment and does not always result in an increase in population (Minnesota IMPLAN Group 1999). Indeed, for service-intensive exports such as recreation, Type II multipliers are preferred over Type III. Thus, this study used Type II multipliers.

An I–O model can describe the economic importance of a fishery in terms of changes in total industry output, value added, labor income (broken down by employee compensation and proprietor income), and employment (i.e., how much additional employment can be supported by that

TABLE 1.—Number of fishing trips, average trip length, and days of participation at Lake Fork, Texas, from June 1, 1994, to May 31, 1995, by angular residence.

Angler type	Number of boat trips	Average trip length (d [SD])	Number of days fishing
Residents of the Lake Fork area	27,953	1.32 (0.12)	36,898
Texas anglers who live outside the Lake Fork area	161,948	1.59 (0.12)	257,457
Out-of-state anglers from bordering states	11,714	2.98 (0.09)	34,908
Out-of-state anglers from nonbordering states	3,124	6.04 (1.07)	18,838
All anglers	204,739		348,181

spending). Total industry output is the dollar value of all goods and services produced to satisfy final demand for goods and services and the interindustry transactions needed to produce them. Output can also be thought of as a value of sales plus or minus inventory (Minnesota IMPLAN Group 1999). Final demand is the dollar value of purchases from producing industries for final consumption. Value added is the difference between purchased inputs and the value of goods and services produced; it includes salary and wages, state and local tax revenue, nonwage employee compensation, federal tax revenues, profits, and net interest.

The aggregate total effects of changes are calculated by matrix inversion, which estimates economic multipliers that reflect direct, indirect, and induced impacts. An assessment of the total economic impacts of angler economic activities must consider the sum of direct, indirect, and induced activities. At each round of spending, some dollars leak from the local economy. Leakages in an I−O model are typically defined as import purchases, taxes, or savings—all of which remove dollars from the initial spending stream as it passes from sector to sector. Calibration of leakages is critical because it affects the size of the multipliers. Because the Lake Fork fishery could require additional expenditures by local county governments for public services such as law enforcement, water supply, and waste treatment, tax income generated locally by anglers must be considered. Indirect business taxes (consisting primarily of excise and sales taxes paid by individuals to business) generated by angler expenditures will probably contribute to local counties through various business sectors.

Results

Overall, 74% of anglers fishing Lake Fork were nonlocal Texans, 10.6% of anglers were local residents from the three adjacent counties, 10% were from adjacent border states (Arkansas, Louisiana, and Oklahoma), and 5.4% were other out-of-state anglers. We estimated 204,739 one-person, multiple-day fishing trips were made to the reservoir between June 1, 1994, and May 31, 1995. Accordingly, nonlocal Texas anglers accounted for most of the fishing trips (79.1%), and out-of-state anglers accounted for 7.2% of the trips at Lake Fork (Table 1). Local residents spent the least per angler per trip (US$44) in the Lake Fork area, whereas out-of-state anglers from nonbordering states spent the most there per angler per trip ($474), nearly two-thirds more than out-of-state anglers from bordering states (Table 2).

Nonresidents of the Lake Fork area accounted for 89.4% of all anglers. Nonlocal Texans made up 82.7% of nonresidents, and border state and non-border-state anglers made up 11.2% and 6.1%, respectively. Using weighted proportions, nearly 23% of the direct expenditures made in the Lake Fork area were for "lodging" and 19% were for "recreation, fishing, and boating fees." Other substantial categories of expenditures were for "eating and drinking" and "transportation," which

TABLE 2.—Average trip-related expenditures (U.S. dollars) per angler per trip for a Lake Fork fishing trip from June 1, 1994, to May 31, 1995.

Angler type	Average expenditures in Lake Fork Area (SE)	Average expenditures elsewhere in Texas (SE)	Average expenditures out-of-state (SE)
Residents of the Lake Fork area	44.46 (4.62)	7.22 (3.76)	
Texas anglers who live outside the Lake Fork area	59.51 (5.02)	58.29 (15.13)	
Out-of-state anglers from bordering states	292.19 (14.93)	39.79 (5.78)	52.24 (4.91)
Out-of-state anglers from nonbordering states	473.74 (42.26)	169.27 (71.68)	145.75 (91.79)

TABLE 3.—Expenditures (U.S. dollars) by anglers for Lake Fork fishing trips from June 1, 1994, to May 31, 1995.

Angler type	Expenditures in Lake Fork area	Expenditures elsewhere in Texas	Expenditures out-of-state	Total expenditures
Residents of the Lake Fork area	1,243,000	202,000		1,445,000
Texas anglers who live outside the Lake Fork area	9,638,000	9,440,000		19,078,000
Out-of-state anglers from bordering states	3,422,000	466,000	612,000	4,500,000
Out-of-state anglers from nonbordering states	1,480,000	529,000	455,000	2,464,000
All anglers	15,783,000	10,637,000	1,067,000	27,487,000

made up nearly 18% and 17% of total expenditures, respectively. Of the total angler expenditures ($15,783,000) made in the Lake Fork area, $14,540,000 (92%) was spent by anglers residing outside of the local area and was included in the local three-county I–O model (Table 3).

Most of the economic effects were generated in the tourism sectors of hotels and lodging, eating and drinking, and recreation services (e.g., boat rentals, boat operation, boat launch fees, fishing guide fees, and fishing licenses). In turn, these expenditures generated additional expenditures by local service providers, such as restaurant and hotel employees, from tips and direct payments for services, which provided additional economic stimulant. The $14,540,000 in direct expenditures made by nonresident anglers (nonlocal, border state, and other non-Texas residents) for local goods and services generated an additional $4,019,871 in economic output, resulting in a total output of $18,559,871 and 367 full- and part-time jobs associated with or generated by this fishery (Table 4). The average output multiplier was 1.28; that is, every dollar spent in the economy generated $1.28 totally. The total value-added generated by this increased level of output was estimated to be $9,355,999. This is smaller than the total output figure because it represents only the amount of income and taxes retained in the three counties surrounding the reservoir. Many of the interindustry inputs such as labor, capital, and wholesale supplies had to be purchased from outside the region. Each of those outside purchases represents "leakage" from the local economy. The more leakage in an economy, the smaller the economic multiplier and the overall economic impacts from changes in final demand. A component of the total value-added impact generated estimated the impact on labor income at $5,912,242 (Table 4).

The fishery had a smaller economic impact at the state level, because only 15.4% of the anglers were not Texas residents (Table 3). Nearly 34% of the direct expenditures made in Texas by nonresident anglers were for lodging, 17% for recreation, fishing, and boating fees (Table 5). Other substantial categories of expenditures were for eating and drinking and transportation, which made up nearly 17% and 16% of total expenditures, respectively. The total output associated with the fishery at the state level was $9,585,057. Finally, $3,361,551 in labor incomes and 163 jobs were contributed to the state of Texas by Texas nonresident anglers.

TABLE 4.—Impacts of angler expenditures on the local economy (Hopkins, Rains, and Woods counties, Texas) from June 1, 1994, to May 31, 1995. Industry output, value added, and labor income are in U.S. dollars; employment is number of jobs.

Sector	Industry output	Value added	Labor income	Employment
Agriculture	946,578	327,639	252,704	22.4
Mining	171,469	88,368	13,129	0.2
Construction	205,202	107,037	99,893	3.5
Manufacturing	1,292,717	405,742	254,654	6.3
Transportation, communication, and utilities	842,049	512,191	224,494	4.6
Trade	2,316,072	1,802,360	1,119,381	59.1
Eating and drinking	2,723,401	1,313,367	925,425	84.2
Finance, insurance, and real estate	1,545,051	1,205,033	627,523	33.9
Hotels and lodging	3,023,700	1,677,525	1,094,055	76.6
Services	2,715,675	1,168,779	823,664	38.8
Boating and recreation	1,116,139	677,629	412,837	34.7
Government	117,616	61,193	55,348	1.3
Other	9,136	9,136	9,136	1.4
Institutions	2,075,069			
Total	18,559,871	9,355,999	5,912,242	367.1

TABLE 5.—Impacts of nonresident angler expenditures on the economy of Texas from June 1, 1994, to May 31, 1995. See the caption to Table 4 for additional details.

Sector	Industry output	Value added	Labor income	Employment
Agriculture	88,250	35,419	23,924	2.0
Mining	92,697	56,292	16,283	0.2
Construction	118,719	65,016	60,047	1.7
Manufacturing	819,733	260,539	152,725	3.7
Transportation, communication, and utilities	474,249	293,700	139,976	2.5
Trade	997,562	765,652	471,696	20.1
Eating and drinking	1,032,472	526,421	370,933	29.4
Finance, insurance, and real estate	944,515	713,027	294,109	10.0
Hotels and lodging	2,010,972	1,212,284	790,760	37.4
Services	1,526,521	902,984	698,965	25.2
Boating and recreation	813,666	482,284	293,850	29.1
Government	112,611	59,467	43,403	1.0
Other	4,881	4,881	4,881	0.6
Institutions	548,209			
Total	9,585,057	5,377,967	3,361,551	163.0

(Table 5). Because expenditures by Texas residents were excluded from the Texas model, fewer total expenditures ($5,897,000) were included. The average output multiplier (1.62) was greater than the local multiplier because the statewide model captures more interindustry activity (i.e., the amount of economic leakage is smaller because the region of concern is larger).

Total direct and induced industry outputs in the taxable sectors (indirect expenditures are interindustry transfers and are not taxable in Texas) resulted in total tax revenue of $2,689,025 to the three local counties. Thirty-five percent of indirect business tax impacts were generated by trade and retail goods, 17% by hotels and lodging places, and 17% by eating and drinking categories.

Discussion

Trip expenditures by local and nonlocal anglers were comparable to those from other freshwater fisheries (Anderson et al. 1986; Schorr et al. 1995). The distribution of local (11%), nonlocal state resident (74%), and out-of-state (15%) anglers at Lake Fork was not comparable to those of other previously studied freshwater fisheries. Nearly twice as many (an estimated 40%) Lake Texoma anglers, for example, were from the local "impact region," and the rest were nonlocals or from out-of-state (Schorr et al. 1995). At Devil's Lake in North Dakota, local anglers, nonlocal anglers, and out-of-state anglers were responsible for 20, 66, and 14% of total fishing trip-related expenditures, respectively. Had Lake Fork been managed under the generic statewide largemouth bass regulations instead of trophy bass limits, it would probably not have "competed" as well against other largemouth bass fishing destinations in the region, it probably would have attracted mainly local anglers, and this study probably would not have been done. Other destinations would have been closer to home than Lake Fork for many and hence cost less for anglers residing in Texas as well as those from out of state. Given no differences in the quality of fishing experience afforded, we would expect these lower trip-cost alternatives would have been used more frequently than the higher-cost Lake Fork experience (Loomis and Walsh 1997). But Lake Fork was designed to yield a unique type of fishing experience and because of this, anglers are apparently willing to incur additional travel costs and bypass other largemouth bass fishing destinations closer to home to be able fish at a location that suits their particular needs.

This paper provides a more conservative and detailed understanding of the economic impacts of a recreational fishery than available in many of the previously conducted studies of freshwater fisheries. Some have used I–O models such as IMPLAN and RIMS (Anderson et al. 1986; Schorr et al. 1995; Steinback 1999; Bohnsack et al. 2002); others have been "quick and dirty" analyses based on state-level impact multipliers derived from the 1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Fish and Wildlife Service and U.S. Bureau of the Census 1997) or approximate multipliers from other sources. The practice of using a single multiplier wrongly assumes that all economic sectors have similar multiplier effects. An initial analysis of economic impacts at Lake Fork, for example, used single local (2.2) and state-level (3.0) multipliers to estimate indirect and induced impacts, respectively

(Hunt and Ditton 1996b). The resulting estimates of local and state-level total industry output impacts were 72% and 85% higher, respectively, than reported here using IMPLAN and their respective data files for county-level and state-level economies. Furthermore, Hunt and Ditton (1996b) were unable to determine which business sectors of the economy were impacted and to what extent by the indirect and induced impacts of angler expenditures.

Whereas we excluded all local and Texas residents when we completed our assessment of economic impacts, this has not always been the case with other economic impact assessments of recreational fisheries. In calculating the regional economic impact of the Devil's Lake fishery in North Dakota, for example, Anderson et al. (1986) used three residency-based scenarios, ranging from the conservative (the economic impacts of nonresidents only) to the optimistic (the economic impacts of locals, nonlocals, and nonresidents) to produce three different estimates of economic impact. Our approach closely approximated the assumptions of the middle scenario used by Anderson et al. (1986), which focused on the economic impacts of nonlocal and nonresident anglers. In contrast, when Schorr et al. (1995) calculated the effects of angler expenditures on the Lake Texoma regional economy, data for regional residents (locals) were included in the final overall estimate of total economic output ($57.4 million).

This analysis also revealed the extent to which respective private sector stakeholders benefit from fisheries. In this case, for example, the largest beneficiaries of the economic impact in terms of the number of part- or full-time jobs at Lake Fork were the hotels and lodging and the eating and drinking sectors. These results are fairly typical for other outdoor recreation activities as well (English and Bowker 1996; Loomis and Walsh 1997). Because these sectors have the most to lose, we would expect their representatives to want to be heard on any proposed changes in fishery rules and regulations that might impact the extent and distribution of current angler clientele. Further, this perspective is in keeping with a social definition of a "fishery" that includes not only fish but also anglers and all other businesses and related infrastructure involved in the provision of recreational fishing opportunities (Ditton 1996).

The total value-added component of economic output (Tables 4 and 5) and its labor component (salaries and wages) are probably more meaningful measures of the economic impact of angler expenditures at a reservoir, for example, than are overall output figures (Crompton and McKay 1994). Accordingly, with regard to related public sector developments, managers can expect the public to be more concerned with how much more income they will earn from nonlocal expenditures than with the extent of expenditures or total economic output.

Consistent with previous economic impact studies of recreational fisheries (Anderson et al. 1986; Schorr et al. 1995; Steinback 1999; Bohnsack et al. 2002), we did not investigate any of the negative effects that may have accompanied this fishery, although we should have done so to provide a more balanced perspective. In addition to estimates of local expenditures and their total economic impact, some consideration needs to be given to the costs of this facility and related activity to local governments and residents (Stokowski 1996). Negative impacts can be physical and environmental, economic, and social in nature (Pizam 1978). Negative physical and environmental impacts can include increased traffic densities and reduced accessibility. Negative economic impacts can include escalation in land prices, employment fluctuation, and dependency on a single industry. Negative social impacts can include crowding and congestion caused by increased fishing activity, introduction of undesirable activities, excessive concern for material gain, and loss of cultural identity. Accordingly, we would expect stakeholders to take these negative aspects into account in assessing the impacts of fishery developments and discount expected positive benefits accordingly.

Several final cautions are necessary. First, the reader is encouraged not to generalize study results to other bodies of water inhabited by largemouth bass or even to those with regulations in place that seek to promote a trophy largemouth bass fishery. Every water body is unique in terms of its resource capability, proximity to angler populations, extent of current use, and competition from other fishing destinations. Whether it will attract nonlocal instate and out-of-state anglers to the same extent should be a planning objective, with exact outcomes remaining to be seen from a study similar to this one. Second, our analysis focused solely on the economic impact of nondurable goods and services; it did not include expenditures associated with the purchase of boats, motors, trailers, and overall fishing equipment, for example, because these expenditures cannot be attributed solely to a particular fishery, nor could we pro-rate the annual depreciation of the items. Hence, our results were conservative in that they included only direct expenditures for fishing at Lake Fork and their impacts. Third, as has been the case in all previous economic impact analyses of recreational fisheries, we failed to consider changes in the value of land surrounding the reservoir. Future studies of the economic impact of recreational fisheries should include a thorough examination of the changes in public and private assets including land (Stoevener et al. 1974). Finally, for clarification purposes, economic impact assessments are useful for estimating the economic effects of injecting new money into an area. They do not measure an angler's willingness to pay (i.e., net economic benefits) and hence they are not suitable for benefit–cost analyses (Propst and Gavrilis 1987; Edwards 1991).

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References

Anderson, R. S., C. J. Schwinden, and J. A. Leitch. 1986. Regional economic impact of the Devils Lake fishery. Fisheries 11(5):14–17.

Bethlehem, J. G., and H. M. P. Kersten. 1985. On the treatment of nonresponse in sample surveys. Journal of Official Statistics 4:251–260.

Bohnsack, B. L., R. B. Ditton, J. R. Stoll, R. J. Chen, R. Novak, and L. S. Smutko. 2002. The economic impacts of the recreational bluefin tuna fishery in Hatteras, North Carolina. North American Journal of Fisheries Management 22:165–176.

Brown, T. L. 1976. The 1973–75 salmon runs: New York's salmon river sport fishery, angler activity, and economic impact. Cornell University, New York Sea Grant Program, Technical Report NYSGP-RS-76-025, Ithaca.

Chase, R. C., and M. Harada. 1984. Response error in self-reported recreation participation. Journal of Leisure Research 16:322–329.

Chen, R. J., J. Fu, and G. Brothers. 2001. Economic impacts of travel to a nature-based regional destination. Consortium Journal of Hospitality and Tourism 5(2):23–36.

Crompton, J. L., and S. L. McKay. 1994. Measuring the economic impact of festivals and events: some myths, misapplications, and ethical dilemmas. Festival Management and Event Tourism 2:33–43.

Deinstadt, J. M. 1987. California's use of catch-and-release angling regulations on trout waters. Pages 49–67 *in* R. A. Barnhart and T. D. Roelofs, editors. Catch and release fishing: a decade of experience. California Cooperative Fishery Research Unit, Humboldt State University, Arcata.

Dillman, D. A. 1978. Mail and telephone surveys: the total design method. Wiley, New York.

Ditton, R. B. 1996. Human dimensions in fisheries. Pages 73–90 *in* A. Ewert, editor. Natural resource management: the human dimension. Westview Press, Boulder, Colorado.

Ditton, R. B., and K. M. Hunt. 1996. Demographics, participation, attitudes, management preferences, and trip expenditures of Texas black bass anglers. Texas A&M University, Human Dimensions of Fisheries Research Laboratory, Report HD-607, College Station.

Ditton, R. B., and K. M. Hunt. 2001. Combining creel intercept and mail survey methods to understand the human dimensions of local freshwater fisheries. Fisheries Management and Ecology 8:295–301.

Driver, B. L. 1985. Specifying what is produced by management of wildlife by public agencies. Leisure Sciences 7:281–295.

Driver, B. L., and R. W. Cooksey. 1977. Preferred psychological outcomes of recreational fishing. Pages 27–40 *in* R. A. Barnhart and T. D. Roelofs, editors. A national symposium on catch and release fishing. California Cooperative Fishery Research Unit, Humboldt State University, Arcata.

Edwards, S. F. 1991. A critique of three "economics" arguments used to influence fishery allocations. North American Journal of Fisheries Management 11:121–130.

English, B. K., and J. M. Bowker. 1996. Economic impacts of guided whitewater rafting: a study of five rivers. Water Resource Bulletin 32:1319–1328.

Fedler, A. J., and R. B. Ditton. 1994. Understanding angler motivations in fisheries management. Fisheries 19(4):6–13.

Fisher, M. R. 1996. Estimating the effect of nonresponse bias on angler surveys. Transactions of the American Fisheries Society 125:118–126.

Hiett, R. L., and J. W. Worrall. 1977. Marine recreational fishermen's ability to estimate catch and to recall catch and effort over time. Human Sciences Research, Research Report HSR-RR/13-CD, McClean, Virginia.

Hunt, K. M., and R. B. Ditton. 1996a. Using survey research in support of fisheries management: the 1994 Texas statewide angler survey. Pages 234–244 *in* L. E. Miranda and D. R. De Vries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society, Symposium 16, Bethesda, Maryland.

Hunt, K. M., and R. B. Ditton. 1996b. A social and economic study of the Lake Fork Reservoir recreational fishery. Texas A&M University, Human Dimensions of Fisheries Laboratory, Report HD-608, College Station.

Hunt, R. L. 1987. Characteristics of three catch-and-release fisheries and six normal-regulation fisheries for brown trout in Wisconsin. Pages 33–48 *in* R. A. Barnhart and T. D. Roelofs, editors. Catch and release fishing: a decade of experience. California Cooperative Fishery Research Unit, Humboldt State University, Arcata.

Krecjie, R. V., and D. W. Morgan. 1970. Determining sample size for research activities. Education and Psychological Measurement 30:607–610.

Kurzawski, K. 2001. A bass act. Texas Parks and Wildlife 59(1):24–29.

Leontief, W. 1986. Input-output economics. Oxford University Press, New York.

Loomis J. B., and R. G. Walsh. 1997 Recreation economic decisions: comparing benefits and costs, 2nd edition. Venture Publishing, State College, Pennsylvania.

Lyons, B., and S. Poarch. 1993. Statewide freshwater fisheries monitoring and management program federal aid in sport fish restoration act. Texas Parks and Wildlife Department, Survey Report for Lake Fork Reservoir, 1992, Project F-30-R-17, Austin.

Maharaj, V., and J. E. Carpenter. 1998. The 1996 economic impact of sport fishing in Texas. American Sportfishing Association, Alexandria, Virginia.

Martin, L. R. G. 1987. Economic impact analysis of a sport fishery on Lake Ontario: an appraisal method. Transactions of the American Fisheries Society 116: 461–468.

McNamara, J. F. 1994. Surveys and experiments in education research. Technomic Publishing, Lancaster, Pennsylvania.

Miller, R. E., and P. D. Blair. 1985. Input-output analysis: foundations and extensions. Prentice-Hall, Englewood Cliffs, New Jersey.

Minnesota IMPLAN Group. 1999. IMPLAN professional: social accounting and impact analysis software. Minnesota IMPLAN Group, Minneapolis.

Pizam, A. 1978. Tourism impacts: the social costs to the destination community as perceived by its residents. Journal of Travel Research 16:8–12.

Propst, D. B., and D. G. Gavrilis. 1987. Role of economic impact assessment procedures in recreational fisheries management. Transactions of the American Fisheries Society 116:450–460.

Rhodes, R. J., and K. G. Iverson. 1998. Economic impacts of a saltwater fishing tournament series in South Carolina. Pages 184–199 *in* 1998 National IMPLAN user's conference proceedings. Minnesota IMPLAN Group, Stillwater.

Reichers, R. K., and A. J. Fedler. 1996. An overview of economic impact and value of recreational fisheries. Pages 245–250 *in* L. E. Miranda and D. R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society, Symposium 16, Bethesda, Maryland.

Schorr, M. S., J. Sah, D. F. Schreiner, M. R. Meador, and L. G. Hill. 1995. Regional economic impact of the Lake Texoma (Oklahoma-Texas) striped bass fishery. Fisheries 20(5):14–18.

Steinback, S. R. 1999. Regional economic impact assessments of recreational fisheries: an application of the IMPLAN modeling system to marine party and charter boat fishing in Maine. North American Journal of Fisheries Management 19:724–736.

Stoevener, H. H., R. B. Rettig, and S. D. Reiling. 1974. Economic impact of outdoor recreation: What have we learned? Pages 235–255 *in* D. R. Field, J. C. Barron, and B. F. Long, editors. Water and community development: social and economic perspectives. Ann Arbor Science, Ann Arbor, Michigan.

Stokowski, P. A. 1996. Riches and regrets: betting on gambling in two Colorado mountain towns. University Press of Colorado, Boulder.

Storey, D. A., and P. G. Allen. 1993. Economic impact of marine recreational fishing in Massachusetts. North American Journal of Fisheries Management 13:698–708.

Strang, W. 1970. Recreation and the local economy: am I/O model of a recreation-oriented economy. University of Wisconsin, Wisconsin Sea Grant Program, Technical Report WIS-SG-71-204. Madison.

U.S. Fish and Wildlife Service and U.S. Bureau of Census. 1997. 1996 National survey of fishing, hunting, and wildlife-associated recreation. U.S. Government Printing Office, Washington, D.C.

Volk, A. A., and V. E. Montgomery. 1973. The economic impact of sport fishing in South Dakota, 1972 with notes on angler traits. University of South Dakota, Federal Aid in Sport Fish Restoration Act, Project F-21-R7 and 8, Vermillion.

Weithman, A. S. 1986. Measuring the value and benefits of reservoir fisheries programs. Pages 11–17 *in* G. E. Hall and M. J. Van Den Avyle, editors. Reservoir fisheries management: strategies for the 80's. American Fisheries Society, Southern Division, Reservoir Committee, Bethesda, Maryland.

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Linking sportfishing trip attributes, participation decisions, and regional economic impacts in Lower and Central Cook Inlet, Alaska

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Abstract. Forecasts of the regional economic impacts of changes in the demand for recreation occasioned by regulatory changes, changes in the quality of the recreation experience, or changes in average trip costs require a model that links changes in these trip attributes to individual participation decisions and population participation rates. The probability that an individual will take a particular recreational trip is described using a nonlinear random effects probit model based on variable trip attributes and individual economic and demographic characteristics. These conditional individual probabilities are transformed into predictions of changes in total recreation demand using a simulation-based sample enumeration method. The regional impacts associated with ensuing changes in primary and secondary expenditure patterns are elucidated with a stand-alone recreation-sector module linked to a regionally adjusted zip code-level input-output model. Because the participation model allows for non-constant marginal utility, primary and secondary impacts exhibit nonlinear responses to variations in trip attributes. The modeling approach is demonstrated in an application to the saltwater sport fisheries for Pacific halibut and salmon in Lower and Central Cook Inlet, Alaska.

JEL classification: C25, C67, Q22, Q26

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1. Introduction

The lure of world-class fresh and saltwater sportfishing opportunities makes Alaska's Kenai Peninsula one of the state's most visited regions. This study examines the regional economic impacts of expenditures related to the saltwater sport fisheries for Pacific halibut (*Hippoglossus stenolepis*), and chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon that take place in the marine waters of Lower and Central Cook Inlet. Most of these trips originate from road-accessible segments of the western shoreline of the Kenai Peninsula. In addition to non-monetary benefits enjoyed by visiting and resident anglers, sportfishing contributes to the economic well being of Kenai Peninsula communities as infusions of new money filter through tourism related businesses and circulate within local economies.

The decision to take a sportfishing trip is predicated on the expectation that the benefits of taking the trip will exceed the associated costs. Consequently, an understanding of how that decision depends on individual demographic characteristics and attributes of the recreation experience allows prediction of how angler behavior will change in response to changes in trip attributes. For example, changes in fish stock abundance that affect catch rates or regulatory measures that affect bag and possession limits will be perceived by anglers as changes in the attribute bundle associated with their fishing trip. Because the likelihood that alternative fishing trips will be taken is expressed in probabilistic terms, confidence bounds around the predicted changes in participation rates and associated changes in regional expenditures can be estimated.

Examples of recent policy initiatives that highlight the need for regional impact analyses to account for the contribution of recreation activities include: damage assessments associated with the *S.S. Glacier Bay* and *S.S. Exxon Valdez* oil spills; potential risks associated with outer continental shelf petroleum development lease sales adjacent to prime commercial and recreational fishing grounds in Lower Cook Inlet and the Gulf of Alaska; and, management decisions to determine the allocations of allowable catches between commercial, sport, and subsistence fishers. Because oil exploration, development, and production activities in Cook Inlet could affect the productivity of adjacent fishing grounds and the quality of recreational activities, economic impact analyses are required to demonstrate the range of potential adverse impacts to communities (Northern Economics 1990; Cohen 1993; MMS 1995; Herrmann et al. 2001a). Another example is the allocation of Pacific halibut between commercial fishermen and sportfishing charterboat operators. Sportfishing in Alaska has increased considerably in the last few decades. Total purchases of fishing licenses have increased from 90,565 in 1961 to 431,894 in 1997. Over the same period, sportfishing catches of Pacific halibut have increased from less than 2% to 18% of total removals. Because Pacific halibut is a fully subscribed fishery with an overall limit on allowable removals, increases in sport catches necessitate concomitant reductions in commercial harvests. Such allocation decisions are subject to statutory and regulatory requirements to consider the effect on net benefits to the nation and the impact on small entities, including communities and small businesses.[1]

[1] Regulatory guidelines for implementation of the Magnuson-Stevens Fishery Conservation and Management Act require that an attempt be made to assess the net economic benefits to the nation of all management actions that affect federally managed fisheries. The Regulatory Flexibility

Estimates of the magnitude of consumer and producer surpluses and associated regional economic impacts are necessary for formal compliance with these requirements (Herrick et al. 1994).

The commercial and sport fisheries of Lower and Central Cook Inlet both contribute to the economic well being of residents of the Kenai Peninsula, Alaska, and the nation. Economic aspects of the commercial halibut fishery have been subject to considerable analysis (e.g., Crutchfield and Zellner 1962; Lin et al. 1988; NPFMC 1991; Homans 1993; Criddle 1994; Herrmann 1996; NRC 1999; Herrmann 2000). Economic aspects of Alaska's commercial salmon fishery have been examined at a similar level of detail (e.g., Herrmann 1993, 1994; Herrmann and Greenberg 1994). In contrast, there has been little formal analysis of Alaska's marine recreational fisheries. Coughenower (1986) provides a qualitative description of the halibut guide/charter fishery. Jones and Stokes (1987) provide a small-sample estimate of the consumer surplus associated with halibut and salmon sportfishing. Northern Economics (1990) provides an estimate of the economic impact of the *S.S. Glacier Bay* oil spill that includes a qualitative discussion of sportfishing benefits. Our study raises the level of sportfishing analysis closer to that available for the commercial fishery. We do so using an econometric model of the determinants of individual participation decisions, a simulation procedure to aggregate across individual decisions and estimate total sportfishing effort, and a regional input-output model that describes primary and secondary expenditure patterns. This approach results in a behaviorally based integrated model of the regional economic impacts of changes in the demand for sportfishing occasioned by, for example, management actions, environmental damage, or natural fluctuations in the abundance of the target species and substitute target species.

2. Data and models

The participation and regional impact models rely on data collected by a postal survey of a random sample of 4,000 anglers who purchased an Alaskan sportfishing license in 1997. The survey solicited socioeconomic and catch data, detailed information regarding expenses incurred on recent salmon and halibut fishing trips, and stated preferences for hypothetical trips. In addition to expenditures directly related to fishing, respondents were also asked to report other trip expenses including transportation and lodging costs. Overall response to the survey exceeded 70%. The survey design, sample frame, and results are described in Herrmann et al. (2001b) and cross-validated with common elements from the Alaska Department of Fish and Game statewide sportfishing harvest survey (ADF&G 1998).

Attributes that affect participation in the Lower and Central Cook Inlet saltwater sport fishery include the number and species of fish caught (including retained and released fish), average catch weight, and trip cost. On an average trip, Alaskans caught 1.71 halibut, 0.19 chinook salmon, and 0.06 coho salmon weighing 34.2, 28.3, and 10.6 pounds each, respectively. The mean

Act requires that the economic impact of proposed federal regulations on small entities be assessed in advance of management action. While these requirements do not specify the methodologies to be used in meeting statutory and regulatory analysis requirements, recent court decisions have set aside management actions based on ad hoc or informal economic assessments.

nonresident trip included catches of 2.43 halibut, 0.14 chinook, 0.31 coho, and average fish weights of 42.7, 30.9, and 9.6 pounds, respectively.

The regional economic impact of sportfishing depends on the number of participants and their expenditure patterns. We grouped recreational fishers into categories because reported expenditures varied substantially across participant origins and sportfishing modes. The residency categories were: Kenai Peninsula Borough residents (local); other Alaskan residents (non-local Alaskan); and, other US citizens (nonresident). The sportfishing modes were: fishing from shore (shore); fishing from a vessel hired for the trip (charter); and, fishing from a vessel that is personally owned or otherwise made available to the trip taker without payment of a rental fee (private). Thus, we model nine distinct expenditure patterns. Mean transportation and living expenses for local residents and other Alaskans ranged between \$30.41 and \$75.66 per day, and from \$62.99 to \$103.87 for nonresidents dependent on fishing mode. Mean living expenditures were lower for nonresidents who fished off private boats than for those who fished from shore or from charter boats, due in part to the fact that the primary trip purpose for many such respondents was to visit friends and family. Mean per-trip fishing expenditures ranged between \$2.14 (shore) and \$137.06 (charter) for local residents. Mean non-local Alaskan sportfishing expenditures varied from \$4.50 (shoreline) to \$129.25 (charter). On average, nonresidents spent \$30.57 to \$190.34 per shore and charter trip, respectively. Detailed information on average daily sportfishing expenditures by category is reported in Herrmann et al. (2001b).

Estimates of 1997 saltwater angling effort in Lower and Central Cook Inlet were obtained from the Alaska Department of Fish and Game annual sport fish statewide harvest survey (ADF&G 1998). Total sportfishing effort was multiplied by the average daily expenditures, disaggregated into time spent on the Kenai and time spent elsewhere in Alaska, and adjusted to reflect trip purpose. The majority (63.5%) of respondents identified fishing for halibut or salmon in Cook Inlet as the primary purpose of their most recent trip. This response was most pronounced for non-local Alaskans, 87.9% of who listed fishing for halibut or salmon in Cook Inlet as the main reason for their trip. Less than half of the nonresidents (43%) identified fishing for halibut or salmon in Cook Inlet as their primary motive. Another important reason (24.4%) for nonresident trips was simply to visit and vacation in Alaska. Freshwater fishing and visiting relatives were also important motives for nonresidents. While the empirical model can be used to estimate the probability that the average angler will take a specified trip, it does not explicitly account for how the probability that a particular angler would take that trip is affected by differences in the primary purpose of that individual's visit to the Kenai Peninsula. To account for these differences, we assumed that individuals who expressed saltwater fishing as the main purpose of their trip would forego their visit to the Kenai entirely if expectations of adverse angling conditions discouraged them from fishing at all. Individuals whose primary trip purpose was to visit friends or relatives, conduct business, or to take a cruise ship voyage or hunting trip were assumed to substitute other activities on the Kenai Peninsula if halibut and salmon saltwater sportfishing conditions were unattractive or unavailable. These assumptions were applied as a downward adjustment to the number of angler days in order to estimate total expenditures that were uniquely attributable to the salmon and halibut sportfishing opportunities in Lower and Central Cook Inlet. The total expenditures in Table 1 can be re-

Table 1. Total 1997 expenditures ($million) attributable to Lower and Central Cook Inlet salt-water sportfishing adjusted to reflect trip purpose

	Spending on Kenai Peninsula	Spending elsewhere in Alaska	Total spending
Fishing expenditures			
Charter fees	$10.366	–	$10.366
Gear	$1.904	$0.074	$1.978
Processing fees	$2.307	–	$2.307
Derby fees	$0.269	–	$0.269
Boat fuel & repairs	$1.732	$0.291	$2.024
Moorage or haul fees	$0.671	–	$0.671
Total fishing expenditures	$17.251	$0.366	$17.617
Ancillary expenditures			
Auto and truck fuel	$2.619	$0.452	$3.071
RV rentals	–	$2.697	$2.697
Lodging	$3.226	$1.015	$4.242
Groceries	$2.864	$0.516	$3.381
Restaurant & bar	$2.561	$0.488	$3.050
Total ancillary expenditures	$11.272	$5.170	$16.443
Total	$28.524	$5.536	$34.061

garded as a measure of the economic significance, in terms of output in 1997 dollars, of the Cook Inlet marine sport fisheries for halibut and salmon. For purposes of generating economic impacts to the western Kenai Peninsula, we begin with a 1997 baseline of $28.5 million. Increased or diminished angler spending will depend on changes in demand for recreational fishing, which is in part, a function of the expected trip attributes. This relationship is explored next.

2.1. Participation-rate model

Changes in expected catch or the expected size of fish caught (changes in trip attributes) affect the average sport fisher's decision to participate in (take) a sportfishing trip, regardless of whether the attribute change is due to natural population fluctuations, regulatory change, or environmental damage. That is, changes in fishery regulations, environmental quality, resource abundance, or trip costs, affect participation decisions. In contrast to previous studies (e.g., Holland and Ditton 1992; Aas 1995; Thunberg et al. 1999) that model population-level changes in the demand for recreational fishing based on exogenous demographic characteristics, we modeled the individual participation decision as a binary dependent variable explained by price, demographic characteristics, and angler success expressed in terms of the composition, magnitude, and average size of fish caught. The model can be expressed as:

$$y_{it}^{*} = \beta_0 + \beta_1 p_{it} + f_1(n_{its}\bar{x}_{its}) + f_2(n_{its}) + f_3(z_{il}) + e_{it} \tag{1}$$

The dependent variable y_{it}^{*} takes on the value of 1 (0) if individual i with demographic characteristics z_{il} would (would not) have taken trip t with price p_{it} and trip attributes n_{its} and $\bar{x}_{its}$. Where the z_{il} are realizations of categorical variables representing per-capita household income, gender, age, and education for individual i, p_{it} is the price paid by individual i for trip t, n_{its} is the

Table 2. Participation model parameter estimates

	Alaskans (local and non-local)		Nonresidents	
	Estimates	t-ratios	Estimates	t-ratios
Intercept	−2.8415	−3.03*	−1.4746	−1.86
Price	−0.0124	−7.39*	−0.0094	−6.96*
$n_{halibut}\bar{x}_{halibut}$	0.0371	3.30*	0.0228	2.53*
$n_{chinook}\bar{x}_{chinook}$	0.1037	4.32*	0.0732	3.56*
$n_{coho}\bar{x}_{coho}$	0.1242	2.95*	0.1163	3.19*
$(n_{halibut}\bar{x}_{halibut})^2$	−0.0001	−2.88*	−0.0001	−1.33
$(n_{chinook}\bar{x}_{chinook})^2$	−0.0006	−3.41*	−0.0004	−2.52*
$(n_{coho}\bar{x}_{coho})^2$	−0.0008	−1.13	−0.0011	−1.82*
$(n_{halibut}\bar{x}_{halibut})(n_{chinook}\bar{x}_{chinook})$	−0.0005	−3.50*	−0.0004	−3.20*
$(n_{halibut}\bar{x}_{halibut})(n_{coho}\bar{x}_{coho})$	−0.0007	−2.84*	−0.0005	−2.38*
$(n_{chinook}\bar{x}_{chinook})(n_{coho}\bar{x}_{coho})$	−0.0018	−3.60*	−0.0010	−2.26*
$n_{halibut}$	1.1033	2.05*	0.9241	2.33*
$n^2_{halibut}$	−0.1492	−2.19*	−0.1297	−2.52*
Per-capita household income	0.0945	1.09	0.0021	0.04
Gender (1 = male)	0.3853	2.03*	0.0963	0.57
Age	0.0080	1.04	0.0003	0.05
Education (1 = college graduate)	0.2827	1.39	0.3853	2.49*
ρ	0.192	2.77*	0.192	2.77*

* Significantly greater (less) than zero at $p \leq 0.05$.

number of fish of species s (halibut, chinook, coho) caught by individual i on trip t, and $\bar{x}_{its}$ is the average weight of fish of species s caught by individual i on trip t. The functions $f_1(\cdot)$ and $f_2(\cdot)$ were specified as simple second order polynomials. Specifically, $f_1(\cdot)$ includes linear and quadratic terms and cross-products for all three species and $f_2(\cdot)$ includes linear and quadratic terms in the number of halibut caught. This specification allows for non-constant marginal utility of catch and substitution/complementarity effects across species. The function $f_3(\cdot)$ was specified as linear and additively separable in all variables.

Survey respondents were presented with trips described by a combination of: one of three costs levels ($100, $170, $240 per day); one of four halibut catch (keep and release) levels (0, 2, 4, 6 fish per trip); one of four average halibut weights (0, 20, 40, 80 lbs per fish); one of three chinook catch levels (0, 1, 2 fish per trip); one of four average chinook weights (0, 15, 25, 50 lbs per fish); one of four coho catch levels (0, 2, 4, 6 fish per trip); and one of two average coho weights (0, 7 lbs per fish). Efficient specification of hypothetical trip attributes, and survey design and administration are described in Hermann et al. (2001a).

Equation (1) was estimated using a random effects probit model following Butler and Moffitt (1982). This model accounts for both the discrete and panel nature of the data. Fully interactive indicator variables were used to estimate separate parameters for Alaskans and nonresidents. Because the same general study design was presented to each group, only one random effect parameter, ρ, was estimated. Estimates of the 35 parameters and associated t-statistics are reported in Table 2. Twenty-six of the parameters are significantly greater (less) than zero at the 5% level and the point estimates of the parameters and their signs accord well with economic theory: the price coefficients are significantly less than zero; the coefficients on halibut, chinook, and coho weights and halibut catches are significantly greater than zero; the weight and catch squared terms are all negative, implying that anglers experience decreasing marginal utility; and, the cross-products of the weights of halibut, chinook, and coho are significantly less than zero, suggesting that catches of each species are substitutes for catches of the others. The presence of an identifiable random effect is supported by the statistical significance of the estimated parameter. With the exception of gender in the Alaskan equation and education in the nonresident equation, the demographic characteristics were not statistically significant.

Model forecasts are based on the sample enumeration method (BenAkiva and Lerman 1987), which takes into account differences in socioeconomic characteristics and variability in the number of days fished per year by developing forecasts for each individual in the sample. This information is used to weight the simulations by the number of days fished:

$$\%\Delta Participation_{\alpha} = \frac{\sum_i[\Phi(\hat{u}_{i,1})days_i] - \sum_i[\Phi(\hat{u}_{i,0})days_i]}{\sum_i[\Phi(\hat{u}_{i,0})days_i]}. \quad (2)$$

Where $\hat{u}_{i,j}$ is the forecast of indirect utility for individual i taking a fishing trip characterized by attributes j, $j = 0$ denotes the initial or starting point fishing trip attributes and $j = 1$ denotes the new fishing trip attribute levels based on an α percent change from the $j = 0$ levels, $\%\Delta$ is used to signify percentage change, $\Phi(\cdot)$ is the cumulative normal distribution function, and $days_i$ is the number of days individual i fished in marine waters off the Kenai Peninsula in 1997. Confidence intervals around the separate estimates for Alaskan resident and nonresident participation-rate levels were generated following Krinsky and Robb (1986).

2.2. *Input-output model*

Input-output models have been widely used to evaluate the regional impacts of development projects and regulatory policy changes. Examples include assessments of the impacts of changes in National Forest harvest policies (Summers and Birss 1991), federal grazing policies (Geier and Holland 1991), community development strategies (Geier et al. 1994), and regulatory changes in management of commercial crab fisheries off Alaska (Natcher 1996) and guided sport fisheries off New England (Steinback 1999).

We selected IMPLAN (Olson and Lindall 1997) as a base for our model. IMPLAN includes a representation of 21 economic and demographic variables for each of 528 industrial sectors. We obtained zip-code area level IMPLAN data sets, the smallest geographical resolution available for coverage of the western Kenai Peninsula. In regions such as Alaska, with small numbers of firms (frequent disclosure problems), and a rapidly evolving and heavily resource dependent economy, it is particularly essential that the transaction coefficients be groundtruthed to the greatest extent practicable. Consequently, team members spent two weeks in the study region meeting with individuals, business owners, industry representatives, and local government officials for purposes of improving the original database. Zip-code area level corrections to the output and value added components for each of the

138 IMPLAN sectors active in the Kenai Peninsula region are detailed in Herrmann et al. (2001a).

Because recreational fishing is not explicitly represented in IMPLAN, we developed a programming module to disaggregate IMPLAN sectors that include recreation-based activities to highlight activities generated by recreational fishing (Hamel et al. 2001). This module utilizes IMPLAN generated response coefficients and secondary regional economic data as inputs in model formulation. The secondary model data is augmented with data for the target sectors (e.g., sport/charter industry) supplied from primary and secondary sources as well as discussions with industry representatives. Thus this module, through its input-output framework, explicitly accounts for linkages between various economic sectors, according to production and consumption patterns. Individual sportfishing activities are accounted for by expenditure patterns in retail and service sectors rather than treated as direct income generating activities such as guiding, harvesting, and processing. The recreational fishing module allocates recreational expenditures among these newly represented sectors. The sportfishing expenditure data were obtained from responses to the angler survey described above. The operating cost data required for modeling charter operations were derived through discussions with charter operators and industry representatives.

In contrast to manufacturing sectors, which are well represented in IMPLAN, retail sectors are highly aggregated. Because impacts associated with changes in sportfishing related expenditures are transacted primarily at the retail level, tracking them requires disaggregation of some of the IMPLAN sectors. While aggregating two or more IMPLAN sectors is straightforward, there are many consistent ways to disaggregate sectors. For example, while charter trip payments are included in IMPLAN's Amusement and Recreation Services sector, a catch-all designation for 106 types of recreational activities, it is not possible to know how to correctly adjust the vector of technical coefficients to isolate transactions specific to guided sportfishing without information describing the intermediate demand components associated with charters. Although it might be tempting to represent a newly constructed "Charter" sector with a vector of technical coefficients generated as a simple fraction of the Amusement and Recreation sector, doing so would render the technical coefficients matrix singular and preclude model solution. Moreover, a "Charter" sector production function derived as a linear combination of other sectors would bear little resemblance to the specific input requirements of the guided sport fishery.

Bushnell and Hyle (1985), Wolsky (1984), and Gillen and Guccione (1990) suggest approaches that directly modify the technical coefficients matrix. Steinback (1999) offers a straightforward yet data intensive solution by creating new sectors of interest within the IMPLAN framework, and reprogramming the model's social accounting matrices to reflect the characteristics of the disaggregated subsector. By including the new sector within the model, the changes are noted within the use (absorption), byproducts, and final demand matrices. Regional purchase coefficients and value-added features are similarly constructed for the new sector. Jensen (1997) addresses the disaggregation problem by running impact scenarios in IMPLAN to mimic the input requirements for the subsector of interest, thereby simulating the intermediate demands. Using IMPLAN's front end, a demand shock is executed with components (events) that mirror the proportions of the simulated sector's

Table 3. Parameters values for the estimated average production function for the marine charter sector

Expense category	Coefficient	Expense category	Coefficient	Value added category	Coefficient
Advertising	0.0410	Medical	0.0015	Employee comp	0.1147
Bait	0.0133	Office supplies	0.0135	Proprietor income	0.1949
Computer total	0.0066	Professional services	0.0098	OPTI	0.0339
Contract services	0.0035	Repair/maint/ tools/supplies	0.0130	Indirect bus tax (sales tax)	0.0306
Dues	0.0139	Subscriptions	0.0018		
Electronic supplies	0.0004	Total boat maintenance	0.0132		
Entertainment	0.0009	Total borough tax	0.0369		
Fed income tax	0.0416	Total insurance	0.0392		
Fuel & lubrication	0.1356	Total licenses	0.0243		
Gear replacement	0.0216	Total travel	0.0181		
Groceries	0.0008	Total truck exp	0.0178		
Hull repair	0.0054	Total utilities	0.0380		
Interest paid (boat)	0.0542	Trade shows	0.0214		
Moorage & boat storage	0.0182	Work gear/client supplies	0.0202		
Absorption coefficient			0.6259	Value Added Coefficient	0.3741

production function. The resulting impacts can then be used to calculate response coefficients (normal multipliers). However, because the new subsector is not explicitly defined in the IMPLAN framework, there is no opportunity for it to play a role in the intermediate demand of other sectors within the model, thus leading to possible underestimation of indirect and induced effects.

A model of the average charter operation's expenditure patterns was constructed using data reported in NPFMC (1997, 2000) as well as discussions with local experts and members of industry. Standard Industrial Classification (SIC) codes for the corresponding inputs were translated to the IMPLAN sectoral scheme and a production function was estimated for the 1997 charter sector sales value of $13.6 million, based on average per day charter fees and Alaska Department of Fish and Game estimates of charter client days (see Herrmann et al. 2001a). The SIC based coefficients were aggregated according to their corresponding IMPLAN sectors to provide an estimate of the average production function for the marine charter sector (Table 3). These technical coefficients were applied to the baseline charter sales data to obtain the coefficient values reported in Table 4. (For a more detailed accounting of the individual expense categories, corresponding SIC codes and translation to the IMPLAN sectoral scheme, see Herrmann et al. 2001a). Impact scenarios were run in IMPLAN to generate response coefficients for all other expenditure categories. These response coefficients and those developed for the charter operation sector were then integrated into the stand-alone recreational module (Herrmann et al. 2001a). Where data limitations prevented construction of

Table 4. Absorption sectors and coefficients for sportfishing expenditure categories

Expenditure category	IMPLAN sector #	IMPLAN sector name	Coefficient
Transportation, food & lodging			
Auto or truck fuel	451	Automotive dealers & service stations	1.00
Groceries	450	Food stores	0.75
	455	Miscellaneous retail	0.25
Lodging	463	Hotels and lodging places	1.00
Restaurant & bar	454	Eating & drinking	1.00
Fishing expenditures			
Boat fuel, lubricants & repairs	393	Boat building and repairing	0.10
	448	Building materials & gardening	0.05
	451	Automotive dealers & service stations	0.70
	455	Miscellaneous retail	0.10
	482	Miscellaneous repair shops	0.05
Charter & guide fees		Table 6	
Fish processing or packaging	98	Prepared fresh or frozen fish or seafood	1.00
Fishing derby entry fees	503	Business associations	1.00
Fishing gear	98	Prepared fresh or frozen fish or seafood	0.15
	421	Sporting and athletic goods, n.e.c.	0.05
	449	General merchandise stores	0.20
	455	Miscellaneous retail	0.50
Haul out & moorage fees	435	Motor freight transport and warehousing	0.10
	436	Water transportation	0.45
	451	Automotive dealers & service stations	0.10
	473	Equipment rental and leasing	0.15
	479	Automobile repair and services	0.20

original production functions, the model defaults to the values reported for input coefficients in Jensen (1997).

To be useful, impact models should be linked to a demand model for the activity in question. Although an accurately groundtruthed input-output model may correctly predict the regional impact of a given change in the number of sportfishing trips taken, that capability is of limited value in the absence of a companion model for predicting how the number of sportfishing trips varies as a function of observable or controllable trip attributes. That is, for an impact model to serve as a tool for evaluating the effects of management actions, fluctuations in resource abundance, or environmental damages, it is essential to know how those attributes affect participation rates. The relevancy of our impact simulations arises from the empirically (behaviorally) based model of participation decisions.

3. Simulations and software

Estimated baseline expenditures and effort were combined with the IMPLAN generated response coefficients and the participation rate model to form an integrated impact model as illustrated in Fig. 1. Designed as a stand-alone module,

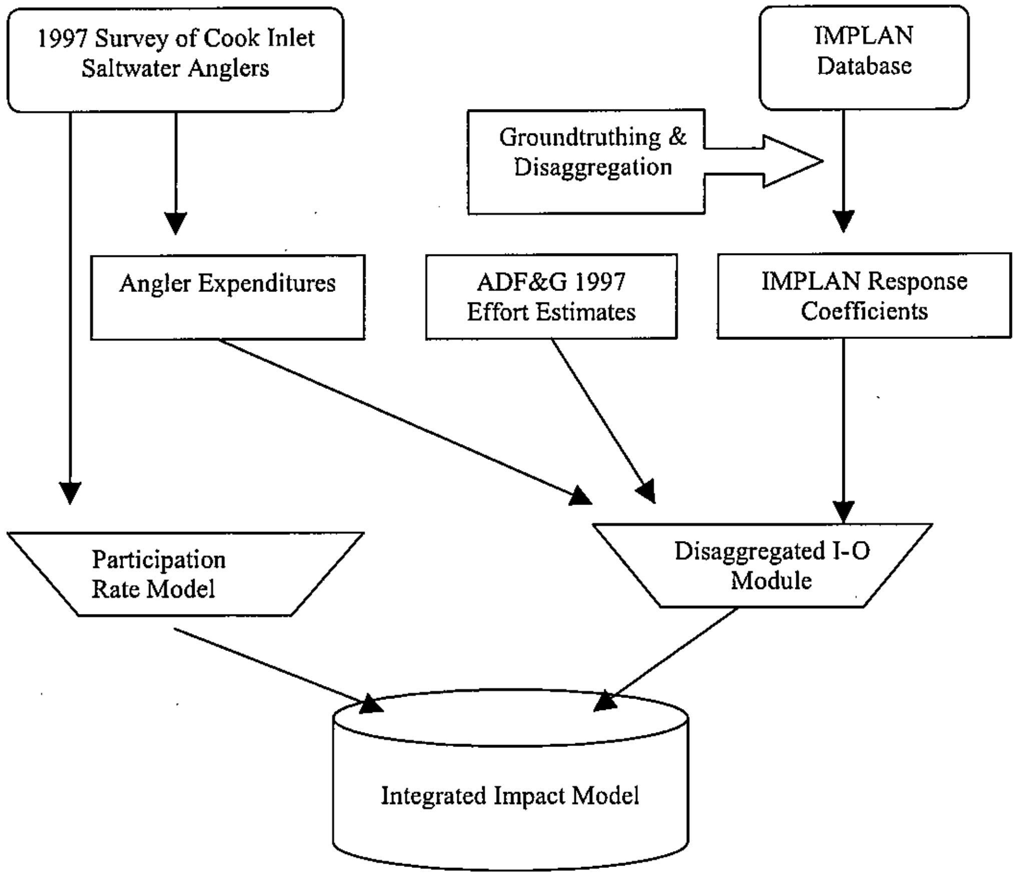

Fig. 1. Modeling components of the integrated impact model

the software (Hamel et al. 2001) provides a user friendly front-end for analysts to simulate the economic impacts of changes in angler spending to the western Kenai Peninsula. The impacts are expressed in terms of output (sales), income, employment, and other value added variables. Altered spending behavior is driven by changes in participation, which are determined by changes in trip attributes (e.g., fish catch and size, and trip cost). We apply the resulting percentage changes in effort, by residency and fishing mode, on a one-to-one basis to baseline angler-day expenditures that are directly attributable to sportfishing.

The simulations begin with the probability that the average angler will take a sportfishing trip, given a set of trip attributes. Regional economic impacts are measured in relation to a baseline of expenditures and vary as sport fishers respond to changes in fishing trip attributes. Each of the nine categories of sport fishers (nonresidents and local and non-local Alaskans engaged in charter or personal vessel and shore based fishing modes) is represented by a distinct expenditure pattern in the integrated model. We begin with the baseline of $28.5 million in total spending on the western Kenai (Table 1). This value can be regarded as a measure of the economic significance of the marine sport fishery in terms of sales, or output. However, this value includes spending by local residents. Because we assume that local residents freely substitute between sportfishing and other regional recreational activities, their expenditures need to be netted out. Subtracting the spending of Kenai Peninsula

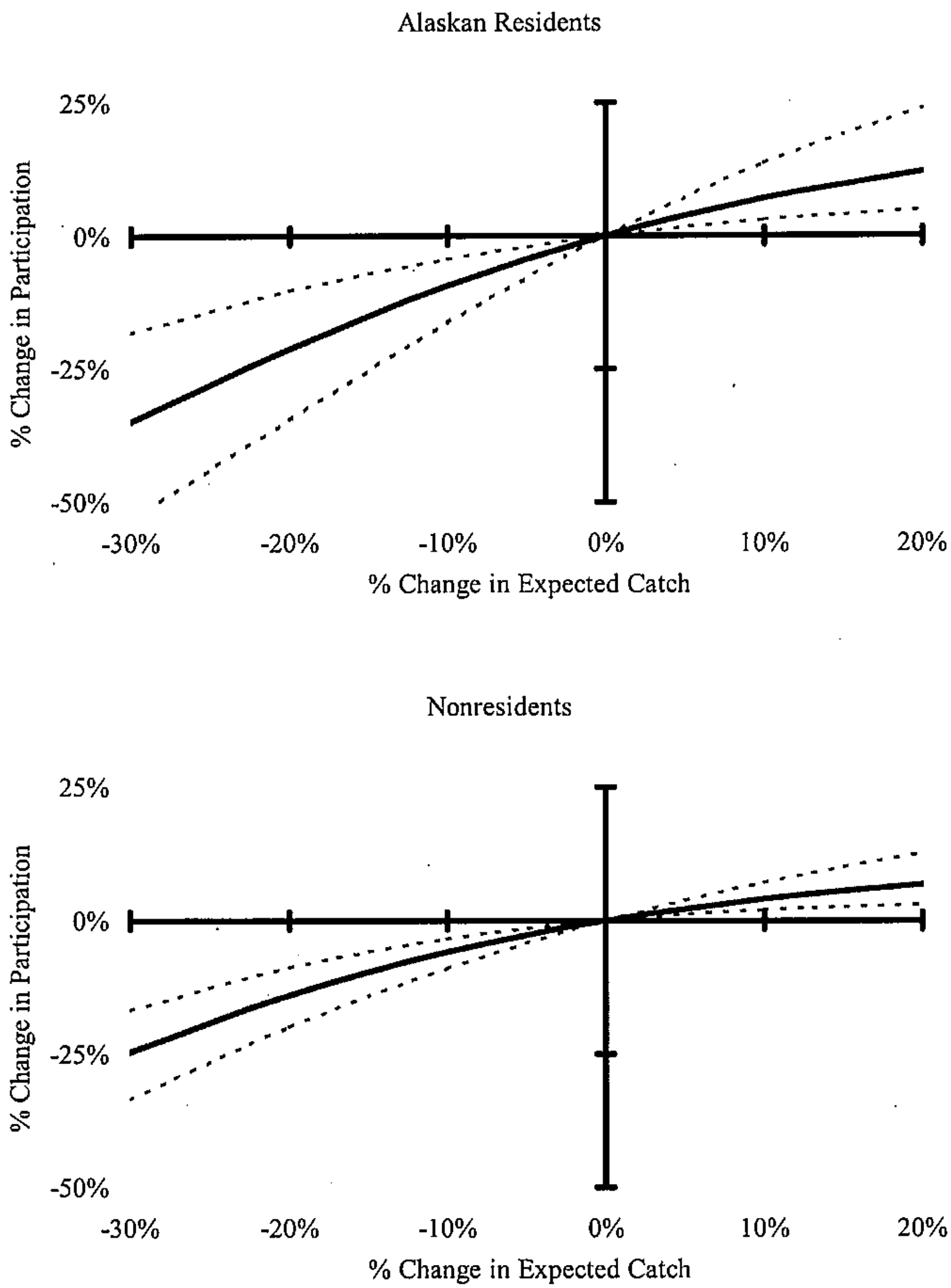

Fig. 2. Percentage changes in days fished by resident and nonresident anglers resulting from changes in the expected sportfishing catches. (90% confidence intervals are represented with *dotted* lines)

Borough residents from the total expenditures attributable to the Lower and Central Cook Inlet sport fisheries leaves $25 million of "new" money; money spent by non-local Alaskans and nonresidents. Fishing related and other expenditures amount to $15.3 million and $9.7 million, respectively.

Increases in the amount of new money spent locally stimulate economic activity whereas decreased spending by non-locals leads to a reduction in economic activity. Variations in spending by non-locals are driven by the

Table 5. Estimated regional economic impacts of changes in expected catch ($)

% Change in catch	% Change in participation	Change in angler expenditures	Change in output ($)	Change in personal income ($)	Change in employment (jobs)
−30%	−31.3%	−6,962,057	−10,062,164	−4,245,863	−292
−20%	−18.5%	−4,026,681	−5,819,726	−2,456,990	−168
−10%	−8.0%	−1,718,435	−2,483,646	−1,049,021	−72
0%	0.0%	0	0	0	0
+10%	+5.9%	1,225,825	1,771,687	748,812	51
+20%	+10.0%	2,068,612	2,989,775	1,263,986	86

changes in effort predicted by the participation rate model. For every percentage change in effort measured by reduced or increased sportfishing-days, there is a proportional change in daily expenditures across each of the residency and sportfishing mode categories. The changed expenditures are summed and multiplied by the response coefficients to generate estimates of the economic impact of regulatory or environmentally induced changes in fishing trip attributes. The impacts are calculated in terms of output, employment, employee earnings, proprietors' income, personal income, other income, indirect taxes, and value added for direct, indirect, and induced effects.

Figure 2 depicts the response of resident and nonresident demand for sportfishing to changes in expected catch levels. The associated regional impacts are reported in Table 5 and represented in Figures 3–6. For example, a 10% reduction in expected catch results in an 8% decrease in overall effort; the weighted average of a 9.3% decrease in resident effort and a 5.8% decrease in nonresident effort. The reduction in resident and nonresident trips results in a $1.7 million decrease in 'new' money spent, and lead to direct, indirect, and induced impacts of −$2.5 million in output, −$1.0 million in personal expenditures, and a net loss of 72 jobs. Note that the impact is nonlinear and that the marginal impact declines as catch increases. That is, there is a larger decline in expenditures and jobs when moving from a 20% decrease to a 30% decrease in expected catch than when moving from a 20% increase to a 10% increase. This result is consistent with the principle of declining marginal utility where utility, and therefore participation, increases at a decreasing rate with incremental changes in angler success.

The software module used to calculate changes in economic activity from hypothetical changes in expected trip attributes is described in Hamel et al. (2001). The model allows users to simulate changes in expected fish catch, size, and trip costs and to isolate these effects to the economic activities of specified fishery modes (charter, private, shore). Although the module was groundtruthed to 1997 values, it can be applied to more recent periods by incorporating updated effort data and using an inflation index. For example, in 1999 when the total fishing days on the lower Cook Inlet was 185,114 angler days, it is estimated that nominal expenditures of $23.5 million was spent in the region by non-local Alaskans and nonresidents ($14.1 million in fishing related expenses and $9.4 million in other expenses). However, these dollar estimates still hinge on 1997 survey data for individual expenses, as would all future estimates until a new survey is undertaken. Because the 1999 estimated expenditures are slightly lower than in 1997, the resulting effects of changes in expected catches are be slightly less.

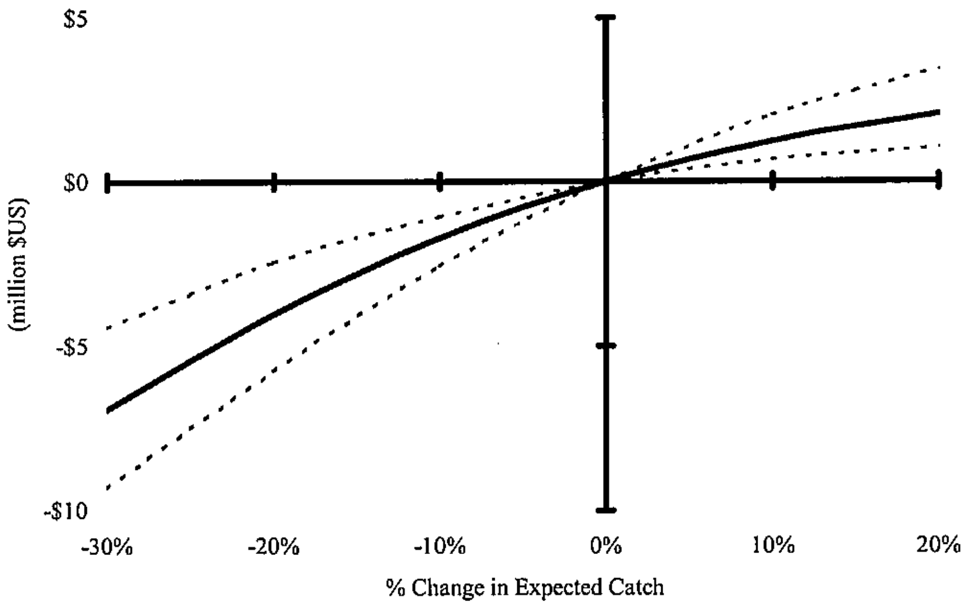

Fig. 3. Change in angler expenditures resulting from changes in the expected sportfishing catches. (90% confidence intervals are represented with *dotted* lines)

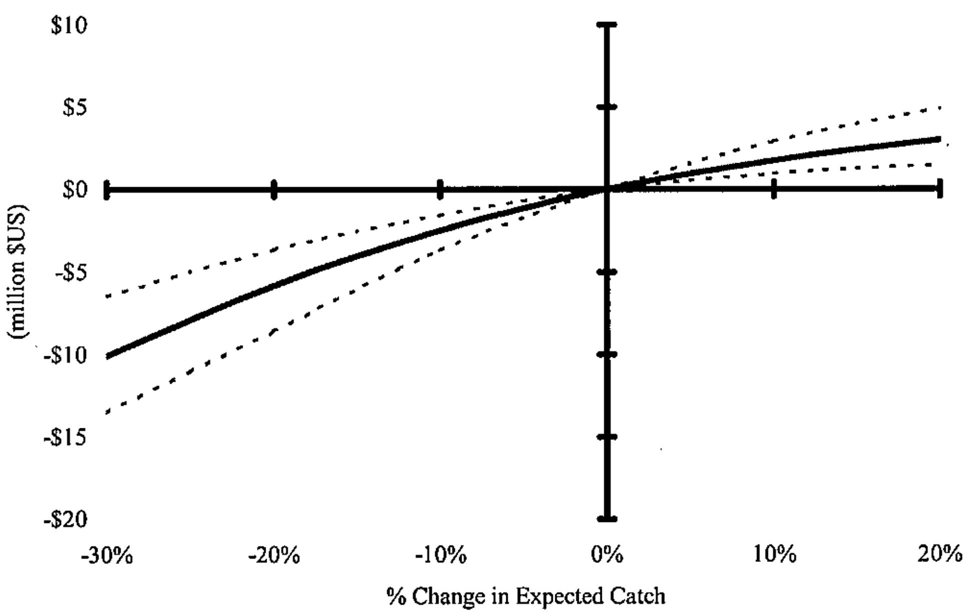

Fig. 4. Change in industry output resulting from changes in the expected sportfishing catches. (90% confidence intervals are represented with *dotted* lines)

4. Conclusions

The regional economic impact of recreational activities depends on the number of participants and their expenditure patterns. Variations in the number of participants arise from changes in the demand for recreational activity and are, in part, due to alterations in expected trip attributes. Consequently,

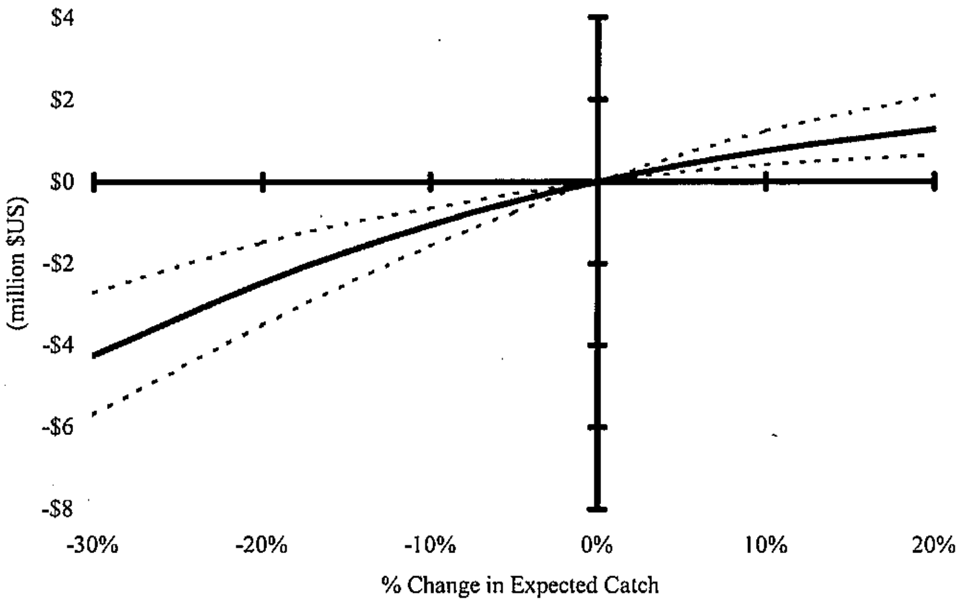

Fig. 5. Change in personal income resulting from changes in the expected sportfishing catches. (90% confidence intervals are represented with *dotted* lines)

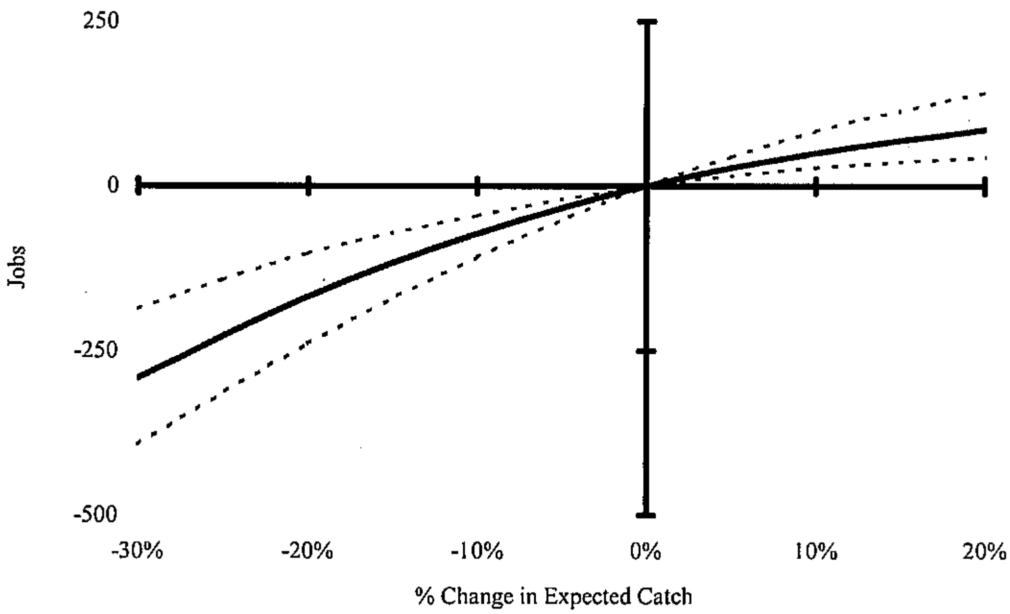

Fig. 6. Change in employment resulting from changes in the expected sportfishing catches. (90% confidence intervals are represented with *dotted* lines)

modifications of trip attributes alter the probability that the mean recreationist will take a given trip, change the expected number of participants, and affect regional economic activity. The advantage of formally linking a behaviorally based model of the demand for recreation with a regional economic model is that so doing allows a direct evaluation of the economic impact of predictable or controllable changes in trip attributes.

This approach is demonstrated in an application to the Lower and Central Cook Inlet saltwater sport fisheries for Pacific halibut and salmon. In the application, an econometric model of the determinants of individual participation decisions is linked to a simulation procedure to aggregate across individual decisions and estimate total sportfishing effort, and a regional input-output model that describes primary and secondary expenditure patterns. Altered spending behavior is driven by changes in participation, which are determined by changes in trip attributes (e.g., fish catch and size, and trip cost). The expenditures are summed and multiplied by the response coefficients to generate estimates of the economic impact of regulatory or environmentally induced changes in fishing trip attributes. The participation model is stochastic and allows for non-constant marginal utility; consequently primary and secondary impacts exhibit nonlinear responses to variations in trip attributes. In addition to being consistent with the theory of declining marginal utility, the nonlinear response of participation to changes in catch has practical relevance: a linear model would over-predict the increase in angler effort associated with an increase in catch or fish size and under-predict the reduction in angler effort that would result from a decrease in catch or fish size. Moreover, because the model is stochastic, confidence bounds can be estimated for changes in participation rates and associated changes in regional expenditures. The software module used to calculate changes in economic activity allows users to simulate changes in expected fish catch, size, and trip costs and to isolate these effects to the economic activities of specified fishery modes (charter, private, shore).

A baseline, reflecting the 1997 mean trip, is reported along with five sample levels of changes in expected catch rates. Such variations in catch could result from natural fluctuations in abundance, changes in allocation between commercial, subsistence, and sport fishers, changes in bag and possession limits, or environmental damage resulting from, for example, minerals exploration, development, production, or transportation activities.

In any large-scale economic study, there is a tradeoff between economic realism and cost in terms of money and time. This analysis is one of the most complex attempted for valuation of a sport fishery. However, every study is limited by explicit and implicit economic assumptions and data limitations. In this study, where there was plenty of theoretical work but very little precedence for applied analysis, much of the applied work was new territory. Looking back over the project some things worked out very well and others could have been improved. For the future, one area that needs further addressing is that in the participation model, when estimating the changes in the probability that individual fishers would take a trip, given varying trip attributes, it is assumed that the price of the trip will remain constant. In other words, we assume that supply was perfectly elastic. While this assumption is reasonable for shore and private trips, it is probably incorrect for charter trips. To the extent that charter trips make up a sizeable portion of sportfishing effort, and to the extent that charter trips do not exhibit perfectly elastic supply curves, there may be price adjustment especially in the short-run. For example, charter operators might respond to a short-run change in expected catches by lowering their prices and keeping their customer base rather than holding prices constant and losing customers as assumed in our model. While our assumption is valid in the long run, it may be less accurate in the short run.

References

Aas O (1995) Constraints on sportfishing and effect of management actions to increase participation rates in fishing. North American Journal of Fisheries Management 15:631–638

Alaska Department of Fish and Game (ADF&G) (1998) Harvest, catch, and participation in Alaska Sport fisheries during 1997. Alaska Department of Fish and Game, Division of Sport Fisheries, 333 Raspberry Road, Anchorage, AK, Fishery Data Series No. 9825

BenAkiva M, Lerman SR (1985) Discrete choice analysis: theory and applications to travel demand. MIT Press, Cambridge, MA

Bushnell RC, Hyle M (1985) Computerized models for assessing the economic impact of recreation and tourism. In: Probst DB (ed) Assessing the economic impacts of recreation and tourism. Southeastern Forest Experiment Station, Asheville, SC

Butler JS, Moffitt R (1982) A computationally efficient quadrature procedure for the one-factor multinomial probit model. Econometrica 50:761–765

Cohen MJ (1993) Economic aspects of technology accidents: an evaluation of the Exxon Valdez oil spill on Southcentral Alaska. Ph.D. dissertation, University of Pennsylvania

Coughenower DD (1986) Homer, Alaska guided sport fishing industry study. Marine Advisory Bulletin No. 22, Alaska Sea Grant College Program, University of Alaska, Fairbanks AK

Criddle KR (1994) Economics of resource use: a bioeconomic analysis of the Pacific halibut fishery. In: Proceedings of the Fourth International Symposium of the Conference of Asian and Pan-Pacific University Presidents, Alaska Sea Grant, Anchorage AK

Crutchfield JA, Zellner A (1962) Economic aspects of the Pacific halibut fishery. Fishery Industrial Research 1:1–173

Geier H, Holland D (1991) Economic aspects of federal livestock grazing policy: a regional economic analysis for the Okanogan-Ferry Area in Washington. Department of Agricultural Economics Staff Paper AE913, Washington State University, Pullman, WA

Geier H, Holland D, Schuster E (1994) Using IMPLAN to analyze small county economies for identification of development opportunities. United States Department of Agriculture, Forest Service Intermountain Research Station

Gillen WJ, Guccione A (1990) Disaggregating input-output models; an alternative to Wolsky's method. Economic Systems Research 2:39–42

Hamel C, Herrmann M, Lee ST, Criddle KR (2001) An economic assessment of Lower Cook Inlet sport fisheries: software program and manual. University of Alaska Fairbanks Coastal Marine Institute, Fairbanks, AK

Herrick Jr SF, Strand I, Squires D, Miller M, Lipton D, Walden J, Freese S (1994) Application of cost-benefit analysis to fisheries allocation decisions: the case of Alaska walleye pollock and Pacific cod. North American Journal of Fisheries Management 14:726–741

Herrmann M (1993) Using an international econometric model to forecast Alaska salmon revenues. Marine Resource Economics 8:249–271

Herrmann M (1994) The Alaska salmon fishery: an industry in economic turmoil. Journal of Aquatic Food Product Technology 3:5–22

Herrmann M (1996) Estimating the induced price increase for Canadian Pacific halibut with the introduction of the individual vessel quota program. Canadian Journal of Agricultural Economics 44:151–164

Herrmann M (2000) The individual vessel quota price induced effects for Canadian Pacific halibut: before and after Alaska IFQs. Canadian Journal of Agricultural Economics 48:195–209

Herrmann M, Greenberg JA (1994) A revenue analysis of the Alaska pink salmon fishery. North American Journal of Fisheries Management 14:537–549

Herrmann M, Lee ST, Hamel C, Criddle KR, Geier HT, Greenberg JA, Lewis CE (2001a) An economic assessment of the sport fisheries for halibut, chinook and coho salmon in Lower Cook Inlet: final report. University of Alaska Fairbanks Coastal Marine Institute, Fairbanks, AK

Herrmann M, Lee ST, Criddle KR, Hamel C (2001b) A survey of participants in the Lower and Central Cook Inlet halibut and salmon sport fisheries. Alaska Fishery Research Bulletin 8:107–117

Holland SM, Ditton RB (1992) Fishing trip satisfaction: a typology of anglers. North American Journal of Fisheries Management 12:28–33

Homans FR (1993) Modeling regulated open access resource use. Doctoral dissertation, University of California, Davis, CA

Jensen Consulting (1997) North Pacific Fishery Management Council recreational economic impact model. Reference manual for version 3.0

Jones and Stokes Associates Inc (1987) Southcentral sport fishing economic study. Alaska Department of Fish and Game, Division of Sport Fisheries, 333 Raspberry Road, Anchorage, AK

Krinsky I, Robb AL (1986) On approximating the statistical properties of elasticities. Review of Economics and Statistics 9:715–719

Lin B-H, Richards HS, Terry JM (1988) An analysis of the exvessel demand for Pacific halibut. Marine Resource Economics 4:305–314

Minerals Management Service (MMS) (1995) Final environmental impact statement for Cook Inlet planning area oil and gas lease sale 149. OCS/EIS/EA 95-0066, U.S. Minerals Management Service, Anchorage, AK

Natcher WC (1996) Economic Evaluation of superexclusive designation for the summer Norton Sound red king crab fishery. Masters Thesis, University of Alaska, Fairbanks, AK

National Research Council (NRC) Committee to Review Individual Fishing Quotas (1999) Sharing the fish: toward a national policy on individual fishing quotas. National Research Council, National Academy Press

North Pacific Fishery Management Council (NPFMC) (1991) Revised supplement to the draft supplemental environmental impact statement and regulatory impact review/initial regulatory flexibility analysis to the groundfish fishery management plans for the Gulf of Alaska and the Bering Sea/Aleutian Islands: longline and pot gear sablefish management in the Gulf of Alaska and the Bering Sea/Aleutian Islands. North Pacific Fishery Management Council, Anchorage, AK

North Pacific Fishery Management Council (NPFMC) (1997) Draft environmental assessment/ regulatory impact review/initial regulatory flexibility analysis for proposed regulatory amendments to implement management alternatives for the guided sport fishery for halibut off Alaska. North Pacific Fishery Management Council, Anchorage, AK

North Pacific Fishery Management Council (NPFMC) (2000) Draft environmental assessment/ regulatory impact review/initial regulatory flexibility analysis for a regulatory amendment to implement management measures under a guideline harvest level and/or moratorium for halibut in areas 2C and 3A. North Pacific Fishery Management Council, Anchorage, AK

Northern Economics (1990) Economic impacts of the S.S. Glacier Bay oil spill. U.S. Minerals Management Service, Alaska Outer Continental Shelf Region, Anchorage, AK

Olson D, Lindall S (1997) IMPLAN professional software, analysis, and data guide. Minnesota IMPLAN Group, Stillwater, MN

Steinback SR (1999) Regional economic impact assessments of recreational fisheries: an application of the IMPLAN modeling system to marine party and charter boat fishing in Maine. North American Journal of Fisheries Management 19:725–736

Summers P, Birss H (1991) Revitalizing the timber dependent regions of Washington: Report for the Washington Department of Trade and Economic Development. Northwest Policy Center, University of Washington Graduate School of Public Affairs, Seattle, WA

Thunberg E, Steinback SR, Gray G, Gautam A, Osborn M (1999) Summary report of methods and descriptive statistics for the 1994 Northeast Region marine recreational fishing participation survey. NOAA Technical Memorandum NMFSF/SPO39

Wolsky AM (1984) Disaggregating input-output models. The Review of Economics and Statistics 66:283–291

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Participation Decisions, Angler Welfare, and the Regional Economic Impact of Sportfishing

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Abstract *We link a stochastic binary choice model of individual decisions to participate in the marine sport fisheries in Cook Inlet, Alaska, with a simulation-based sample enumeration procedure for aggregating estimates of individual angler welfare and a regionally adjusted zip code-level input-output model of regional economic activity. The result is a behaviorally based model for predicting changes in angler welfare and regional economic activity occasioned by changes in the demand for sportfishing that arise from changes in trip costs or the expected number, size, or mix of species caught. The advantages of this approach are that: changes in angler participation are determined by variables that are observable, predictable, or subject to management control; participation reflects declining marginal utility, and substitution and complementary effects across trip attributes; estimates of changes in aggregate angler welfare and changes in regional economic impacts are derived from changes in individual participation probabilities.*

Key words Recreational demand, angler welfare, regional economic impacts.

JEL Classification Codes Q22, Q26, R12, C25, C67.

Introduction

The marine sport fisheries of Lower and Central Cook Inlet, Alaska, support a large, recreation-based economic sector that provides non-pecuniary benefits to participants and income and net revenues to residents and businesses of the Kenai

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Peninsula region. Although the primary focus of this analysis is the fishery for Pacific halibut (*Hippoglossus stenolepis*), the region's most important saltwater sports fishery, the marine sport fisheries for chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon are treated as potential substitutes and complements. These fisheries are subject to intrinsic and fishery-induced variations in abundance and are managed under overlapping and evolving combinations of state and federal regulations and international agreements that affect the magnitude and allocation of sustainable harvests across commercial, subsistence, and recreational fisheries.

Pacific halibut are managed under the aegis of the Halibut Convention of 1923, an international treaty between the US and Canada. Under this agreement, the International Pacific Halibut Commission (IPHC) is responsible for establishing area-specific limits on the total direct and incidental harvest of Pacific halibut. The constant exploitation yield (CEY) management strategy used by the IPHC can be motivated as a strategy that maximizes the expected sustainable yield of halibut. Authority to apportion the CEY among competing commercial, sport, and subsistence interests is delegated to the individual nations. Allocations of the halibut CEY off Alaska are set by the US Secretary of Commerce based on recommendations of the North Pacific Fishery Management Council (Council).

Several current and potential policy issues highlight the importance of modeling changes in aggregate angler welfare and changes in regional economic impacts associated with recreational fisheries. For example, the *SS Glacier Bay* and *SS Exxon Valdez* oil spills occasioned a need for assessment of damages to commercial and recreational fisheries (Northern Economics 1990; Cohen 1993). Similarly, leasing of outer continental shelf minerals exploration and development rights requires an economic impact analysis that describes the likelihood that an oil spill could occur and how a spill would affect commercial and recreational catches, welfare, and regional economic activity (Herrmann, Lee, Hamel, and Criddle 2001). Another example is the allocation of catches between user groups. Historically, the Council has specified a commercial total allowable catch (TAC) for Pacific halibut as the regionally apportioned CEY less a bycatch allowance and expected non-commercial (sport and subsistence) catches. As the share of halibut caught by sport fishers has increased, commercial fishers have lobbied the Council to take actions to limit erosion of the commercial TAC. Growth of halibut sportfishing catches has been particularly pronounced in the Central Gulf of Alaska Region (Prince William Sound, Resurrection Bay, Kodiak, Yakutat, and especially Cook Inlet and adjacent portions of the Gulf of Alaska), where landings have increased from less than 2% of the CEY in the late 1970s to over 18% of the CEY before the end of the 1990s. During the same period, the number of Alaska resident sportfishing licenses sold increased 41% (from about 122,000 to 172,000 per year) and nonresident license sales increased 480% (from about 56,000 to 269,000 per year). In response to the increasingly acrimonious allocation conflicts between commercial and sport interests, the Council recently approved a guideline harvest level (GHL)—a flexible cap for charterboat-based sportfishing catches of halibut. The initial GHL was set equal to the 1995–99 average catch with provisions for adjustments in response to changes in halibut biomass (NPFMC 2000). Under the GHL, expected subsistence harvests and expected harvests by sport fishers who do not hire charterboat services continue to be deducted from the CEY and thus from the commercial TAC. If approved by the Secretary of Commerce, the GHL will be implemented in 2003. The GHL is regarded as a stopgap measure because there is little confidence that traditional sport fishery management measures can hold catches to no more than the GHL. To address these concerns, the Council approved the establishment of an individual fishing quota (IFQ) program for charter-based sportfishing catches of halibut (NPFMC 2001). Under the IFQ program, voluntary market transactions will allocate halibut within the charterboat sector and between commercial and charter operations. Subject to approval by the Secretary of Commerce, the charter IFQ program will replace the GHL. Cost-benefit analyses of these policy alternatives require an understanding of how the alternatives would affect angler participation rates, angler welfare, and regional economic activity.

There are two components to a comprehensive evaluation of the economics of marine sportfishing: estimation of the net benefits that accrue to sport fishers and assessment of the economic impact generated by marine sportfishing. We use a binary choice model of individual participation decisions to derive estimates of angler welfare and a regionally adjusted input-output model to estimate regional economic impacts.

The two most widely applied models for binary choice panel data are the fixed effects model (Chamberlain 1982) and the random effects model (Butler and Moffitt 1982). The fixed effects model accounts for heterogeneity by allowing individual-specific parametric shifts in the response function; thus it is appropriate for forecasting responses for those particular individuals. In contrast, the random effects model assumes that each individual's responses are correlated. Consequently, the random effects framework is more appropriate when the data are a random sample of individuals from a larger population of interest (Maddala 1987; Greene 1997). Moreover, the random effects model allows inclusion of variables that do not vary across trips (*e.g.*, socioeconomic variables), while the fixed effect model does not. A Monte Carlo experiment by Guilkey and Murphy (1993) has shown that use of the standard binomial probit model in cases where there is a random effect can bias the estimates of the parameters' standard errors. We use a random effects probit model of individual participation decisions and a Monte Carlo-based aggregation procedure to estimate changes in angler welfare conditioned on changes in sportfishing trip attributes. Many marine sport fishers contract with private charter operators for guide services. However, because the number of charter service providers is large and the barriers to entry are small, we assume that the charter sector can be characterized as perfectly competitive; thus charter operators earn normal profits. The economic impact of expenditures by anglers and charter operators is represented in a regional input-output model of the Kenai Peninsula region. We use a simulation model that links the participation rate, angler welfare, and regional economic impact models to estimate the changes in regional economic activity occasioned by environmental or regulatory changes.

Development of our model and presentation of the results is organized in three sections. We begin with a description of the data used to estimate model coefficients. In the second section, we describe the model framework and baseline parameter estimates. The third section integrates the participation-rate, angler welfare, and regional impact models in a set of simulations for various halibut catch levels and trip costs.

Description of Data

Three data sources were used to support our analyses: voluntary responses to two postal surveys and onsite interviews with Kenai Peninsula region local government officials and business community members.

UAF Angler Survey

The University of Alaska Fairbanks (UAF) angler survey (Lee *et al.* 1998; Herrmann, Lee, Criddle, and Hamel 2001) was developed and administered following Dillman's Total Design Method (Dillman 1978). An initial draft of the survey was administered to a small sample of anglers intercepted in the cities of Homer and

Seward, Alaska. Respondent comments were used to guide the development of a revised draft survey which was pre-tested using verbal protocol analysis (Ericsson and Simon 1993)—one-on-one interviews of randomly selected potential survey recipients from Fairbanks and Anchorage. These interviews provided an opportunity to study angler attitudes and vocabulary, their decision-making processes, and their ability to answer the survey questions. Information from all pre-testing stages was used to improve the content and clarity of the survey instrument, questions, format, cover design, and cover letters. The survey was mailed to 4,000 anglers randomly drawn from a list of individuals who purchased an Alaskan sportfishing license in 1997. The initial survey mailing was followed by a reminder card. Non-respondents were sent a second copy of the survey 14 days after the initial survey mailing. The first two survey mailings and the reminder card were sent by first class mail. A third survey was sent by certified mail to those who did not respond within 14 days after the second survey mailing. All survey mailings included a cover letter motivating the survey and a prize entry card to increase the response rate. Survey recipients were informed that by returning the prize entry card, they would be entered into a drawing for their choice of either a one-day halibut sportfishing trip aboard a charter vessel based in Homer, Alaska, or $150. The cover letter noted that three prizes would be awarded based on a random drawing from the entry cards returned.[1] The overall response rate was 70.1% on the 3,767 delivered surveys. Of the 2,641 respondents, 352 took at least one salmon or halibut sportfishing trip in marine waters off the Kenai Peninsula during 1997.

Responses to the UAF angler survey provided baseline demographic information (household after tax income, household size, and respondent gender, age, and education level), information about expenditures incurred and attributes of recent sportfishing trips taken in Lower or Central Cook Inlet, and angler preferences regarding hypothetical trips. Information on expenditures included transportation (*e.g.*, vehicle rental fees, vehicle fuel expenditures, and airfare), food and lodging (*e.g.* grocery purchases, restaurant and bar expenses, hotel/motel room rentals, vacation rentals, campground fees, other lodging), and fishing expenditures (*e.g.*, guide and charter fees and tips, fishing gear purchased specifically for the trip, fish processing and packaging fees, fishing derby entry fees, boat fuel and lubricants, and moorage and haulout fees). Survey responses were used to develop the individual-level participation rate model and to parameterize a regional economic model.

Nonresidents spent an average of $294.21 per charter-based sportfishing day: $103.87 in transportation and living expenses and $190.34 in fishing expenses. Nonresident fishing expenditures were dominated by charter fees ($140.75) and fish handling/processing charges ($32.72). Alaska residents from outside the Kenai Peninsula Borough spent an average of $204.91 per charter-based sportfishing day. Locals (Kenai Peninsula Borough residents) averaged $167.47 in fishing expenditures per day of charter-based fishing. The average cost-per-day for charter-based sportfishing trips was 64% higher than the average for trips taken on private vessels. Overall angling effort was distributed: 40% charter; 46% private vessel; and 14% from shore. While charter-based effort accounted for only 25% of the angling effort by Alaskans, it accounted for 59% of the angling effort by nonresidents. When aggregated across charter vessel, private vessel, and shore-based fishing modes, the average saltwater fishing trip yielded catches of 1.71 halibut for Alaskans and 2.43 halibut for nonresidents. Anglers who participated in dedicated halibut charters averaged catches of 3.51 fish per angler-day. Most survey respondents who took a saltwater sport fishing trip to the Cook Inlet region during 1997 took only one trip.

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[1] All three prize winners selected the cash award.

ADF&F Angler Survey

The annual Alaska Department of Fish and Game (ADF&G) angler survey was sent to 22,000 individuals in 1997 and yielded a response rate of 45.8% on delivered surveys after three mailings (Howe *et al.* 1998). Sportfishing effort in Lower and Central Cook Inlet during 1997 was estimated to total 197,556 angler-days. Participation by nonresidents accounted for 44% of total days fished (86,970 angler-days). In the more expensive charter fishery, nonresidents comprised 65% of the total charter effort, while comprising just 28% and 37% of the private vessel and shoreline fishing days, respectively. A Monte Carlo simulation procedure was used to combine the participation rate model and effort estimates from the ADF&G survey to form estimates of total angler participation and net benefits.

Onsite Interviews

Responses to the UAF angler survey were combined with State and Borough employment and earnings data and information gathered through onsite interviews with local government officials and business leaders. It was then used to update and groundtruth the technical coefficients of a regional input-output model of the Kenai Peninsula economy and to disaggregate the sportfishing sector (Herrmann, Lee, Hamel, and Criddle 2001; Herrmann, Lee, Criddle, and Hamel 2001).

Because marine sportfishing was not the sole or primary motivation for trips taken by some survey respondents, it would have been inappropriate to attribute all of the trip expenses to the existence of marine sportfishing opportunities.[2] Expenditure estimates were, therefore, adjusted downwards using data on trip purpose from the survey (see Herrmann, Lee, Criddle, and Hamel 2001). The total spending directly attributable to the fishing component of trips taken in 1997 (*i.e.*, money that would not have been spent if the fishing component were cancelled) was estimated at $34.1 million, $28.5 million of which was spent on the Kenai. Because we assumed that local residents would substitute spending on other regional recreational activities (*e.g.*, freshwater sportfishing or marine sportfishing in Prince William Sound) for foregone marine sportfishing expenditures, their expenditures ($3.5 million) were also deducted. The $25.0 million remainder reflects an estimate of the infusion of spending on the Kenai Peninsula that would not have occurred in the absence of marine sportfishing opportunities in Lower and Central Cook Inlet (table 1). The adjusted 1997 expenditure data were used as a baseline in the regional economic model.

Model Framework and Baseline Estimates

Individual Participation Decisions

Changes in trip costs, expected catch rates, fishery regulations, and environmental quality affect the expected net benefit associated with sportfishing, and therefore the decision to participate in (take) a sportfishing trip. Previous studies (*e.g.*, Holland and Ditton 1992, Aas 1995, Thunberg *et al.* 1999) have used variation in demo-

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[2] While the unadjusted values may be a better predictor of the level of expenditures attributable to the mix of participants in the fishery in a typical year, only expenditures by those whose trip destination decision was influenced by the existence of marine fishing opportunities can be viewed as being contingent on the existence and attributes of the marine sport fisheries.

Table 1
Kenai Peninsula Area Expenditures by Alaskans (Non-local) and Nonresidents that can be Directly Attributed to Lower and Central Cook Inlet Halibut or Salmon Sportfishing Trips

	Expenditures ($ million)	
	Fishing Expenditures	Other Expenditures
Auto fuel		2.208
Auto/RV rentals		0
Lodge		3.061
Groceries		2.443
Restaurant & bar		1.997
Charter	9.518	
Gear	1.659	
Processing	2.202	
Derby	0.171	
Boat fuel	1.279	
Haul/moorage	0.433	
Total	15.263	9.710

graphic characteristics to explain changes in the demand for recreational fishing. While such models may provide useful descriptions of past participation decisions, they are not useful for predicting future participation rates because the resulting forecasts are conditional on uncertain conjectures about demographic change. That is, such models shift the focus from forecasting changes in participation to predicting demographic change and are not suitable for predicting changes in the demand for recreational fishing that might arise in response to changes in trip costs, fishing conditions, or management actions. Our approach avoids these problems by focusing on explanatory variables that are predictable or subject to management control. For example, total catch levels are a management choice subject to population dynamics that are well characterized for halibut and conditionally predictable for salmon. In addition to being constrained by overall catch limits, catch levels are subject to management actions related to season length, bag, possession, and catch-and-release regulations. Similarly, charter trip costs are subject to management influence through the erection of barriers to entry (license limitation) and the direct effect of permit and license prices. Consequently, our model is better suited for policy evaluation and forecasting participation rate responses to changes in trip costs and catch rates.

In the UAF survey, respondents were presented a set of hypothetical fishing trips and asked to identify which trips they would take. Each hypothetical trip was described in terms of one of three cost levels ($100, $170, or $240 per day), one of four halibut keep and release levels (0, 2, 4, or 6 fish per trip), one of four average halibut weights (0, 20, 40, or 80 lbs. per fish), one of three chinook catch levels (0, 1, or 2 fish per trip), one of four average chinook weights (0, 15, 25, or 50 lbs. per fish), one of four coho catch levels (0, 2, 4, or 6 fish per trip), and one of two average coho weights (0 or 7 lbs. per fish). Attributes of the hypothetical trips were derived from historical mean catch and average weight data and pretest discussions with recreational fishers. The cost per day was identified as the sum of sportfishing related costs, such as tackle and bait purchased specifically for the trip, charter/guide fees, and trip specific transportation costs such as auto and boat fuel. For consistency, average catch (weight) was set to zero whenever average weight (catch) was zero. In order to estimate an indirect utility function that includes the main effects and all relevant two-way interactions, 27 trips were selected and assigned to nine distinct three-trip blocks. The 27 trips and their nine blocks were simultaneously selected based on a criterion that maximized the determinant of the information matrix. The resulting parsimonious experimental design allows for the efficient identification of substitution and complementary effects across attributes, and for the possibility of nonlinear marginal utility. While these types of effects are predicted in economic theory, they are seldom identified in empirical studies of actual trips because attributes are often highly collinear or lack sufficient variation. Each of the 4,000 survey recipients was randomly assigned one of the nine blocks of three hypothetical trips.

The participation decision was modeled as a nonlinear random utility function. The utility that individual i derives from trip t is given by:

$$u_{it} = f(x_{it}, z_i, \beta, \gamma) + e_{it},$$

where the vector, x_{it}, describes the attributes of the t-th trip taken by the i-th individual; socioeconomic and demographic variables for each individual are included in the vector z_i; β and γ are vectors of parameters associated with the fishing trip attributes and socioeconomic variables, respectively; and the errors, e_{it}, are normally distributed with an expected value of zero.

Respondents were asked whether they would take a trip, described by attributes x_{it}. Those who would take the trip obtain a utility level of u_{it}. Those who would not take the trip receive:

$$u_{i0} = f(0, z_i, \beta, \gamma) + e_{i0},$$

the utility level associated with not taking the trip, which is also the opportunity cost of taking the trip. Since the actual levels of utility are unobservable, the model is made operational by specifying a binary indicator y^* that denotes which choice was made; that is, $y^*_{it} = 1$ if the respondent would take trip and $y^*_{it} = 0$ otherwise. Assuming that individuals make rational choices, $y^*_{it} = 1$ implies that the expected utility of taking the trip is greater than the expected utility of not taking the trip; that is, $E(u_{it} \geq u_{i0})$. Conversely, $y^*_{it} = 0$ implies that $E(u_{it} < u_{i0})$.

We specified the random utility model as:

$$y^*_{it} = \alpha_0 + \alpha_1 P_t + w_t^T B w_t + n_t^T \Lambda n_t + z_i^T \Gamma \tag{1}$$

$$= \alpha_0 + \alpha_1 P_t + \begin{bmatrix} w_t^h \\ w_t^{ch} \\ w_t^{co} \\ \hline 0 \end{bmatrix}^T \left[\begin{array}{c|ccc} \beta_{11} & \beta_{12} & 0 & 0 \\ \beta_{21} & \beta_{22} & \beta_{23} & 0 \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \hline 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} 1 \\ \hline w_t^h \\ w_t^{ch} \\ w_t^{co} \end{bmatrix}$$

$$+ \begin{bmatrix} n_t^h \\ 0 \\ 0 \\ \hline 0 \end{bmatrix}^T \left[\begin{array}{c|ccc} \lambda_{11} & \lambda_{12} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 \end{array}\right] \begin{bmatrix} 1 \\ \hline n_t^h \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} sex_i \\ age_i \\ edu_i \end{bmatrix}^T \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \end{bmatrix}$$

where the binary variable y_{it}^{*} was assigned a value of 1 when survey respondent i indicated a willingness to take trip t, and 0 otherwise. The variables P_t, n_t^s, and w_t^s are hypothetical attributes that denote the cost-per-day of taking trip t and the number and total weight (a product of the number of fish caught and average weight per fish) of species s caught on trip t, where halibut, chinook, and coho are denoted by the superscripts h, ch, and co, respectively. The variables sex_i, age_i, and edu_i are the gender, age, and education level reported by individual i. The superscript T is used to denote matrix transposition.

The data and coefficient matrices are partitioned to emphasize components responsible for linear and quadratic factors and to highlight the exclusion restrictions. Because the plausible catches for chinook were 0, 1, or 2 fish, the data lacked sufficient variation to estimate the linear, quadratic, and interaction terms that we considered to be important. The weight variable was not subject to this limitation because the hypothetical trips included total catch weights of 0, 15, 25, 30, 50, and 100 lbs. of chinook, enough variability to support the estimation of all of the linear and nonlinear direct and interaction terms of interest. Although we had ample variation in coho catches (0, 2, 4, 6), the invariance in coho weight (7 lbs. per fish for all hypothetical trips where coho were caught) would have caused the information matrix to be singular if we had included data representing both the weight and number of coho caught. We chose to exclude coho numbers in order to be able to estimate an interaction between coho and chinook, an interaction that focus groups suggested could be important. That is, because we lacked sufficient variation to specify a full set of interactions in Β and Λ, we chose a full specification for Β and a restricted specification for Λ.

The coefficient matrices α, Β, Λ, and Γ, and a random effects parameter, ρ, were estimated simultaneously for resident and nonresident respondents using a random effects probit procedure. To ensure that the participation decisions were grounded in recent experience, coefficient estimation was based on the 352 surveys returned by respondents who took at least one salmon or halibut sportfishing trip in marine waters off the Kenai Peninsula during 1997. Each respondent answered questions regarding three different hypothetical trips, yielding a total of 1,056 observations.

Coefficient estimates are reported in table 2. The random effect parameter, ρ, is statistically different from zero at the 99% level, confirming the presence of a random effect. The point estimates of the parameters accord well with economic theory: the price coefficient is negative; the coefficients on total halibut, chinook salmon, and coho salmon weights and halibut catches are positive; coefficients on the quadratic terms and cross products are negative, implying that recreational fishers experience decreasing marginal utility and that catches of each species are substitutes for catches of the others; and the probability of taking a trip increases as a function of income, age, and education, and is higher for males. With exception of the coefficient on squared halibut weight in the nonresident equation and the coefficient on squared coho weight in the Alaskan resident equation, all coefficients on price and linear, nonlinear, and cross-product terms for catch weight and numbers were significantly different from zero at the 5% level (table 2). Resident gender and nonresident education level were the only socioeconomic variables found to be statistically significant. Overall model performance was good: the log likelihood at convergence was –542.503 and –731.047 when the parameters were set to zero, and R^2 was 0.442.[3]

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[3] The log-likelihood at convergence is the value of the log-likelihood function evaluated at the parameter values we report. These are the parameter values that maximize the log-likelihood function and were found by using a numerical optimization algorithm. Our estimate of R^2 follows Veall and Zimmermann (1996):

$$R^2 = \frac{(LL_m - LL_0)}{(LL_m - LL_0 + N)} \Big/ \frac{-2\ LL_0}{(N - 2\ LL_0)},$$

where LL_m is the value of the log-likelihood function from the model, LL_0 is the value of the log-likelihood function with all of the slope coefficients set at zero, and N is the total number of observations.

Table 2
Random Effects Probit Model Parameter Estimates

	Alaskans (local and non-local)		Nonresidents	
	Estimates	t-ratios	Estimates	t-ratios
Intercept	−2.7965	−3.01	−1.4818	−1.94
Price	−0.0124	−7.59*	−0.0094	−6.98*
Total weight of halibut	0.0373	3.28*	0.0229	2.54*
Total weight of chinook	0.1038	4.35*	0.0734	3.62*
Total weight of coho	0.1263	3.02*	0.1165	3.20*
Squared halibut weight	−0.0001	−2.91*	−0.0001	−1.34
Squared chinook weight	−0.0006	−3.44*	−0.0004	−2.59*
Squared coho weight	−0.0008	−1.18	−0.0011	−1.82*
Product of total weight of halibut and coho caught	−0.0005	−3.55*	−0.0004	−3.22*
Product of total weight of halibut and chinook caught	−0.0007	−2.92*	−0.0005	−2.41*
Product of total weight of chinook and coho caught	−0.0018	−3.62*	−0.0010	−2.30*
Number of halibut caught	1.1228	2.11*	0.9263	2.36*
Squared number of halibut caught	−0.1513	−2.25*	−0.1300	−2.56*
Gender (1=male)	0.4048	2.17*	0.0970	0.59
Age	0.0103	1.44	0.0003	0.05
Education (1=college graduate)	0.3394	1.79	0.3839	2.50*
ρ	0.1942	2.82*	0.1942	2.82*

* Significantly greater (less) than zero at $p \leq 0.05$ for one-sided tests on all variables except the socio-economic variables where two-sided tests were performed.

Although changes in resource abundance that arise from stock dynamics or changes in environmental conditions are not explicitly represented in the participation model, such changes affect the average weight and number of fish caught in the sport fishery, trip attributes that are explicitly represented in our model. This linkage is implicit in ADF&G's escapement-based management strategy for salmon and is explicit in the CEY management strategy for halibut. Although the management agencies (ADF&G for salmon and NPFMC for halibut) are not required to distribute changes in the salmon guideline harvest level or halibut CEY proportionally among commercial, sport, and other fisheries, the history of management actions in the salmon fishery is consistent with this assumption. In addition, subject to approval of the Secretary of Commerce, recent Council action (NPFMC 2001) explicitly specifies a proportionality principle for accommodation of changes in the halibut CEY.

Total Demand and Angler Welfare

The conditional individual participation probabilities were aggregated into estimates of total demand using a simulation-based sample enumeration method that takes into account differences in demographic characteristics and variability in the number of days fished per year. The sample enumeration method, described in BenAkiva and Lerman (1985), takes into account differences in socioeconomic characteristics and variability in the number of days fished per year by developing forecasts for each individual in the sample. We use this information to weight the simulations by the number of days fished. The simulation provides separate results for Alaskan residents and nonresidents. The general formula for all forecasts is:

$$\%\Delta Y = \frac{\sum_{i=1}^{n} \Phi(\hat{u}_{i,1})\, days_i - \sum_{i=1}^{n} \Phi(\hat{u}_{i,0})\, days_i}{\sum_{i=1}^{n} \Phi(\hat{u}_{i,0})\, days_i}, \tag{2}$$

where $\%\Delta Y$ is the percentage change in total participation occasioned by a change in trip attributes. The indirect utility that individual i derives from a trip with baseline attributes is denoted $\hat{u}_{i,0}$. In contrast, $\hat{u}_{i,1}$ denotes the indirect utility obtained from a fishing trip with attribute levels that reflect an α percent change from the baseline levels. The number of days fished by individual i in marine waters off the Kenai Peninsula during 1997 is represented by $days_i$. The notation $\Phi(\cdot)$ represents the cumulative normal distribution function. Because point estimates of percentage changes in the number of angler-days are highly nonlinear, confidence intervals were based on 10,000 draws of a Monte Carlo procedure described in Krinsky and Robb (1986).

Following Hanemann (1999), conditional estimates of angler welfare were calculated from the estimated participation rate model as the product of the weighted average compensating variation[4] per trip taken and the total number of angler-days spent fishing for salmon and halibut in Lower or Central Cook Inlet. The expected maximum utility that individual i derives from trip j can be represented by $M_{i,j} = E[\max(u_{i,1}, u_{i,0})]$, where $u_{i,1} = v_{i,1} + e_{i,1}$ denotes the utility received from taking a fishing trip and $u_{i,0} = v_{i,0} + e_{i,0}$ denotes the utility received from not taking a fishing trip. The economic welfare associated with the choice is $cv_{i,j} = -M_{i,j}/\pi_p$, where $cv_{i,j}$ is the compensating variation that individual i derives from trip j with corresponding attributes, and π_p is the marginal utility of income and is equal to the coefficient estimate on the price (cost of trip) variable. Since the marginal utility of income is held constant in our model, this welfare measure is also the equivalent variation welfare measure.

The value of $M_{i,j}$ can be calculated from the probability density function:

$$M_{i,j} = \int_{-\infty}^{+\infty}\int_{-\infty}^{v_0+e_0-v_1} (v_{i,0} + e_{i,0})\phi(e_{i,0},e_{i,1})\partial e_{i,1}\partial e_{i,0} + \int_{-\infty}^{+\infty}\int_{-\infty}^{v_1+e_1-v_0} (v_{i,1} + e_{i,1})\phi(e_{i,0},e_{i,1})\partial e_{i,0}\partial e_{i,1},$$

where $\phi(\cdot)$ is the bivariate normal probability density function. If the utility of not taking a trip is normalized such that $u_{i,0} = 0$, then a trip will only be taken when $v_{i,1} + e_{i,1} \geq 0$, and M simplifies to:

$$M = \int_{-v_1}^{+\infty} (v_{i,1} + e_{i,1})\phi(e_{i,1})\partial e_{i,1} = v_{i,1}\Phi(v_{i,1}) + \phi(v_{i,1}).$$

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[4] Compensating variation is a measure of net benefit to consumers. It can be motivated as an additional cost that, if added to the cost of a particular sportfishing trip, would leave the sport fisher indifferent between taking and not taking the trip.

The estimated weighted average compensating variation across all individuals for trip *j* with corresponding attributes is:

$$\hat{cv}_j = \frac{\sum_{i=1}^{n}\left[\hat{cv}_{ij}\ days_{ij}\Phi(\hat{u}_{ij})\right]}{\sum_{i=1}^{n}\left[days_{ij}\Phi(\hat{u}_{ij})\right]}, \tag{3}$$

where $days_{ij}$ is the number of angler days fished by angler *i* during 1997 in the Lower and Central Cook Inlet salmon and halibut sport fisheries (Howe *et al.* 1998).

The estimated total compensating variation for trip *j* with corresponding attributes is:

$$CV_j = \hat{cv}_j\ Days_j(1 + \%\Delta Y), \tag{4}$$

where $Days_j$ is the total number of angler-days fished for salmon and halibut in Lower or Central Cook Inlet by all individuals, and %ΔY is the change in participation relative to the baseline 1997 season.

Changes in compensating variations will then be calculated as:

$$\Delta CV = CV_j - CV_k, \tag{5}$$

where CV_j is the compensating variation associated with trips with attributes *j*, and CV_k is the compensating variation associated with trips with attributes *k*.

The estimated average daily compensating variation for fishing trips in 1997 was $82.51 for Alaskans and $118.88 for nonresidents (table 3). The corresponding estimate of total compensating variation was $19.46 million ($10.34 million for nonresidents and $9.12 million for residents). Every change that affects sportfishing trip attributes affects the average sport fisher's decision to participate, regardless of whether the attribute change is due to changes in the cost of a sportfishing trip, natural population fluctuations, regulatory change, or environmental damage. Changes in the probability of individual participation lead to shifts in the total demand for sportfishing trips and changes in angler welfare.

Table 3

Estimated Compensating Variation

			CV per Day ($)		Total CV ($ million)
Residency Category	Angler Days	Mean	90% Lower Bound	90% Upper Bound	Mean
Local	48,877	82.51	47.44	123.89	4.032
Alaskan	61,709	82.51	47.44	123.89	5.091
Nonresident	86,970	118.88	85.20	155.95	10.339
Total	197,556				19.463

Regional Impact Analysis

Marine sportfishing can take place from shore, private or rented boats, or charter boats. The expenditures associated with each of these choices contribute to regional economic activity; thus changes in participation that arise from changes in trip attributes affect regional economic activity. Impact analysis focuses on the direct, indirect, and induced effects that changes in expenditures have on output (production), income, and employment. Direct effects are changes associated with immediate changes in final demand. Indirect effects are changes associated with changes in the demand for inputs to the production process. Induced effects result from changes in household spending patterns that arise from changes in household income as a consequence of the direct and indirect effects.

The Magnuson-Stevens Fisheries Conservation and Management Act (US Department of Commerce 1996) places importance on both efficiency and equity issues when managing the nation's fisheries. While economic efficiency (*i.e.*, consumer surplus for anglers and producer surplus for charter operators) is a standard objective identified by economists, recent litigation involving fisheries has stressed distributional issues in addition to efficiency considerations (*e.g.*, Northern Economics 1990; Marine Advisory Program 1992; Cohen 1993). Economic impact analysis provides a snapshot of the economic interdependencies of various industries in a regional economy, and therefore allows analysts to model the downstream effects of demand changes for commodities or services. Because opportunity costs and willingness to pay do not enter into the impact assessment framework, the results of an economic impact analysis should not be confused with statements of value. It should be noted, however, that the results that yield the greatest value under a net benefit analysis could imply very disproportional allocations among stakeholders. Although notions of fairness and equity do not enter into the standard net benefits framework, economic impact analyses are useful tools for tracking and identifying impacts of alternative policies on revenue, income, and employment. For a more detailed discussion on the differences and appropriate uses of cost-benefit and economic impact analyses in fisheries, see for example, Edwards (1994) or Steinback (1999).

Development of the regional economic model is detailed in Herrmann, Lee, Hamel, and Criddle (2001) and Hamel *et al.* (2002); a brief summary is included here for convenience of the reader. We used IMPLAN (Olson and Lindall 1997) as the foundation of a zip-code level economic model of the Kenai Peninsula. Although the technical coefficients used by IMPLAN are regularly updated, regions such as Alaska, where the small numbers of firms creates disclosure problems, and where the economy is rapidly evolving, are not well characterized by the technical coefficients included in the IMPLAN database. To address this problem, we used State and Borough employment and earnings data, information reported in NPFMC (2000), and information gathered during two weeks of onsite interviews with local government officials and business leaders in Kenai Peninsula Borough communities. Individuals interviewed and specific changes to the IMPLAN technical coefficients are identified in Herrmann, Lee, Hamel, and Criddle (2001).

Although IMPLAN represents 528 economic sectors, sectors that are regionally important but small relative to other sectors in the national economy are often subsumed in general categories. For example, IMPLAN's amusement and recreation sector includes sportfishing and 105 other types of recreation. In order to highlight the regional economic impacts of changes in sportfishing participation levels, it was necessary to disaggregate marine sportfishing from the amusement and recreation sector. We followed a disaggregation procedure for the sportfishing sector suggested in Steinback (1999), which involved constructing additional sectors within the

IMPLAN framework and reprogramming the corresponding social accounting matrices to reflect the characteristics of the disaggregated subsector. This choice was driven by our interest in examining changes in final demand that might arise from incremental changes in predictable or controllable trip attributes. If we had wanted to measure the effects of a complete shutdown of the charter fishery to simulate, for example the result of a catastrophic oil spill, the supply side approach used in Leung and Pooley (2001) might have been more appropriate. However, because forward linkages from the charter sector to other industry sectors on the Kenai Peninsula are negligible (the guided sport fishery is fueled almost exclusively by angler demand), and given an absence of intra-sectoral sales, multipliers derived from a hypothetical extraction method would not have likely affected impacts of a significantly greater scale than those from a traditional demand shock. For a detailed accounting of the individual expense categories, corresponding Standard Industrial Classification codes and translation to the IMPLAN sectoral scheme, the reader is referred to Herrmann, Lee, Hamel, and Criddle (2001).

Individual sportfishing activities are accommodated differently from direct income-generating activities, such as guiding. We account for individual sportfishing activities by identifying their expenditure patterns in retail and service sectors; that is, by treating visiting anglers as "cost centers" for various goods and services rather than as an identifiable economic sector (Jensen Consulting 1997). We allocate recreational expenditures among these sectors, using angler expenditure data gleaned from the UAF angler survey (Herrmann, Lee, Criddle, and Hamel 2001). Finally, impact scenarios were run in IMPLAN to generate corresponding response coefficients for each of the retail service sectors frequented by anglers. These response coefficients and those developed for the charter sector were linked in a stand-alone recreational module (Hamel *et al.* 2001).

Simulation Results and Analysis

The simulation model integrates the participation-rate, angler welfare, and regional economic impact models and can be used to explore the effects of changes in trip costs and expected catches on angler-days fished, angler welfare, and regional economic activity.[5] The model was developed, in part, to meet the needs of environmental and regulatory impact analyses related to outer continental shelf minerals exploration, development, and production activities in the Cook Inlet Planning Area (Herrmann, Lee, Hamel, and Criddle 2001). However, preliminary model results have also been used in regulatory analyses related to recent management actions designed to constrain the expansion of charter-based sportfishing for halibut (NPFMC 2000) and analyses related to the adoption of individual fishing quotas for charter-based halibut catches (NPFMC 2001).

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[5] Due to space constraints, it is not possible to report all the details that went into the modeling and simulation analysis. Because of this, we offer the reader the following products that can be obtained by contacting the authors.

- The simulation program <$FISH.XLS> can be downloaded as a compressed file, extracted, and run in Microsoft Excel.
- The manual to <$FISH.XLS> (Hamel *et al.* 2001) is available as an Adobe Acrobat (pdf) file.
- The final project report to Minerals Management Service-University of Alaska Coastal Marine Institute (Herrmann, Lee, Hamel, and Criddle 2001) is available as an Adobe Acrobat (pdf) file. This file also includes the software manual to run $FISH.XLS.
- The survey data and methods are more fully explained in a final report to Alaska Sea Grant, Lee *et al.* (1998), available as an Adobe Acrobat (pdf) file.

Changes in the probability that the average sport fisher will take a trip are calculated using the parameters estimated from the probit model and aggregated into predictions of changes in total sportfishing effort. They are then used to predict changes in angler welfare and regional economic impacts. Figure 1 depicts changes in the magnitude of sportfishing effort as a function of changes in the expected catch of halibut.[6] For example, a 30% reduction in expected catch-per-day is predicted to lead to a 25.1% reduction in angler participation, while a 30% increase would be expected to increase total angler-days fished by 11.0%. Because the estimated participation model is nonlinear and convex, successively larger increases in the expected catch of halibut lead to successively smaller incremental increases in the number of angler-days fished. That is, changes in participation show a declining marginal utility of catch and that Alaskans are more sensitive than nonresidents to changes in expected catch.

Reductions (increases) in expected catch reduce (increase) the compensating variation in two ways. First, the marginal sport fisher will drop out (enter) of the fishery as the expected benefits (in terms of catch) decrease (increase), thereby decreasing (increasing) the total net benefits of the fishery. Second, the net benefit of taking a trip is also reduced (increased) for all the sport fishers who continue to participate because each trip produces less (more) net benefit when the catch rate declines (increases). These changes are represented in figure 2. For example, a 30% reduction in expected catch is predicted to lead to a 56.7% reduction in total compensating variation. Conversely, changes in halibut abundance or management

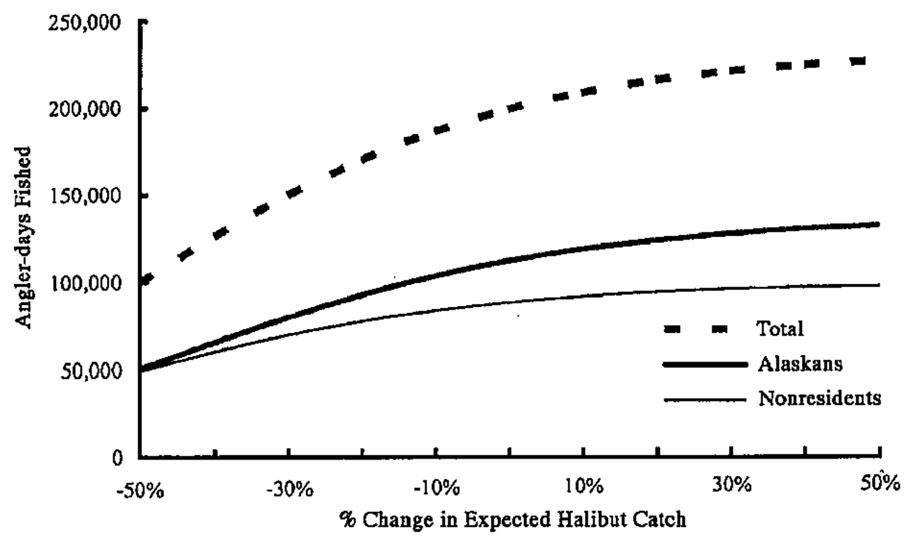

Figure 1. The Effect of Changes of Expected Halibut Catch on Angler Participation

[6] Changes in fishery regulations or environmental changes that affect fishery biomass can be expected to change the total weight of harvested fish through both fish numbers and average weight of the fish. In this manuscript, we hold the average weight of fish constant and focus our analysis on changes to expected catch, which is likely to be the dominant change to total weight from regulatory or environmental changes.

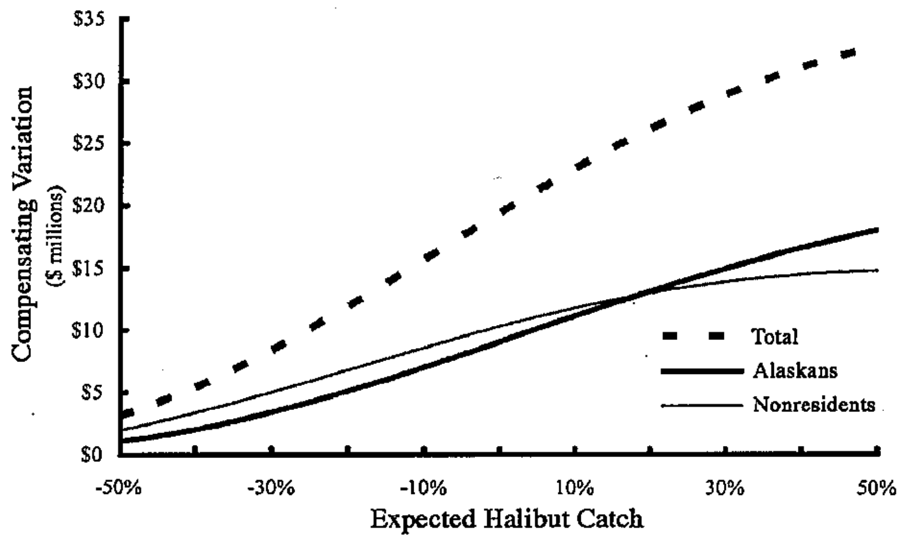

Figure 2. The Effect of Changes in Expected Halibut Catch on the Magnitude of Total Compensating Variation

policies that increase expected halibut catch-per-day by 30% could be expected to increase angler net benefits by $5.8 million for residents and $3.6 million for non-residents, a 48.4% increase in total angler welfare. Note that the total net benefits that accrue to Alaskan anglers are more responsive to changes in expected catch than are those obtained by nonresidents.

Unlike angler net benefits, which are a measure of economic efficiency, impact analysis is a measure of distribution. That is, changes in average daily compensating variation affect regional economic activity when they lead to changes in the total number of sportfishing days. Furthermore, the net regional impact is limited to those recreators who do not substitute other types of expenditures on the Kenai Peninsula in lieu of expenditures that they would have made if they had gone fishing. Assessment of the regional economic impacts of marine sportfishing on the Kenai Peninsula Borough begins with a baseline of expenditures that fluctuates as sport fisher behavior responds to changes in fishing conditions. Table 1 breaks out the $25 million of "new" money to the region spent by non-local Alaskans and nonresidents ($15.3 million of fishing related expenses and $9.7 million of other expenses). Changes in expected angler success (catch) affect participation decisions and, consequently, angler expenditures, industry output, personal income, and employment. The magnitudes of these effects are reported in table 4. The results indicate, for example, that for a 10% decrease in expected halibut catches, net benefits to resident and nonresident sport fishers will decrease by $3.7 million (19.2%). The regional impacts include a $2.0 million (7.1%) decrease in marine sport fishing related direct, indirect, and induced output expenditures in the Kenai Peninsula region, which will result in a decrease of $0.9 million (7.1%) in personal income and a loss of 59 jobs related to the marine sport fishery. For a 10% increase in expected halibut catch-per-day, net benefits to sport fishers will increase by 18.1%, and there will be a 5.3% increase in direct, indirect, and induced output expenditures in the Kenai

Peninsula region, which will result in a 5.3% increase in personal income and a 5.2% increase in related jobs. The marginal effect of each of these impacts is smaller at higher catch levels and larger at lower catch levels, a consequence of the declining marginal value of catches and, therefore, participation.

Angler net benefits and regional economic impacts are also affected by changes in trip costs (figures 3, 4). Trip costs might increase as a result of increased license fees, as an unintended consequence of management actions taken to limit halibut sportfishing catches, or other changes in the supply of or demand for trips. Figure 3 illustrates that the number of angler-days fished by Alaskans is more sensitive to trip cost increases than is the number of angler-days fished by nonresidents. Consequently, if fishery managers seek to limit sportfishing catches through an equal

Table 4
Changes in Compensating Variation (CV) and Regional Economic Impacts in Response to Changes in Halibut Catch

% Change in Catch	% Change in Participation	Change in Total CV ($ million)	Change in Expenditures ($ million)	Change in Personal Income ($ million)	Change in Employment (Jobs)
−50%	−50.2%	−16.4	−16.8	−7.1	−487
−40%	−37.1%	−14.1	−12.2	−5.1	−353
−30%	−25.1%	−11.0	−8.1	−3.4	−234
−20%	−14.8%	−7.5	−4.7	−2.0	−136
−10%	−6.5%	−3.8	−2.0	−0.9	−59
0%[1]	197,556	$19.5	$28.5	$12.0	822
+10%	4.9%	3.5	1.5	0.6	43
+20%	8.5%	6.7	2.6	1.1	75
+30%	11.0%	9.4	3.3	1.4	96

[1] These values are baseline levels and provided to add a relative context to the absolute changes.

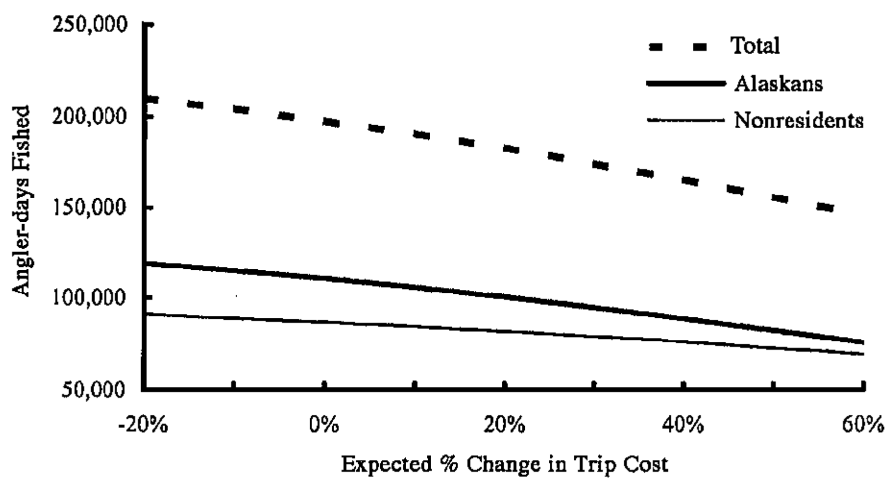

Figure 3. The Effect of Expected Fishing Trip Costs Changes on Angler Participation

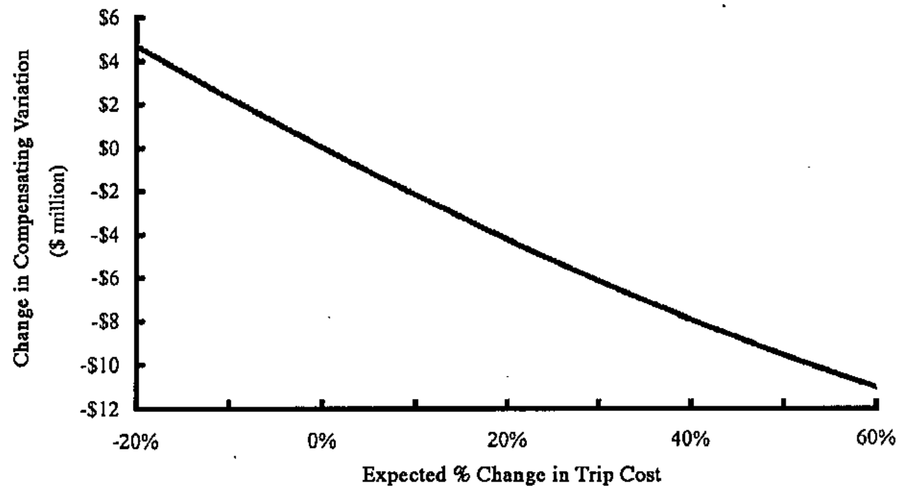

Figure 4. The Effect of Expected Fishing Trip Costs Changes on the Magnitude of Total Compensating Variation

increase in resident and nonresident license fees, the percent reduction in trips taken by Alaskans will be larger than the percent reduction in trips taken by nonresidents. Alternatively, if managers wanted to achieve identical percent reductions in resident and nonresident trips, they could impose a larger fee increase on nonresidents than residents. Moreover, if managers were strictly concerned with benefits to Alaskan resident anglers and concerned that the imposition of a binding GHL might lead to increases in the cost of charter trips, they could select a nonresident license fee that would induce a reduction in nonresident demand sufficient to choke off any upward pressure on charter trip prices. It should be noted that such fees would need to be based on the number of days fished or the number of fish caught. No such fees currently exist for halibut sportfishing in Alaska, and the authors do not necessarily advocate the creation of such fees.

The regional economic impacts of changes in trip costs are reported in table 5. Note that although participation is a linear function of trip cost, angler welfare and regional economic activity are nonlinear. The results indicate, for example, that for a $10 increase in expected trip costs, the number of angler-days fished will decline by 3.6%, net benefits to sport fishers will decrease by $2.2 million (11.3%), sportfishing related expenditures in the Kenai Peninsula region will fall by $1.1 million (4%), Kenai Peninsula Borough personal income will decline by $0.5 million (4%), and there will be a loss of 33 related jobs. Again, these effects are nonlinear, with increasingly larger impacts at increasingly higher prices.

In the participation-rate model, when estimating changes in the probability that individual fishers would take a trip, given varying trip attributes, it is assumed that the price of the trip will remain constant at P. In other words, we assume that supply is perfectly elastic. While this assumption is appropriate for shore and private trips, it is probably not entirely accurate for the charter sector. To the extent that charter trips make up a sizeable portion of sportfishing effort, and to the extent that charter trips do not exhibit perfectly elastic supply curves, there may be price adjustment, especially in the short run. For example, charter operators might respond to a short-

Table 5
Changes in Days Fished and Regional Economic Impacts in Response to Increases in the Average Cost of a Sportfishing Trip

Change in Average Trip Cost	% Change in Angler-days Fished	Change in Total CV ($ million)	Change in Expenditures ($ million)	Change in Personal Income ($ million)	Change in Employment (Jobs)
+$5	−1.8%	−1.1	−0.6	−0.2	−16
+$10	−3.6%	−2.2	−1.1	−0.5	−33
+$15	−5.6%	−3.3	−1.8	−0.7	−51
+$25	−9.7%	−5.3	−3.0	−1.3	−88
+$50	−21.3%	−9.7	−6.7	−2.8	−193
0[1]	197,556	$19,463,536	$28,524,174	$12,034,000	822

[1] The values reported in the last row are baseline levels and provided to add a relative context to the absolute changes.

run change in expected catches by lowering their prices and keeping their customer base rather than holding prices constant and losing customers as assumed in our model. While our assumption is valid in the long run, it may be somewhat unrealistic in the short run. (If there is an upward sloping supply curve for charters, then there would still be a loss in surplus associated with the charter industry when there is an environmental change; however, some of the surplus would come from producers instead of consumers.) Additionally, if price were lowered to maintain the current level of participation, there would be little regional impact outside of fish processing. Therefore, for the charter industry, our results more closely reflect long-run rather than short-run results, especially with respect to income distribution. For shore and private vessels, this is not a factor.

Conclusions

This study develops estimates of the net economic benefits that accrue to participants in the Lower and Central Cook Inlet halibut sport fisheries, the relationship between catch, size of catch, and the number of sportfishing days, and the regional (Kenai Peninsula area) economic impact of changes in the annual total number of person-days fished. The integrated model is used to explore changes in net benefits and changes in regional impacts associated with changes in trip costs and angler success. Changes in expected catch could result from predictable changes in stock abundance; conditionally predictable environmental damages resulting from minerals exploration, development, production, or transportation activities; or from controllable management actions that affect the allocation between commercial, subsistence, and sport fishers, bag and possession limits, fishing methods, or other measures that affect average catches. Changes in cost might arise as a result of predictable shifts in the demand for sportfishing; as the result of deliberate management actions such as changes in resident or nonresident license fees, stamps, or endorsements; or incidental to management actions such as the GHL or charter IFQ, which may affect the supply or character of sportfishing trips.

The advantages of our integrated model are that: changes in participation are determined by variables that are observable, predictable, or subject to management control; nonlinear preferences are easily accommodated; aggregation of the individual participation probabilities provide a method for estimating angler welfare;

and estimated changes in aggregate participation can be linked to a regional input-output model to provide estimates of the regional economic impacts of changes in trip attributes. Although the model was developed, in part, to meet the needs of environmental and regulatory impact analyses related to outer continental shelf minerals exploration, development, and production activities in the Cook Inlet Planning Area (Herrmann, Lee, Hamel, and Criddle 2001), preliminary model results have also been used in regulatory analyses related to recent management actions designed to constrain the uncompensated reallocation of halibut from the commercial fishery to the charter-based sport fishery (NPFMC 2000, 2001).

References

Aas, O. 1995. Constraints on Sportfishing and Effect of Management Actions to Increase Participation Rates in Fishing. *North American Journal of Fisheries Management* 15:631–8.

BenAkiva, M., and S.R. Lerman. 1985. *Discrete Choice Analysis: Theory and Applications to Travel Demand*. Cambridge, MA: MIT Press.

Butler, J.S., and R. Moffitt. 1982. A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model. *Econometrica* 50:761–5.

Chamberlain, G. 1982. Analysis of Covariance with Qualitative Data. *Review of Economic Studies* 47:225–38.

Cohen, M.J. 1993. *Economic Aspects of Technological Accidents: An Evaluation of the Exxon Valdez Oil Spill on Southeastern Alaska*. Ph.D. Dissertation, University of Pennsylvania, Philadelphia, PA.

Dillman, D.A. 1978. *Mail and Telephone Surveys*. New York: John Wiley & Sons.

Edwards, S.F. 1994. *An Economics Guide to Allocation of Fish Stocks Between Commercial and Recreational Fisheries*. NOAA Technical Report. Northeast Fisheries Center, National Marine Fisheries Service, Woods Hole, MA, 29 pp.

Ericsson, K.A., and H.A. Simon. 1993. *Protocol Analysis, Verbal Reports as Data*. Cambridge, MA: MIT Press.

Greene, W.H. 1997. *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall.

Guilkey, D.K., and J.L. Murphy. 1993. Estimation and Testing in the Random Effects Probit Model. *Journal of Econometrics* 59:301–17.

Hamel, C., M. Herrmann, S.T. Lee, and K.R. Criddle. 2001. *$FISH: An Economic Assessment of Lower Cook Inlet Sport Fisheries*. Department of Economics, University of Alaska Fairbanks, Fairbanks, AK, 12 pp.

Hamel, C., M. Herrmann, S.T. Lee, K.R. Criddle, and H.T. Geier. 2002. Linking Sportfishing Trip Attributes, Participation Decisions, and Regional Economic Impacts in Lower and Central Cook Inlet, Alaska. *Annals of Regional Science* 36:247–64.

Hanemann, M.W. 1999. Welfare Analysis with Discrete Choice Variables. *Valuing Recreation and the Environment: Revealed Preference Methods in Theory and Practice*, J.A. Herriges and C.L. Kling, eds., pp. 33–64. Northampton, ME: Edward Elgar.

Herrmann, M., S.T. Lee, K.R. Criddle, and C. Hamel. 2001. A Survey of Participants in the Lower and Central Cook Inlet Halibut and Salmon Sport Fisheries. *Alaska Fishery Research Bulletin* 8:107–17.

Herrmann, M., S.T. Lee, C. Hamel, and K.R. Criddle. 2001. *An Economic Assessment of the Sport Fisheries for Halibut, Chinook and Coho Salmon in Lower and Central Cook Inlet*. Final Report, Mineral Management Service-University of Alaska Coastal Marine Institute project 12-35-0001-30661 task order 14196, Fairbanks, AK, 135 pp.

Holland, S.M., and R.B. Ditton. 1992. Fishing Trip Satisfaction: A Typology of Anglers. *North American Journal of Fisheries Management* 12:28–33.

Howe, A.L., G. Fidler, C. Olnes, A.E. Bingham, and M.J. Mills. 1998. Harvest, Catch, and Participation in Alaska Sport Fisheries During 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-25, Anchorage, AK.

Jensen Consulting. 1997. *North Pacific Fishery Management Council Recreational Economic Impact Model.* Reference manual for version 3.0.

Krinsky, I., and A.L. Robb. 1986. On Approximating the Statistical Properties of Elasticities. *Review of Economic Statistics* 9:715–9.

Lee, S.T., I. Wedin, K.R. Criddle, M. Herrmann, and J. Greenberg. 1998. *Summary of Angler Survey: Saltwater Sport Fishing off the Kenai Peninsula, Alaska.* Final report, Alaska Sea Grant Award #98-403 R14-17, Fairbanks, AK, 56 pp.

Leung, P.S., and S.G. Pooley. 2001. Regional Economic Impacts of Reductions in Fisheries Production: A Supply-Driven Approach. *Marine Resource Economics* 16:251–62.

Maddala, G.S. 1987. Limited Dependent Variable Models Using Panel Data. *The Journal of Human Resources* 22:307–38.

Marine Advisory Program. 1992. After the Exxon Oil Spill. *Alaska's Marine Resources.* University of Alaska Sea Grant College Program, Fairbanks, AK.

Northern Economics. 1990. *Economic Impacts of the S.S. Glacier Bay Oil Spill.* Minerals Management Service, Alaska Outer Continental Shelf Region, Anchorage, AK, 91 pp.

NPFMC (North Pacific Fishery Management Council). 2000. *Draft Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis for a Regulatory Amendment to Implement Management Measures Under a Guideline Harvest Level and/or Moratorium for Halibut in Areas 2C and 3A.* North Pacific Fishery Management Council, Anchorage, AK.

___. 2001. *Draft Environmental Assessment/Regulatory Impact Review/Initial Regulatory Flexibility Analysis for a Regulatory Amendment to Incorporate the Halibut Charter Sector into the Halibut Individual Fishing Quota Program or Implement a Moratorium on Entry into the Charter Fleet for Pacific Halibut in Areas 2C and 3A.* North Pacific Fishery Management Council, Anchorage, AK.

Olson, D., and S. Lindall. 1997. *IMPLAN Professional Software, Analysis, and Data Guide*. Stillwater, MN: Minnesota IMPLAN Group.

Steinback, S.R. 1999. Regional Economic Impact Assessments of Recreational Fisheries: An Application of the IMPLAN Modeling System to Marine Party and Charter Boat Fishing in Maine. *North American Journal of Fisheries Management* 19:725–36.

Thunberg, E., S.R. Steinback, G. Gray, A. Gautam, and M. Osborn. 1999. *Summary Report of Methods and Descriptive Statistics for the 1994 Northeast Region Marine Recreational Fishing Participation Survey.* NOAA Technical Memorandum NMFSF/SPO39.

US Department of Commerce. 1996. *Magnuson-Stevens Fishery Conservation Act.* NOAA Technical Memorandum NMFS-F/SPO-23.

Veall, M.R., and K.F. Zimmermann. 1996. Pseudo-R^2 Measures for Some Common Limited Dependent Variable Models. *Journal of Economic Surveys* 10:241–59.

Appendix

There are many reasons for visiting Alaska and the Kenai Peninsula. Respondents to the UAF angler survey (Herrmann, Lee, Criddle, and Hamel 2001) cited nine primary trip purposes. Table A1 summarizes the reasons given by respondents who fished for halibut or salmon in Cook Inlet.

Table A1
Primary Purpose of Trip to Alaska

	Alaskans (non-local)	Nonresidents
Saltwater fishing in Cook Inlet	87.9%	43.0%
Visit/vacation (in Alaska) in areas outside of Kenai Peninsula	2.9%	24.4%
Visit relatives	1.7%	12.0%
Freshwater fishing on Kenai Peninsula	5.2%	11.2%
Business trip	1.2%	3.7%
Combined marine/freshwater fishing	0.0%	2.5%
Visit friends	1.2%	0.4%
Cruise ship		1.2%
Hunting		1.7%

Because there is not an exact correspondence between visits to Alaska and the desire to fish for halibut or salmon in Cook Inlet, it was necessary to adjust the total expenditure estimates to reflect those regional expenditures that are uniquely attributable to fishing in the Cook Inlet. Consequently, after discussion with fishery participants and representatives of related tourism and fishery sectors, we adopted a set of assumptions regarding what respondents would do if the Cook Inlet sportfishing portion of their trip were cancelled (table A2).

Table A2
Assumed Response of Respondents to Cancellation of the Cook Inlet Sportfishing Portion of their Trip

Main Trip Purpose	Alaskans (non-local)	Nonresidents
Saltwater fishing in Cook Inlet	Cancel entire trip to the Kenai	Cancel entire trip to the Kenai
Visit/vacation (in Alaska) in areas outside of Kenai Peninsula	Replace days on Kenai with days elsewhere in Alaska	Replace days on Kenai with days elsewhere in Alaska
Visit relatives	Take full Kenai trip	Take full Kenai trip
Freshwater fishing on Kenai Peninsula	Reduce trip length by lost fishing days	Reduce trip length by lost fishing days
Business trip	Take full Kenai trip	Take full Kenai trip
Combined marine/freshwater fishing	Reduce trip length by lost fishing days	Reduce trip length by lost fishing days
Visit friends	Take full Kenai trip	Take full Kenai trip
Cruise ship	No observations	Take full Kenai trip
Hunting	No observations	Take full Kenai trip

The total amount of effort from table A1 was combined with the assumptions of what an individual would do of the fishing trip were cancelled, to form the overall reduction in expenses associated with a reduction in Cook Inlet sportfishing effort (table A3).

Table A3
Reduction in Fishing or Visitation Rates for a 100% Reduction in Fishing Effort (days)

	Alaskans (non-local)	Nonresidents
Fishing reduction	100%	100%
Kenai living expenses	89.5%	64.0%

For example, if a person does not take a fishing trip, we assumed that there would be a 100% reduction of new money flowing into the Kenai Peninsula from marine sportfishing-related expenditures (as the trip is not taken). However, there still may be reason for the trip to be taken even if the individual does not fish. Our calculations indicate that if an Alaskan (non-local) does not fish, 89.5% of the redistribution of primary living expenditures from outside to inside the Kenai Peninsula will not take place (note that 88% of the Alaskans took their Kenai Peninsula trip primarily to engage in marine sportfishing). For nonresidents, we estimate that approximately 64.0% of the living and transportation expenditures taking place on the Kenai Peninsula are a direct result of the fishing component of the saltwater fishing trip (36% of these primary living expenditures would still take place, as there are more reasons for non-residents to visit the Kenai Peninsula than for non-local Alaskans.

Although these are very broad assumptions, and other scenarios (such as substitute fishing trips) are plausible, we believe that estimates based on these assumptions are better than estimates that assume that all trip expenditures are derived from the Cook Inlet halibut and salmon-fishing component. By reducing total expenditures attributable to fishing, we represent a conservative view which is not only more plausible, but also more defensible when valuing a fishery and calculating economic impacts of fishery changes to changes in expected fishing harvest.

ATTACHMENT 6

THE ECONOMIC IMPACT ON PLUMAS COUNTY OF ALTERNATIVE NORTHERN PIKE ERADICATION AND MANAGEMENT SCENARIOS FOR LAKE DAVIS: FINAL REPORT

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Executive Summary

Ranking the alternative methods of dealing with the northern pike problem in Lake Davis is relatively straightforward when the sole criterion is the economic impact on the Plumas County economy. The analysis contained in this report supports the conclusion that eradication is preferable to the current management program. Compared to the use of the current pike management program alone, even a failed attempt at eradication yields a better economic outcome for Plumas County. Among the alternative methods of eradication proposed scenario 3 yields the greatest local economic benefits, although scenario 1, the preferred alternative, is a close second. Both are preferable, on the basis of economic impact, to scenario 2 since the latter implies the loss of the recreational use of the lake for a full three years.

For each of the scenarios Plumas County income was estimated for a 22 year period or two eradication cycles. For the three eradication scenarios (scenarios 1-3) the total income impacts for successful eradication are $17.82 million, $16.19 million, and $18.06 million (in undiscounted constant 2005 dollars) respectively. The multiple failed eradication case (one of two failed eradication cases considered, the other being just a single attempt) leads to 22 year income impacts of $14.26 million for scenario 3, $13.74 million for scenario 1 (the preferred alternative), and $11.59 million for scenario 2. For all eradication scenarios, estimated income impacts, even where eradication efforts fail, exceed the contribution Lake Davis will make to Plumas County income with a continuation of the current pike management program alone (scenario 4). It is estimated that continued pike management without an attempt to eradicate the pike will generate only $9.03 million in local income over the next 22 years.

The choice between scenarios 1 and 3 is a difficult one and one that cannot be made on the basis of economic impact alone. For the successful eradication case there is a difference of just $18,840 in the annual effect on gross sales and a difference of $11,041 in the estimated impact on annual local income. While the differences are greater for the failed eradication case, the disparity is insignificant relative to the gap between the successful and failed eradication cases. If eradication were to be unsuccessful, and were to be repeated periodically (every 11 years in this case), under scenario 3 annual gross business sales would average $295,166 less (over the 22 year period used in the analysis) than for the successful case. In addition, annual income would be lower by an average of $172,972. The disparity between impacts on gross business sales and local income are likewise significant for scenario 1, the preferred alternative. Under this option a failed eradication effort with multiple attempts would reduce average annual gross sales and local income by $316,254 and $185,330, respectively.

On the basis of economic impact on the Plumas County economy, a pike eradication effort by any of the proposed methods is preferable to continuing the current pike management program alone. And, since the differences in the impacts among the alternative scenarios are insignificant (at least for scenarios 1 and 3) relative to the local economic cost of a failed eradication attempt, the particular eradication method chosen should be the one having the greatest probability of success.

Introduction

Purpose of the Study

The purpose of this economic study is to examine the short- and long-term economic effects of pike and pike eradication efforts both locally and statewide. There are two key elements to the economic analysis that need to be completed in order to accomplish this purpose. The first is to estimate the economic impacts of pike eradication efforts on the Plumas County economy. Second, a travel cost study is undertaken to estimate the value of Lake Davis to all recreational users including those from outside of the county.

The study examines the economic costs and benefits of several pike eradication scenarios. It will function as an informational document for the California Department of Fish and Game (DFG) and the general public in regards to the relative economic effects of various methods to eradicate pike including the no project alternative. This economic study is being conducted separate from, but in parallel with, a joint Environmental Impact Report/Environmental Impact Statement being prepared by a private consultant under contract with the DFG.

Cautionary Notes

Study Scope

The impacts assessed in this study are limited to those non-resident users of the recreational resource directly affected by the quality of the lake and fishery. Thus the analysis focuses on non-resident anglers and boaters and thus the number of annual visitors used in the analysis is considerably smaller than what is used In the EIR/EIS.

Impacts on Local Property Values

The analysis contained within this report estimates four local economic impacts associated with pike eradication efforts at Lake Davis: gross sales, income, employment, and county government revenues. There is another possible impact that is not included and that is the potential transitory impact on local property values that might be experienced during the treatment process. There are two reasons for excluding this potential impact, the most important of which is that it is impossible to determine with any degree of precision. The excluded effect is that local recreational property might become less attractive to buyers from outside of the county. This could occur for two reasons: because the lake level has been lowered during the treatment process and thus is unavailable for a period of time that depends on the scenario chosen, or because of the adverse publicity associated with the real or imagined consequences of the treatment itself. The impact of the lake closure should, at most, be the interest cost of delaying property sales for the period of time the lake is closed and is not likely to be significant relative to the estimated impacts on local income contained in the report.

Second, the effect on property values generated by changes in local income is already included in the local economic impact estimates. Income impact estimates include the effect on property income and thus including a property value impact would involve double counting.

Some might point to the effects on property values experienced during the 1998 treatment as evidence that this impact is large and should not be excluded from the analysis contained within this report. However, examination of that evidence is likely to lead to the conclusion that the effects of closure of Lake Davis during those years cannot be separated from the other factors that affected property values in the mid to late 1990's. Rising interest rates and other national and state economic factors depressed real estate prices throughout California and recovery of real estate prices did not begin in earnest until interest rates declined after the year 2000.[1]

Economic Impact Analysis

The economic impact analysis performed for this study is used to estimate the effect on local economic activity of the various pike eradication scenarios. There are four key elements to this analysis. First, the amount of spending per visitor day is established for several important industry specific categories. This information is derived from the surveys administered at various Lake Davis boat ramps by employees of the Center for Economic Development (CED) at the California State University, Chico. Second, the total number of annual non-resident visitor days is estimated. This is accomplished using the CED surveys and counts, the DFG angler surveys, and campground usage data obtained from the U.S. Forest service. Spending per visitor day by industry sector is multiplied by the estimated total of visitor days to determine total spending by industry category. The third element of the analysis is to use the industry spending data in conjunction with the IMPLAN input-output model to calculate the annual impacts of Lake Davis recreational use on Plumas County output, income, employment, and county revenues. Fourth, adjusting for effects of fishery quality on lake usage and the amount of time the lake would be unavailable under the various pike eradication scenarios, allows computation of the relative economic impacts of the four scenarios analyzed.

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[1] Plumas County did experience a decrease in new homes permitted (one measure of property related activity) in 1999. The decrease was from 123 in 1998 to 101 in 1999, or less than an 18% decrease. By the year 2000 housing permits had increased to 188, with increases to 191 and 260 in the next two years. By way of comparison, Lassen County experienced a decrease in new homes permitted of 31% from the 1996 peak to the activity level in 1997 and 1998, with recovery to the 1996 level delayed until 2002. Adjacent Yuba County saw a surge in building activity in 1999 (probably due in part to damage from the 1997 flood), a 62% decline in new housing permits issued in 2000, and rapid growth in building activity beginning in 2002. Sierra County experienced a decrease in new housing permits issued of almost 41% for 1997 and 1998 from the year 1996 with a return to 1996 levels in the year 2000. In general, while the timing is not precisely the same, surrounding counties experienced larger percentage downturns in late 1990's housing construction activity than did Plumas County. (DOT 2005)

While the majority of the economic impacts are likely to be felt in the City of Portola, the analysis is performed for Plumas County as a whole. It would be possible to separate the impacts for Portola from those of the remainder of the county by running the IMPLAN model at the ZIP code level. However, the authors' previous experience with IMPLAN is that the smaller the defined economic unit, the less reliable the estimates.

The local economic impacts contained in this report can be interpreted as worst case estimates. First, this is true if the county-wide impacts are assumed to represent the effect on the Portola economy. Second, there is the implicit assumption that all of those non-resident recreational users of Lake Davis will find other options outside of Plumas County. That, in fact, may not be the case and therefore a portion of the estimated visitor spending may still positively affect the local economy.[2]

Resource Valuation

Estimation of the value of the Lake Davis is accomplished using a travel cost model. The use of travel cost to estimate the demand for recreational sites was first suggested by H. Hotelling in the late 1940's. The model was further developed by Knetsch and Clawson in the 1950's and 1960's and has since gained broad acceptance among resource economists. The literature in resource and environmental economics contains numerous studies using variations on the travel cost model.

This approach to valuing a resource is based on the idea that the cost of getting to a recreational site is a measure of the value individuals place on its use. A demand curve is generated from the various travel costs and the associated number of trips. It is fundamental to economic theory that the higher the price of a good or service the smaller the quantity demanded. In the vernacular of the travel cost model this means that as travel cost increases, as it does with distance from the site, the smaller the number of trips made annually. The total value of the resource is estimated as the area under the generated demand curve but above the average travel cost for all surveyed users. In order to maintain the continuity of the economic impact analysis, the results of the travel cost study are included in Appendix A instead of the main body of the report.

Background

Plumas County

Plumas County is located in Northern California, bordered by Lassen County on the north and Sierra and Yuba counties on the south. In 2004 Plumas County had a population of 21,230 and total wage and salary employment of 7,630. The average salary per worker was $35,840. With total county personal income of $632.23 million, 2004 per capita income was $29,780, and median household income was estimated at $53,900.

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[2] Sixty percent of those responding to the survey indicated that they would "definitely" or "probably" come to the area even if Lake Davis were unavailable.

Wage and salary employment grew by 50 jobs during 2004, representing a slowdown from the rate of job growth experienced in the four previous years. Most of the jobs created during 2004 were in leisure services, retail trade, construction, and agriculture, with retail trade adding 80 jobs during the year. Employment in some other sectors actually declined, with the largest decrease in the government sector which lost 81 jobs. Annual employment growth is expected to increase to 150 new jobs in 2005, and then to stabilize at between 50 and 100 new jobs annually through the year 2025.

In 2004 the Plumas county population increased by 0.6%, while the population of the incorporated city of Portola declined by 0.5%. The county's rate of population growth through the year 2025 is forecast to remain below the state average and is expected to increase at 0.6% annually for the 2005-10 period and remain well below 1% annually through 2025.

Real per capita income is forecast to increase by 1.8% in 2005, slowing to a 0.8% rate of increase over the next five years. Taxable sales are also expected to grow in 2005 at a rate above the long term trend, or by 4%, slowing to an average of 2.1% annually over the next five years. In nominal terms (unadjusted for inflation) the rate of growth in taxable sales is forecast to grow at a 4.02% annual rate through the year 2025. Through the year 2025 nominal personal income is forecast to grow at a 2.95% annual rate, with an annual real rate of growth averaging less than 0.5%. (DOT 2005)

Northern Pike in Lake Davis

Lake Davis is located in the Feather River drainage of the Sacramento River system at an elevation of 5,775 feet. The dam creating the lake was constructed by the California Department of Water Resources (DWR) in 1967. It is located near Portola in Plumas County on Big Grizzly Creek, a tributary to the middle fork of the Feather River. It has a storage capacity of 84,371 acre feet, covers 4,026 acres, and has a mean depth of 20.5 feet. (Lee 2001)

The existence of northern pike in Lake Davis was initially confirmed by an angler catch in August of 1994. Northern pike were caught with increasing frequency through 1994 and 1995 and in 1995 the DFG "...concluded that the eradication of the predatory pike was necessary in order to prevent their further spread in the state and to protect the trout fishery in Lake Davis". (Lee 2001, DFG 2003)

1997 Pike Eradication Efforts

The DFG received the necessary permits by October 1997 and on October 14, 1997 treatment with powered rotenone and liquid Nusyn-Noxfish began. The lake still held 50,000 acre feet at the time of treatment, 20,000 acre feet more than it would have had the project not been delayed by a restraining order. By late November of that year it was determined that most of the treatment chemicals had degraded except for pipernyl butoxide. The persistence of this synergistic chemical was aided by a thick icecap and low water temperatures, and because of its presence, restocking with rainbow trout was delayed until June of 1998. Unfortunately in May 1999 northern pike were again discovered in Lake Davis. (Lee 2001)

Pike Population Management

Following a May 1999 meeting between DFG Director Robert Hight and members of local communities, a task force was formed to study pike management options and to develop recommendations. Input concerning potential alternatives was sought from the public, and, fishery biologists and others having direct experience with pike population management were brought in to discuss and evaluate suggested control strategies. In January of 2000 the task force steering committee and DFG jointly authored a report entitled *Managing Northern Pike at Lake Davis: A Plan for Y2000* containing a series of recommended strategies for northern pike population control. (Lee 2001, SLDTFSC/DFG 2000)

Program Results

In September 2003 DFG published a report outlining the results of over three years of northern pike population management at Lake Davis. The report concluded that, although field crews removed 28,100 pike weighing 4,250 pounds, the yearly harvest continued to increase and pike density increased through at least the first three years of the program. There were two important adverse consequences resulting from the failure of the implemented management techniques to limit pike populations. First, due to increasing numbers of northern pike, the risk of release to downstream waterways has increased. Second, the catch rate for rainbow trout had declined substantially, falling from a rate of 0.28 per hour in 2000 to 0.12 per hour in 2003. (DFG 2003) The decline in trout fishing success in all likelihood imposed economic costs on the local economy with a 33% decrease in visitor days recorded at Lake Davis campgrounds between 2000 and 2004. (USFS 2005)

Scenarios Analyzed

Scenario 1: Preferred Alternative

Description

The preferred alternative involves drawing the lake down to a volume of between 10,000 and 20,000 acre feet and then applying a liquid rotenone formulation in order to eliminate the pike. The rotenone treatment would also extend to tributaries to the lake, wetlands, and other potentially infested areas within the Lake Davis watershed. Drawdown would take place between January and September of the project year, and depending on the rainfall year, would result in a volume of water within the lake of 10,000 to 20,000 acre feet by September of the same year. Neutralization of the rotenone will occur by one of a number of methods currently under evaluation. (DFG 2005)

Impacts on Fishery and Lake Availability

Lake Davis boat ramps will be unusable when the lake level drops below 40,000 acre feet. With the draining commencing in January of year 1 that level is likely to be reached by March of the same year. Following eradication, trout will be restocked in May of year 2 and at that time the lake will be available for the full spectrum of recreational uses. It is assumed that successful eradication of pike will lead to an improvement in the trout fishery of 100% by year 5.[3] If eradication efforts are unsuccessful it assumed that it will be a periodic effort (e.g. once every 11 years) or will be attempted just once and the trout fishery will improve by 100% by year 5 and decline to pre-treatment levels by year 11. If just one treatment is attempted the fishery quality will continue to decline after year 11 until the catch rate falls by an additional 50% by year 21.

Scenario 2: Complete Dewatering of the Reservoir

Description

This alternative involves the use of existing dam outlets and pumps and the use of additional piping and siphons. Installation of structures will be necessary in order to prevent downstream release of adult pike, juveniles, larvae, or eggs. In the summer or fall, and when lake volume reaches 90 acre feet, the remaining water and all inflow will be treated with rotenone. (DFG 2005)

Impacts on Fishery and Lake Availability

Under this alternative Lake Davis boat ramps will be unusable between March of year 1 and April of year 4. Following eradication, trout will be restocked in May of year 4. Successful eradication is assumed to lead to the same improvement in trout fishery quality described under the preferred alternative. As with the preferred option, the impact of this method will be evaluated under the alternative assumptions that eradication of pike is a successful one-time event, that it is unsuccessful and will be repeated periodically, or that it is attempted just once. The impact on catch is assumed to follow the same post treatment patterns used in the analysis of the preferred alternative.

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[3] In 2000 the catch rate for trout in Lake Davis was 0.28 trout per hour, but by 2003 that rate had declined to 0.12, presumably due to increased predation by northern pike. Thus removal of pike from the lake should result in a comparable reversal of the catch rate, leading to more than a 100% increase in the number of trout caught per hour. Even though an increase from 0.12 to 0.28 is more than a 100% increase, it is assumed that the quality of the fishery increases by just 100%. That is because quality (and angler response to quality changes) is also affected by the size of fish caught and the average size of trout caught has increased significantly over the same period. (DFG 2003, Loomis 2005)

Scenario 3: Draw Down to 48,000 Acre Feet

Description

For this alternative the minimum lake level will be 5,767 feet above sea level and the lake volume will not fall below 48,000 acre feet. The standing water and all flowing water will be treated with liquid rotenone in the summer or fall of year 1. Until treatment occurs boat ramps will remain usable. Restocking will be done in late spring of year 2. (DFG 2005)

Impacts on Fishery and Lake Availability

This option somewhat reduces the time the lake will be unavailable (boat ramps can remain open), however since trout will not be restocked during year 1 and the lower water level will reduce the aesthetic value of the lake for recreation, use during year 1 is likely to be reduced substantially. Successful eradication is assumed to lead to the same improvement in trout fishery quality described under the preferred alternative. As with the preferred option, the impact of this method will be evaluated under the alternative assumptions that eradication of pike is a successful one-time event, that it is unsuccessful and will be repeated periodically, or that it is attempted just once. The impact on catch is assumed to follow the same post treatment patterns used in the analysis of the preferred alternative.

Scenario 4: No Action

Description

Under this option there will be no attempt to eradicate the pike from Lake Davis. The current management plan, implemented to control the numbers of pike in the lake, will be continued. This option might include continued stocking of trout, although it is likely that a change towards larger fish, less susceptible to predation by pike, will be desirable. (DFG 2005)

Impacts on Fishery and Lake Availability

If this option were chosen there would be no interruption in the availability of the lake for recreation. Under the continued stocking alternative the quality of the trout fishery it is assumed to decline with average trout populations declining 25% by year 5 and 50% by year 10. (DFG 2005)

Survey and Results

General

Surveys and visitor counts were conducted at Lake Davis on 13 days in September and October of 2005 and for 12 days during May, June, and July of 2006. Over that time interval 238 parties were surveyed representing 477 individual visitors. (See Appendix B for the actual form used). Interviews were conducted at four boat launch points including Honker Cove, Mallard Cove, Eagle Point, and Camp 5. Some refused to be surveyed, but the majority of those approached willingly participated.

There was an average of 2.01 individuals per interviewed party with 97.4% of those interviewed visiting from outside of Plumas County. The duration of the average visit was 3.14 days, while the average visiting party makes 2.09 trips to Lake Davis annually. Most visitors (87.5%) listed the primary purpose of their visit as fishing, with 5.73% visiting friends and the remainder traveling to the area for business or other recreation. 67.9% of surveyed visitors stayed in the local area, with 46.0% of those staying locally utilizing campground facilities, 18.0% staying in hotels or motels, 14.9% staying with friends, and the remainder listing "other", primarily second homes.

Visitor Spending

Local expenditures for all surveyed non-residents totaled $42,648, or $31.06 per non-resident visitor day.[4] The expenditures were entered into six separate categories for use in the local impact analysis. Local spending per visitor day was $7.06 for restaurant meals, $7.05 for lodging, $7.73 for transportation, $2.38 for fishing-related spending, $4.57 for groceries, and $2.27 for other local retail. [5]

Impact of Presence of Northern Pike

Of those surveyed 96.6% were aware of the presence of northern pike in Lake Davis. Most (85.7%) indicated that it did not affect their willingness to utilize the lake fishery. For the few individuals saying that it did affect the number of annual visits, six said the presence of northern pike in the lake increased the number of annual visits, while 16 said that knowledge reduced the number of annual visits. However, when considering the impact of pike predation on the trout catch rate, there is likely to be a substantial negative impact on annual use of the Lake Davis fishery.

Effect of Catch Rate on Annual Visits

Only 26.05% of surveyed anglers reported that they typically caught their daily limit of trout at Lake Davis. When asked if they would increase their annual visits to the lake were they to catch twice as many fish daily, 78.21% answered yes, with an average

[4] Total spending per non-resident visitor day is somewhat lower than what was used in the Preliminary Report. The additional surveys done during the summer of 2006 reduced average daily spending from $35.60 to $31.06.

[5] Due to a misunderstanding with those conducting the surveys during the May through July, 2006 period spending was reported as a total instead of being separated by expenditure category. Therefore, the total spending is allocated to the individual expenditure categories based on the surveys done during September and October of 2005. Because the majority of the surveys were collected in the earlier period and since sector spending multipliers are very similar, this approach has no significant impact on the study results.

increase in annual visitation of 122.39%. Adjusting for the percent currently catching their limit and those who indicate no impact on their annual visitation, the implication is that a doubling of the catch rate would lead to a 63.2% increase in annual visitor days.[6]

Methodology

Estimating Total Annual Visitor Days

Data Sources

In order to estimate the local economic impacts of Lake Davis recreational use it is necessary to determine the total annual visitor days for lake users from outside Plumas County. Since no actual count has been made, usage must be estimated from sampling. There are three sources of data that permit estimation of annual use. First, the U.S. Forest Service (USFS) maintains a count of individuals using their campground facilities at the lake. Second, the California Department of Fish and Game (DFG) has done angler surveys and the summary data includes a total count for the days surveyed. Third, surveys were administered and counts made during September and October of 2005 by employees of the Center for Economic Development (CED). The range of estimates annual visitor days derived from the three sets of data is 13,291 to 22,360. Table 1 summarizes the estimates and a brief description of how each estimate was obtained is included in the following three sections.

Table 1: Estimated Annual Recreational Visitor Days at Lake Davis

Primary Data Source	*Description*	*Annual Visitor Days*
USFS Campground Data	Campground use for the years 2001-2005	22,360
DFG Angler Surveys	Based on 2001 angler counts unadjusted	18,041
DFG Angler Surveys	Based on 2001 angler counts adjusted to 2005 using USFS relative campground use	13,291
DFG Angler Surveys	Based on the average of five years of count data collected between 1986 and 2004	16,344
CED Surveys	Based on the average hourly count of recreational users	20,458
CED Surveys	Based on the average hourly weekday and weekend day count of recreational users	17,697

[6] Those who currently catch their daily limit were asked if a halving (a 50% decrease) in their daily catch rate would affect the number of annual visits to Lake Davis. For those answering the question, 46.0 % said that it would decrease their annual use of the lake, with an average reported decrease of 38.09%. However, the relatively small sample size (17) makes the estimates of questionable value and they are not used in this report.

U.S. Forest Service Campground Usage Data

Campground usage data was obtained from the USFS for the years 1996 through 2005. The annual average for the ten year period was 28,807 campers with peak use in 2001, followed by a steady decline, falling to 20,653 campers by 2004. There was a slight increase in 2005 to a total of 21,569 campers. The annual use of Lake Davis in 2005 is obtained by taking the number of campers in that year and adjusting for the number who would come even if the lake were unavailable for use.

In May and June of 1998, prior to the restocking that followed chemical treatment, the total campers at the USFS Lake Davis campgrounds totaled 584, or 6.7% of the 8715 camper 1999-2005 May-June average. Assuming that the difference represents recreational users of the lake, that would imply that 20,124 of the campers are there only because of the availability of the lake. Adjusting for the percent of lake users who camp implies that total annual use by non-residents is 22,360 visitor days.

California Department of Water Resources Creel Surveys

DWR surveys were administered for a number of years, involving twenty-eight days of surveying and angler counts between late April and early November. The 2001 survey is used here for purposes of estimating total annual angler use. In that year angler counts were obtained on twenty-eight days between April 28 and November 15. A total of 542 anglers were counted, or an average of 2.647 per hour. Adjusting for the 2562 fishing hours available annually (14 hours per day for 183 days) that leads to an estimated 2001 angler use of 18,041 visitor days. Adjusting for the difference in campground use between 2001 and 2005, results in an estimated 13,291 visitor days for 2005. If the average for the five years for which the DWR completed counts is used (excluding 1998), annual visitor days are projected to be 16,344. However, since the DWR counts include anglers only, both of these figures probably underestimate total annual visitor days by at least 12.5% (87.5% are primarily visiting to fish).

Current Survey Data Collected for This Study

Survey data collected by CED employees is used to obtain two separate estimates of annual visitor days at Lake Davis. First the average number of recreational users counted per hour of surveying, 2.363, is used to estimate use for September of 2005. The estimate of 2,347 visitor days is then divided by the ratio of total campers in September to the annual total, or 12.91% for 2005. Using this approach the estimated annual non resident usage of Lake Davis for the year 2005 is 20,458 visitor days.

A second method, using separate visitor counts for weekdays and weekend days, yields a lower estimate. Hourly counts for weekend days (3.07) and for weekdays (2.45) are multiplied by the available annual weekend and weekday fishing hours (for May 15-November 15), respectively. Annual non-resident visitor days at Lake Davis for 2005 are estimated to be 17,697 using this approach.

Visitor Spending by Category

Each surveyed visitor was asked to estimate his or her local spending delineated by six expenditure categories: restaurant meals, lodging, transportation, fishing related, groceries, and other local retail. The results are included in Table 2, summarized by total reported spending and spending per visitor day.

Table 2: Local Visitor Spending by Non-Residents: Total and Expenditures Per Visitor Day

Expenditure Category	*Survey Total*	*Per Visitor Day*
Restaurant Meals	$9,692	$7.06
Lodging	$9,680	$7.05
Transportation	$10,614	$7.73
Fishing Related	$3,270	$2.38
Groceries	$6,277	$4.57
Other Local Retail	$3,115	$2.27
Total Local Spending	$42,648	$31.06

The IMPLAN Input-Output Model

In order to determine the total impact on county income and employment, direct visitor expenditures are entered into the appropriate sector of the IMPLAN model for the Plumas County economy. IMPLAN is an input-output model (I-O) that separates the economy into 509 industrial sectors, classifying each according to the primary product or service it provides. The transaction matrix is the model that estimates impacts. The transaction matrix contains the purchases and sales that occur among the various sectors. The column entries are the purchases made by a particular sector from all other sectors included in the model. The row elements are the industry destinations of the sector's sales. The I-O model permits assessment of the total impact of an initial change in income or expenditures. (MIG 2005)

The total impact is the sum of the direct, indirect, and induced impacts. The indirect impacts are the result of purchases (by the sectors directly affected) from local industries supplying inputs. The induced effects are due to the spending of additional income earned through the enhanced business activity generated by the direct impacts. The model output includes estimated impacts on output, income, employment and state and local taxes.

Estimated Local Impacts per 10,000 Visitor Days

Output, Income, Employment, and Revenue Impacts

Table 3 contains the IMPLAN model estimates of the local economic impacts for each 10,000 non-resident visitor days at Lake Davis. The estimates are generated from the direct spending by sector listed in Table 2. The effect on total output, or $414,519, is equivalent to total expenditures or gross business sales within Plumas County. However, since the value of output includes the value of inputs purchased from outside of the ounty, the output effect significantly overstates the impact on incomes within the county.[7] The second row of Table 3 includes the direct, indirect, induced, and total income impacts. Income is defined as the sum of employee compensation, proprietor income, other property income, and indirect business taxes. The direct income effect is the result of visitor spending within the sectors designated in Table 2, while the indirect income impact is derived from purchases of inputs from suppliers within the county. The induced impact is the result of spending of the added income in the industries directly and indirectly affected by the visitor spending linked to the use of Lake Davis. The total income impact is simply the sum of the direct, indirect, and induced impacts, or $242,915 per 10,000 non-resident visitor days.

The employment impacts are included in the last row of Table 3. Visitor spending by non-resident recreational users of Lake Davis generates 9.4 jobs per 10,000 visitor days. However, these are not full-time jobs, but rather they are based on the Department of Commerce definition of employment. Employee compensation per job averages $12,945, far below the average full-time wage rate ($35,840 in 2004) within the county.

Indirect business taxes are included in the income impact and total $35,739 per 10,000 visitor days. Total state and local taxes, including income taxes and contributions to social insurance, are $40,879, with sales taxes ($16,858) and property taxes ($11,412) providing the bulk of the revenues. The local share of revenues is estimated to be $15,262 per 10,000 visitor days.

Table 3: Impacts on Plumas County Output, Income, and Employment per 10,000 Non-Resident Visitor Days

Impact Type	*Direct*	*Indirect*	*Induced*	*Total*
Output	$310,600	$49,809	$54,109	$414,519
Income	$181,595	$27,663	$33,656	$242,915
Employee Compensation	$95,498	$12,862	$13,618	$121,978
Proprietor Income	$38,438	$3,078	$3,038	$44,554
Other Property Income	$18,534	$9,185	$12,926	$40,645
Indirect Business Taxes	$29,126	$2,539	$4,074	$35,739
Employment	7.9	0.7	0.8	9.4

Individual Industry Impacts

Table 4 contains the IMPLAN estimates of total income impacts by sector for the Plumas County economy. The table includes all sectors where income is affected by more than $5,000 per 10,000 visitor days ($0.50 per visitor day), and, the listed sectors receive 77% of the total income impact within the local economy. The greatest income impacts are in

[7] Output can be interpreted as gross business sales and that term is used in place of output in the summary tables at the end of the report. Since the impact of greatest concern for local businesses and employees is income, the majority of the analysis is focused on the effect on local income.

those sectors receiving the most direct visitor spending. Owners and employees in hotels and motels ($50,645); gasoline stations ($48,132); food services and drinking places ($34,794); and food and beverage stores ($27,918) receive the greatest boost to income from visitor spending linked to Lake Davis recreational use.

Table 4: Total Income Impacts by Sector per 10,000 Non-Resident Visitor Days

IMPLAN Sector Number	*Sector Description*	*Total Income Impact*
405	Food and Beverage Stores	$27,918
407	Gasoline Stations	$48,132
409	Sporting Goods	$11,045
431	Real Estate	$7,194
479	Hotels and Motels	$50,645
481	Food Services and Drinking Places	$34,794
509	Owner Occupied Dwellings	$8,379

Estimated Impacts for 2005

Income Impacts

The 2005 impact on the Plumas County economy of spending by recreational users of Lake Davis is calculated by multiplying the impacts per visitor day by the estimated visitor days for that year. Table 1 contains the various estimates for 2005 non-resident visitor days, and while the range is fairly wide (13,291 to 22,360), most of the estimates fall between 18,000 and 22,000 visitor days. Thus, the estimates contained here are based on a mid-range non-resident visitor day estimate of 20,000 with a variance of plus or minus 2,000.

Table 5 contains the estimated impacts of 2005 Lake Davis non-resident visitor spending on income of owners and employees of Plumas County businesses. The estimates include employee compensation, proprietor income, property income, and indirect business taxes. The income impact for the baseline estimate of 20,000 annual visitor days is $485,831, with a possible income impact ranging from a low of $437,238 (18,000 visitor days) to a high of $534,414 (22,000 visitor days).

Table 5: Estimated 2005 Income Impacts on the Plumas County Economy

Impact Estimate	*Direct*	*Indirect*	*Induced*	*Total*
Income: Midrange	$363,191	$55,327	$67,313	$485,831
Employee Compensation	$190,996	$25,724	$27,237	$243,955
Proprietor Income	$76,875	$6,156	$6,076	$89,107
Other Property Income	$37,068	$18,371	$25,851	$81,290
Indirect Business Taxes	$58,251	$5,078	$8,149	$71,478
Income: High	$399,510	$60,860	$74,044	$534,414
Income: Low	$326,872	$49,794	$60,582	$437,248

Estimated income impacts by industry are similarly derived from the Table 4 estimates of impacts per 10,000 visitor days. Table 6 contains the effects on industry income for all sectors receiving income of $0.50 or more per visitor day from spending by Lake Davis recreational users. The largest effect on income is in the hotel and motel sector, with a midrange impact of $101,290, and a range of estimates from a low of $91,161 to a high of $111,420. Other sectors experiencing a midrange income impact in excess of $50,000 include gasoline stations ($96,263), food services and drinking places ($69,588), and food and beverage stores ($55,836).

Table 6: Estimated 2005 Income Impacts by Industry

IMPLAN Sector Number	Sector Description	Midrange	High	Low
405	Food and Beverage Stores	$55,836	$61,420	$50,253
407	Gasoline Stations	$96,263	$105,890	$86,637
409	Sporting Goods	$22,089	$24,298	$19,880
431	Real Estate	$14,387	$15,826	$12,948
479	Hotels and Motels	$101,290	$111,420	$91,161
481	Food Services and Drinking Places	$69,588	$76,547	$62,630
509	Owner Occupied Dwellings	$16,758	$18,434	$15,083

Other Impact Measures

Income is the best measure of the contribution of Lake Davis visitor spending to the Plumas County economy, yet other measures might be useful for some purposes. The impact on county output represents the effect on gross sales, but since it includes the value of industry purchases from businesses outside of the county, it is not an appropriate measure of the impact on local income. In addition, although effects on county employment are generated by the IMPLAN model, the jobs created or sustained are neither full-time, not full-time equivalent jobs. County revenues are included in the income impact estimates as a portion of the entry for indirect business taxes.

Estimates for each of these additional impact measures are included in Table 7, with entries for the midrange, high and low estimates of total 2005 visitor days at Lake Davis. Visitor spending generates a total of $829,039 in output (gross sales) within Plumas County, with the estimated impact ranging from a low of $746,135 to a high of $911,942. A total of between 17.0 and 20.7 jobs result from that spending, with a most likely estimate of 18.8 jobs. Plumas County and the City of Portola receive revenues equal to 6.28% of local income (excluding state and federal aid). Thus estimated 2005 local revenue ranges from a low of $27,471 to a high of 33,576, with the estimate for midrange non-resident visitor days equal to $30,523.

Table 7: Estimated 2005 Impacts on Output (Gross Sales), Employment, and Plumas County Revenue

Impact Type	Midrange	High	Low
Output	$829,039	$911,942	$746,135
Employment	18.8	20.7	17.0
Local Revenues	$30,523	$33,576	$27,471

Study Results: Local Economic Impacts

Assumptions

Fishery Quality

Successful Eradication

With successful eradication of northern pike from Lake Davis it is assumed that the quality of the fishery will double within four years of project completion. The 2003 angler survey indicated a catch rate of 0.12 trout per hour, while in 2000 the catch rate was 0.28 trout per hour. Although the 2000 catch rate was more than double that of 2003, the average fish caught in 2003 was significantly larger. However, the assumptions that the catch rate will only double, and not until four years following completion of the eradication project, are relatively conservative. It is possible that from the anglers' prospective the quality will more than double and that improvement will be achieved in as little as two years after initial restocking. Earlier recovery of fishery quality increases the local economic benefits of both the successful and failed eradication cases.

Failed Eradication

If eradication is unsuccessful it is assumed that the fishery quality will follow a somewhat different path. Following attempted eradication it is assumed that the quality of the fishery will double within four years of project completion, however after that year the catch rate will decline until at the end of ten years it will have returned to current levels.

Visitor Response to Changes in Fishery Quality

The impact of changes in fishery quality on visitor days depends on the response of anglers to the catch rate and the timing of that response. The Lake Davis angler survey performed by the Center for Economic Development (CED) determined that a 100% increase in the catch rate will lead to a 63.2% increase in visitor days. This is very close to the 64.5% response rate from the environmental economics literature and the 63.2% figure from the survey is used in the economic impact analysis performed for each of the pike eradication and management scenarios. It is also assumed that angler visitor days are determined by the previous year's catch rate. Thus the peak for visitor days will always lag the peak for the catch rate by one year. In addition the angler response rate of 63.2% is used for both an increase and a decrease in fishery quality. (Loomis 2005)

Scenario 1: The Preferred Alternative

Table 8 includes the impacts on Plumas County income of both successful and failed eradication using the method proposed under the preferred alternative. In both cases the lake is unavailable for one year and thus for that year visitor days are assumed to be zero. In the second year visitor days return to their pretreatment levels, growing at a 13% annual rate until they reach a peak at 32,600 in year 6. The actual annual growth rate for visitor days is higher than 13% and continues beyond year 6 due to growth in population in those areas from which visitors are drawn. [8]

The income impacts are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenarios.[9] The total contribution to Plumas County income for the 22 years is $17.82 million for the successful eradication case, and, $13.74 million and $11.62 million for the two failed eradication cases.[10] For all of the scenarios the failed eradication cases are delineated according whether the attempt is repeated at 11-year intervals (failed/repeat) or done just once (failed/once). All totals are in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $12.39 million, $9.70 million and $8.51 million for the successful and the two failed eradication cases, respectively.[11]

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[8] The annual rate of growth in visitor days is the weighted average of the projected rates of population growth for California, the Northeastern Counties, and Washoe County Nevada. The weights are from the California Department of Water Resources (DWR 2005) survey of angler origin. The projected rates of population growth are from the California Department of Finance (DOF 2005) and the Nevada State Demographer (NSD 2005). Based on this approach regional population growth is projected to increase visitor days at Lake Davis by 1.03% annually.

[9] There are two failed eradication cases: one assuming eradication is a periodic event repeated every 10 years (11 years including the treatment period for the preferred alternative) and another where eradication fails, but is not attempted again within the 22 year period of the analysis. By including the multiple treatment case, the California Department of Fish and Game is not implying that it contemplates periodic treatments on an 11 year cycle. Obviously the intention is for the primary treatment to be successful and both the failed eradication cases are included only for purposes of comparison with scenario 4, the no action alternative.

[10] The income impacts are derived directly from the visitor day estimates. In order for the improvements in fishery quality to generate an increase in visitor days, it is necessary that potential visitors become aware of the changes in catch rate, and for that to occur, it is necessary that they choose Lake Davis as a fishing destination. For that reason it might be argued that there is a degree of uncertainty in the local income impact estimates. It is true that the level of uncertainty is greater than the 100% chance that the lake will be unavailable during the treatment period, however, anglers did return to the lake after the 1998 treatment and are likely to do so again.

[11] For each of the scenarios analyzed the 22 year totals are presented in both undiscounted and discounted form. The discounted totals place greater importance on income received in earlier years, implicitly recognizing the time value of money. A 3% real discount rate is typically used for decisions involving environmental changes and other public goods and is equal to the real interest rate on relatively risk free investments. The real interest rate is the difference between the nominal interest rate and the rate of inflation.

Table 8: Non-Resident Visitor Days and Impact on Plumas County Income for the Preferred Alternative: Successful and Failed Eradication Efforts

	Visitor Day Estimates			*Income Impacts*		
	With Population Growth			*With Population Growth*		
Years	**Successful**	**Failed/Repeat**	**Failed/Once**	**Successful**	**Failed/Repeat**	**Failed/Once**
1	0	0	0	$0	$0	$0
2	20,206	20,206	20,206	$490,796	$490,796	$490,796
3	23,066	23,066	23,066	$560,271	$560,271	$560,271
4	26,331	26,331	26,331	$639,581	$639,581	$639,581
5	30,059	30,059	30,059	$730,118	$730,118	$730,118
6	34,314	34,314	34,314	$833,470	$833,470	$833,470
7	34,667	31,440	31,440	$842,055	$763,665	$763,665
8	35,024	28,807	28,807	$850,728	$699,706	$699,706
9	35,385	26,394	26,394	$859,491	$641,104	$641,104
10	35,750	24,184	24,184	$868,343	$587,410	$587,410
11	36,118	22,158	22,158	$877,287	$538,213	$538,213
12	36,490	0	21,632	$886,323	$0	$525,434
13	36,866	22,617	21,118	$895,452	$549,357	$512,959
14	37,245	25,819	20,617	$904,676	$627,122	$500,780
15	37,629	29,473	20,128	$913,994	$715,895	$488,890
16	38,017	33,645	19,650	$923,408	$817,234	$477,283
17	38,408	38,408	19,183	$932,919	$932,919	$465,951
18	38,804	35,191	18,728	$942,528	$854,785	$454,888
19	39,203	32,244	18,283	$952,236	$783,194	$444,088
20	39,607	29,543	17,849	$962,044	$717,600	$433,544
21	40,015	27,069	17,425	$971,953	$657,499	$423,251
22	40,427	24,802	17,011	$981,964	$602,432	$413,202
Total				$17,819,638	$13,742,373	$11,624,605
Net Present Value (3% Real Discount Rate)				$12,386,630	$9,697,774	$8,507,678

Scenario 2

Scenario 2 involves drawing the lake down to its minimum capacity, and as a result, using this eradication method involves loss of recreational use of the lake for a period of three years. Table 9 includes the impacts on Plumas County income of both successful and failed eradication using the method proposed under scenario 2. In both cases the lake is unavailable for three years and thus visitor days are assumed to be zero for those years. In the fifth year visitor days return to their pretreatment levels, growing at a 13% annual rate thereafter until they reach a peak of 32,600 in year 8. As with the preferred alternative the actual annual growth rate for visitor days is higher than 13% and continues beyond year 8 as population grows within the area served by Lake Davis.

As in the case of the preferred alternative, the income impacts are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenario, but also considered is the option of treating the lake just once with this method. The total contribution to Plumas County income for the 22 years is lower than for scenario 1 at $16.19 million for the successful eradication case, and, $11.59 million and

$11.72 million for the failed eradication cases, with all in totals in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $10.92 million, $7.89 million and $8.19 million for the successful and two failed eradication cases, respectively.

Table 9: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 2: Successful and Failed Eradication Efforts

	Visitor Day Estimates			*Income Impacts*		
	With Population Growth			*With Population Growth*		
Years	**Successful**	**Failed/Repeat**	**Failed/Once**	**Successful**	**Failed/Repeat**	**Failed/Once**
1	0	0	0	$0	$0	$0
2	0	0	0	$0	$0	$0
3	0	0	0	$0	$0	$0
4	20,624	20,624	20,624	$500,958	$500,958	$500,958
5	23,544	23,544	23,544	$571,872	$571,872	$571,872
6	26,877	26,877	26,877	$652,824	$652,824	$652,824
7	30,681	30,681	30,681	$745,235	$745,235	$745,235
8	35,024	35,024	35,024	$850,728	$850,728	$850,728
9	35,385	32,091	32,091	$859,491	$779,478	$779,478
10	35,750	29,403	29,403	$868,343	$714,194	$714,194
11	36,118	26,941	26,941	$877,287	$654,379	$654,379
12	36,490	0	26,301	$886,323	$0	$638,842
13	36,866	0	25,677	$895,452	$0	$623,674
14	37,245	0	25,067	$904,676	$0	$608,867
15	37,629	23,085	24,472	$913,994	$560,732	$594,411
16	38,017	26,353	23,891	$923,408	$640,107	$580,298
17	38,408	30,084	23,324	$932,919	$730,719	$566,520
18	38,804	34,342	22,770	$942,528	$834,156	$553,069
19	39,203	39,203	22,229	$952,236	$952,236	$539,938
20	39,607	35,920	21,701	$962,044	$872,484	$527,119
21	40,015	32,912	21,186	$971,953	$799,411	$514,603
22	40,427	30,155	20,683	$981,964	$732,459	$502,385
Total				$16,194,237	$11,591,974	$11,719,395
Net Present Value (3% Real Discount Rate)				$10,921,600	$7,893,204	$8,188,873

Scenario 3

Scenario 3 involves drawing the lake down to 48,000 acre feet, and as a result, using this eradication method involves minimal loss of recreational use of the lake. That is because all boat ramps will continue to be usable, and although the lake will not be stocked during year one of this eradication option, some fishing activity will likely continue. Table 10 includes the impacts on Plumas County income of both successful and failed eradication using this method and assuming lake use will be affected for just 50% of year 1. In this case visitor days total 10,000 for year 1 and then return to the current estimated use of 20,000 (plus the effect of population growth) in year 2. As with the other eradication options the improvement in catch rate causes visitor days grow at 13% annually until they reach a peak in year 6 (five years after completion of treatment), while actual use grows at a higher rate, reflecting population growth in the area served by Lake Davis.

The total contribution to Plumas County income for the 22 years is slightly higher than for scenarios 1 and 2 at $18.06 million for the successful eradication case, and, $14.26 million and $11.87 million for the failed eradication cases, all in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $12.62 million of the successful eradication case, and, $10.12 million and $8.74 million for the failed eradication cases.

Table 10: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 3: Successful and Failed Eradication Efforts

	Visitor Day Estimates			*Income Impacts*		
	With Population Growth			*With Population Growth*		
Years	**Successful**	**Failed/Repeat**	**Failed/Once**	**Successful**	**Failed/Repeat**	**Failed/Once**
1	10,000	10,000	10,000	$242,896	$242,896	$242,896
2	20,206	20,206	20,206	$490,796	$490,796	$490,796
3	23,066	23,066	23,066	$560,271	$560,271	$560,271
4	26,331	26,331	26,331	$639,581	$639,581	$639,581
5	30,059	30,059	30,059	$730,118	$730,118	$730,118
6	34,314	34,314	34,314	$833,470	$833,470	$833,470
7	34,667	31,440	31,440	$842,055	$763,665	$763,665
8	35,024	28,807	28,807	$850,728	$699,706	$699,706
9	35,385	26,394	26,394	$859,491	$641,104	$641,104
10	35,750	24,184	24,184	$868,343	$587,410	$587,410
11	36,118	22,158	22,158	$877,287	$538,213	$538,213
12	36,490	11,193	21,632	$886,323	$271,878	$525,434
13	36,866	22,617	21,118	$895,452	$549,357	$512,959
14	37,245	25,819	20,617	$904,676	$627,122	$500,780
15	37,629	29,473	20,128	$913,994	$715,895	$488,890
16	38,017	33,645	19,650	$923,408	$817,234	$477,283
17	38,408	38,408	19,183	$932,919	$932,919	$465,951
18	38,804	35,191	18,728	$942,528	$854,785	$454,888
19	39,203	32,244	18,283	$952,236	$783,194	$444,088
20	39,607	29,543	17,849	$962,044	$717,600	$433,544
21	40,015	27,069	17,425	$971,953	$657,499	$423,251
22	40,427	24,802	17,011	$981,964	$602,432	$413,202
Total				$18,062,534	$14,257,147	$11,867,501
Net Present Value (3% Real Discount Rate)				$12,622,451	$10,124,286	$8,743,499

Scenario 4

Scenario 4, the no action alternative, yields the smallest contribution to Plumas county income. Although there are no years for which visitor days are zero, the postulated declining catch rate attracts fewer visitors each year through year 11. After year 10 it is assumed that the ongoing pike management program successfully halts the decline in the catch rate, but not until the quality of the fishery has declined by 50% from current levels.

As is the case for all of the eradication scenarios, population growth in the areas from which Lake Davis visitors are drawn leads to an increase in annual visitor days, in this case after the minimum is reached in year 11.

The contribution to Plumas County income of spending by Lake Davis visitors is lower than for any of the eradication scenarios. The total for the 22 years is $9.03million in 2005 dollars, while the net present value at a 3% real discount rate is $6.61 million. Even if improved methods of managing northern pike were capable of maintaining the current trout catch rate, all of the pike eradication scenarios result in more income for Plumas County. With base year visitor days at 20,000, and with population growth resulting in an annual increase in visitor days of 1.03%, the total contribution to local income for the 22 year period is $11.93 million, just 67% of the amount generated for the same period using the preferred alternative for pike eradication.

Table 11: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 4: No Action Alternative

	Visitor Day Estimates		*Income Impacts with Population Growth*
Years	*Without Population Growth*	*With Population Growth*	
1	20,000	20,000	$485,792
2	19,326	19,525	$474,258
3	18,675	19,062	$462,998
4	18,046	18,609	$452,005
5	17,438	18,167	$441,274
6	16,850	17,736	$430,797
7	16,167	17,192	$417,587
8	15,511	16,665	$404,782
9	14,882	16,154	$392,370
10	14,279	15,658	$380,339
11	13,700	15,178	$368,676
12	13,700	15,335	$372,473
13	13,700	15,493	$376,310
14	13,700	15,652	$380,186
15	13,700	15,813	$384,102
16	13,700	15,976	$388,058
17	13,700	16,141	$392,055
18	13,700	16,307	$396,093
19	13,700	16,475	$400,173
20	13,700	16,645	$404,295
21	13,700	16,816	$408,459
22	13,700	16,989	$412,666
		Total	$9,025,747
Net Present Value (3% real discount rate)			$6,608,624

Economic Impacts by Pike Management Scenario

Successful Eradication vs. Ongoing Pike Management

Table 12 includes the impacts on annual sales, income, employment, and county revenues for each of the eradication scenarios (scenarios 1-3) and the ongoing pike management scenario (scenario 4). It is clear that from the perspective of the Plumas County economy any of the eradication options, if successful, is preferable to the current pike management option. For the 22 year period covered by the analysis average annual gross sales for Plumas County businesses are higher by $682,100 for the preferred option (scenario 1) relative to ongoing pike management. Average annual Plumas County income, employment, and local revenue are also higher by $399,722, 16 jobs, and $25,113, respectively.

The economic advantage of pike eradication is somewhat greater for scenario 3 with average annual gross sales for Plumas county businesses higher than for the pike management option by $700,940 and exceeding that for the preferred option by $18,840. Income, employment, and county revenues are also somewhat higher than for the preferred option. However, the important result is that, because of the long term impact on the quality of the Lake Davis fishery, successful eradication by any of the means under consideration is preferable to the current strategy of pike management alone.

Table 12: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: Successful Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	*Scenario Number*			
	1	*2*	*3*	*4*
Sales	$1,382,184	$1,256,110	$1,401,024	$700,084
Income	$809,984	$736,102	$821,024	$410,261
Employment	31	29	32	16
Revenue	$50,889	$46,247	$51,583	$25,776

Failed Eradication vs. Ongoing Pike Management

While the results included in Table 12 indicate that successful eradication of pike from Lake Davis would have clear economic advantages for Plumas County, the possibility that any eradication effort might fail must also be considered. In that case pike eradication would be a periodic event (every 11 years) or a one-time effort, with current management techniques employed in the interim. Table 13 includes the impact on Plumas County gross sales, income, employment, and county revenues for each of the failed repeat eradication scenarios. Table 14 includes the economic impacts for a one-time failed eradication effort. For purposes of comparison the management option is also included under scenario 4 in both Tables 13 and 14.

The results clearly indicate that repeating a failed eradication effort is preferable to the current strategy of pike management alone. Using the preferred alternative, average annual gross sales for Plumas County businesses are $365,846 higher than for the management option. Average annual Plumas County income, employment, and local revenue are also higher by $214,392, 8 jobs, and $13,470, respectively. As in the case of successful eradication, the economic advantages of scenario 3 over ongoing pike management are somewhat greater. With this scenario estimated annual gross sales of Plumas County businesses exceed those associated with scenario 4 by $405,775 and are $39,929 higher than for the preferred alternative. Income, employment, and county revenues are also somewhat higher than for the preferred option. [12]

Table 13: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: Repeat Failed Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	*Scenario Number*			
	1	*2*	*3*	*4*
Sales	$1,065,930	$899,134	$1,105,859	$700,084
Income	$624,653	$526,908	$648,052	$410,261
Employment	24	20	25	16
Revenue	$39,245	$33,104	$40,715	$25,776

With the one-time failed eradication cases included in Table 14 there is very little difference in the annual impacts on sales, local income, employment, and local government revenue. Average annual impacts range from $901,665 to $920,505 for gross sales; from $528,391 to $539,432 for income; from 20 to 21 jobs: and from $33,197 to $33,891 for local government revenue. As in the repeat failed eradication cases, the average annual impacts exceed those of scenario 4, using ongoing pike management alone.

Table 14: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: One-Time Failed Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	*Scenario Number*			
	1	*2*	*3*	*4*
Sales	$901,665	$909,017	$920,505	$700,084
Income	$528,391	$532,700	$539,432	$410,261
Employment	20	21	21	16
Revenue	$33,197	$33,468	$33,891	$25,776

[12] It might be argued that the advantages of a failed eradication attempt are overstated due to the assumptions regarding the period of time that the quality of the fishery can be sustained. For each of the scenarios it is assumed that the quality of the fishery improves for the first four years following the eradication project. Yet, there is clear evidence that the catch rate for Lake Davis trout had declined beginning three years after the restocking that followed the 1997-98 effort. However, the assumption of an additional year of sustained growth is reasonable since it is likely that this time around, if pike reappear in the lake, DFG will immediately implement those management techniques that have proven to be most effective. The assumption of an additional year of sustained fishery quality is simply a reflection of the value of previous management experience.

Conclusions

Ranking the alternative methods of dealing with the northern pike problem in Lake Davis is relatively straightforward when the sole criterion is the economic impact on the Plumas County economy. The conclusion based on the analysis contained within this report is that eradication is preferable to the current management program. Even a failed attempt at eradication (repeat or one-time) yields a better economic outcome for Plumas County. Among the alternative methods of eradication proposed scenario 3 yields the greatest local economic benefits, although scenario 1, the preferred alternative, is a close second. Both are preferable, on the basis of economic impact (in all but the one-time failed eradication case), to scenario 2 since the latter implies the loss of the recreational use of the lake for a full three years.

The choice between scenarios 1 and 3 is a difficult one and one that cannot be made on the basis of economic impact alone. For the successful eradication case there is a difference of just $18,840 in the annual effect on gross sales and a difference of $11,041 in the estimated impact on annual local income. While the differences are greater for the repeat failed eradication case, the disparity is insignificant relative to the gap between the successful and failed eradication cases. If eradication were to be unsuccessful, and were to be repeated periodically (every 11 years in this case), under scenario 3, annual business sales would average $295,166 less than for the successful case. In addition, annual income would be lower by an average of $172,972. The disparity between impacts on gross business sales and local income are likewise significant for scenario 1, the preferred alternative. Under this option a failed repeat eradication effort would reduce average annual gross sales and local income by $316,254 and $185,330, respectively.

On the basis of economic impact on the Plumas County economy, a pike eradication effort by any of the proposed methods is preferable to continuing the current pike management program alone. And, since the differences in the impacts among the alternative scenarios are insignificant (at least for scenarios 1 and 3) relative to the local economic cost of a failed eradication attempt, the choice of an eradication method should be made on the basis of which one has the greatest probability of success.

References

California Department of Fish and Game (DFG 2003), *History of Lake Davis Fishery and Management*, Portola field Office, Draft Report, December 15, 2003

California Department of Fish and Game (DFG 2003), *Managing Northern Pike at Lake Davis a Plan for Year 2000: Three Year Report*, September, 2003

California Department of Fish and Game (DFG 2005), *Notice of Preparation of a Draft Environmental Impact Report*, September 2005

California Department of Finance (DOF 2005), Population growth projections for California Counties through 2030, http://www.dof.ca.gov/HTML/DEMOGRAP/DRU_Publications/Projections/P3/P3.htm, December, 2005

California Department of Transportation (DOT 2005), *California: 2005-2025 County-Level Economic Forecast*, http://www.dot.ca.gov/hq/tpp/offices/ote/forecast2005/2005%20all%20county%20Forecast%20Book.pdf

California Department of Water Resources (DWR 2003a), 1986 Lake Davis Creel Census, Memorandum to Kathy Hill dated November 20, 2003

California Department of Water Resources (DWR 2003b), 1998 Lake Davis Creel Census, Memorandum to Kathy Hill dated October 8, 2003

California Department of Water Resources (DWR 2003c), 2001 Lake Davis Creel Census, Memorandum to Kathy Hill dated October 8, 2003

California Department of Water Resources (DWR 2005), Angler origin at Lake Davis 1986-2004, provided by email November, 2005

City of Portola Finance Office, Interview on with Susan Scarlett, August 21, 2006

Graham-Tomasi, T., Adamowicz, W.L. and Fletcher, J.J. (1990), *Errors of Truncation in Approximation to Expected Consumer Surplus*, Land Economics, Vol. 66, No.1, 1990, p. 50-55

Kerkvliet, Joe and Clifford Nowell (2000), *Tools for Recreation Management in Parks: the Case of the Greater Yellowstone's Blue Ribbon Fishery*, Ecological Economics, Vol. 34 (2000), p. 89-100.

Lee 2001, *Northern Pike Control at Lake Davis, California*, American Fisheries Society, 2001

Loomis 2005, *The Economic Value of Recreational Fishing & Boating to Visitors and Communities Along the Upper Snake River*, Colorado State University, Fort Collins, May 2005

Minnesota IMPLAN Group (MIG 2005), IMPLAN model using 2001 data, January 2005

Nevada State Demographer (NSD 2005), Projected population growth for Washoe County, Nevada, http://www.nsbdc.org/demographer/pubs/pop_increase.html, December 2005

Plumas County, Auditor/Controller's Office (PCAC 2006), Interview regarding property and sales tax allocations to Plumas County and the City of Portola, August 17, 2006

Plumas County Budget, http://www.countyofplumas.com/admin/2005-2006_budgetbook.pdf

Save Lake Davis Task Force Steering Committee and the California Department of fish and Game (SLDTFSC/DFG 2000), *Managing Northern Pike at Lake Davis: A Plan for Y2000*, January 2000

U.S. Census Bureau (USCB) 2005, www.census.gov

U.S. Census Bureau (USCBa) 2005, http://quickfacts.census.gov/qfd/states/06000.html

United States Forest Service (USFS 2005), Lake Davis campground use from 1996 through 2005, provided by phone October-November 2005

Appendix A

Resource Valuation

As the previous economic impact analysis has shown, improving the quality of the Lake Davis fishery, by eradicating the Northern Pike, has the potential to increase the local economic benefits of Plumas County. By improving the quality of the fishery we can expect an increase in visitation and expenditures which results in an increase in income to local businesses such as restaurants, gas station owners, motel owners, and other retail businesses. The local community in-turn also benefits as the increase in economic activity also leads to increases in employment, and local government tax revenue. However, expenditures by visitors which contribute income to the local community are costs rather than benefits to the local visitor.

In conventional economics it is generally accepted that measures of economic value should be based on the preferences of individuals. More specifically, the economic value of a resource is measured by the maximum willingness to pay to obtain a good or service. Dollars are a universally accepted measure of economic value because the amount that people are willing to pay for something reflects how much of all other for-sale goods and services they are willing to give up to get it. Under most circumstances individuals must pay an actual price or incur expenses to obtain the good. So, to determine the value that visitors place on the Lake Davis resource, economists estimate consumer surplus or net willingness to pay, which is defined as the difference between the maximum an individual is willing to pay to fish at Lake Davis versus the expenditures paid to fish Lake Davis. For example, if a visitor is willing to pay up to $90 to fish at Lake Davis and incurred $50 in expenses while traveling to and fishing Lake Davis, then the net economic value that the visitor places on Lake is $40. By taking the summation of the consumer surplus or net willingness to pay by all visitors to Lake Davis, we can estimate the value that visitors place on the Lake Davis resource. With improvement in the quality of the fishery, we would expect an increase in visitation and willingness to pay, resulting in an increase in the value of the Lake Davis resource.

Estimation of the value of Lake Davis is accomplished using a travel cost model. The use of travel cost to estimate the demand for recreational sites was first suggested by H. Hotelling in the late 1940's. The model was further developed by Knetsch and Clawson in the 1950's and 1960's and has since gained broad acceptance among resource economists. The literature in resource and environmental economics contains numerous studies using variations on the travel cost model.

This family of approaches to valuing a resource is based on the idea that the cost of getting to a recreational site is a measure of the value individuals place on its use. A demand curve is generated from the various travel costs and the associated number of trips. It is fundamental to economic theory that the higher the price of a good or service the smaller the quantity demanded. In the vernacular of the travel cost model this means that as travel cost increases, as it does with distance from the site, the smaller the number of trips made annually. The total value of the resource is estimated as the area under the generated demand curve but above the average travel cost for all surveyed users.

The individual travel cost method was chosen for the study utilizing surveys to collect data specific to each individual visitor's travel distance and demographic information. Individuals were asked about the distance traveled, travel time, the expenses they incurred traveling, the length of their trip, how much time they spent at the site, the quality of their recreation experience at the site, their perception of the site's environmental quality, characteristics of the site, and residence (used to determine whether they reside in a rural of urban area).

Data Sources

Surveys and visitor counts were conducted at Lake Davis on 13 days in September and October of 2005 and for 12 days during May, June, and July of 2006. Over that time interval 238 parties were surveyed representing 477 individual visitors. (See Appendix B for the actual form used). Interviews were conducted at four boat launch points including Honker Cove, Mallard Cove, Eagle Point, and Camp 5. Some refused to be surveyed, but the majority of those approached willingly participated.

There was an average of 2.01 individuals per interviewed party with 97.4% of those interviewed visiting from outside of Plumas County. The duration of the average visit was 3.14 days, while the average visiting party makes 2.09 trips to Lake Davis annually. Most visitors (87.5%) listed the primary purpose of their visit as fishing, with 5.73% visiting friends and the remainder traveling to the area for business or other recreation. Just fewer than 70% of surveyed visitors stayed in the local area, with 45.96% of those staying locally utilizing campground facilities, 18.01% staying in hotels or motels, 14.91% staying with friends, and the remaining 21.12% listing "other", primarily second homes.

Wage data by county is from the 2000 Census (USCB 2005). Conversion to hourly wage rates is accomplished by dividing by 1948, the average annual hours worked (USCB 2005). Driving distance is calculated from the origin ZIP codes to the destination ZIP codes and cost per mile was obtained from the AAA website.

The Model and Variables Included

The travel cost model specifies a relationship between the number of annual visitor days per travel party from a particular origin to a particular destination and the cost of the trip (travel cost). There are also four dummy variables included, one specifying whether the county of origin is urban or rural, and three that determine whether the visitor is staying at their primary residence, in a cabin or second home, staying with friends, or staying somewhere else, such as campsite or a motel/hotel. The final dummy variable specifies whether the primary purpose of visitation was to fish or to do something else.

Travel cost includes three elements. It is defined as the sum of the direct cost of the trip, the opportunity cost in terms of lost wages for the duration of the trip, and the on-site preparation time for boat launching or getting to a site for fishing. Each of these elements of travel cost is estimated in the conventional manner. Direct travel cost is equal to the cost per mile (56.2 cents) times the number of miles required to make the round trip to the site. Opportunity cost is calculated as 30 percent of the average hourly wage rate for the county of origin times the number of hours of travel time. The cost of preparation time is computed in the same manner, and for all sites is equal to one-half hour times 30 percent of the hourly wage rate. Where there is more than one individual in the fishing party it is assumed that direct travel cost is shared equally among the members.

Where a visitor chose to stay was also accounted for in the analysis. Home is equal to one if a visitor is staying in their primary home, while if a visitor stays elsewhere a value of zero is assigned. Cabin is equal to one if a visitor is staying in a cabin or second home, while if a visitor stays elsewhere a value of zero is assigned. Friend is equal to one if a visitor is staying with friends, while if a visitor stays elsewhere a value of zero is assigned. The coefficient for the cabin and friend variables are expected to be positive because we believe that a visitor is likely to stay longer or visit more often if friends or cabin are present. Conversely, the coefficient for the home variable is expected to be negative because we believe that a visitor is likely to stay over less or visit less if they must drive back to their primary residence. We also believe that the coefficient for the fish variable will be positive, given that fishing is the most popular activity in the area of study.

Whether an area is urban or rural is an important determinant of resident participation in fishing activity. Compared to residents of rural areas, there is a lower probability of an urban resident being a frequent angler (USFWS 1996). The difficulty is in distinguishing rural from urban areas. The definition adopted here is that a county with a population over 750,000 and where 30% or more of the county population lives in a city of more than 100,000 residents is urban. If the ZIP code reported on the survey entry is in an urban county the observation is assigned a zero, while if it is in a rural county a value of one is assigned.

Estimated Equation

The following equation was estimated in log-log form using ordinary least squares.

$$\text{Ln}(\text{Visitordays}/\text{Pop}_{ij}) = a + b\ \text{Ln}(\text{TC}_{ij}) + c\ \text{Cabin}_j + d\ \text{Friends}_j + e\ \text{Home}_j + f\ \text{Fish}_j + g\ \text{Rural}_i$$

Where, for each of the 279 observations representing 11,410 visitor days:

$\text{Ln}(\text{Visitordays}_{ij}/\text{Pop}_{ij})$ is the dependent variable. For each observation it represents the number of visitor days by a traveling party from county of origin, i to destination, j (Lake Davis). It is equal to the number of individuals in the fishing party multiplied by the length of stay multiplied by the number of annual visits, divided by the population (in millions) of the county of origin.

TC_{ij} = travel cost from ZIP code origin, i to Lake Davis (j) =
($0.562*round trip distance in miles)/number in fishing party
+ 0.3*hourly wage rate*round trip travel time
+ 0.3*hourly wage rate*0.5 hours

$Cabin_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is utilizing a cabin or second home (1) or staying someplace else (0).

$Friend_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is staying with a friend (1) or staying someplace else (0).

$Home_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is staying at their primary residence (1) or staying someplace else (0).

$Fish_j$ = 0 or 1 and is a dummy variable indicating whether a visitor's primary purpose for visiting is to fish (1) or something else (0).

$Rural_i$ = 0 or 1 and is a dummy variable defining the county of origin as rural (1) or urban (0)

a – g are the coefficients to be estimated

Coefficient Estimates

The estimated equation is:

Ln(Visitordays/pop) = -6.260177 - 1.280362Ln(TC) + 1.011768Cabin + .7397405 Friend + -1.072858Home + .8982976Fish + 1.348624Rural

Table A1: Regression Coefficients, Standard Errors, and T-Values[13]

Variable	*Coefficients*	*Standard Error*	*t Stat*
Intercept	-6.260177	.6866137	-9.12*
Ln(TC)	-1.280362	.1160389	-11.03*
Cabin	1.011768	.3219867	3.14**
Friend	.7397405	.3675501	2.01**
Home	-1.072858	.2407894	-4.46*
Fish	.8982976	.353026	2.54**
Rural	1.348624	.2766694	4.87*

[13] * Indicates statistically significant variables at the 1% level or better.
** Indicates statistically significant variables at the 5% level or better.

Table A1 contains the coefficients, their respective standard errors and t-values. Table A2 includes the adjusted R-square and F-value for the regression.

Table A2: Regression Statistics: Adjusted R-Square and F-Value

Regression Statistics	
Observations	279
R Square	0.4955
Adjusted R Square	0.4844
F(6, 272)	44.53

Table A1 shows that there is a relationship, significant at the 1% confidence level, between the visitor day variable and the variables for travel cost, staying in a primary residence and counties of origin designated rural. As expected, visitor days and travel cost are negatively related, while visitor days and rural counties of origin are positively related. Visitor days and staying in a primary residence are negatively related. Staying with friends, staying in a cabin or second home, and primary purpose for visiting is to fish are significant and positively related to visitor days at the 5% level.

The 2005 Value of the Lake Davis Fishery Resource to Freshwater Anglers

Using the statistical results from the model and the visitor day use from the U.S. Forest Service (USFS), California Department of Fish and Game (DFG), and the Center for Economic Development (CED) allows estimation of the current (2005) value of the recreation opportunities at Lake Davis. To calculate net WTP on consumer surplus per visitor day for the log-log functional form, we utilize the approximation developed by Graham-Tomasi, Adamowics and Fletcher (1990), if $b < -1$:

$$CS/Q = (1/(b+1) * TC*Q),$$

where Q represents the actual per capita visitor days and TC is the travel cost corresponding to the sample average per capita visitor days. The visitors net WTP per day from the travel cost model is $59.88. Given that nearly 87.5% of visitors indicate that the primary purpose of visiting Lake Davis is fishing, the value of $59.88 per visitor day likely captures the value fisherman place on Lake Davis trout. The estimate of $59.88 per visitor day is consistent with the estimated value of other trout fisheries cited in the environmental and resource economics literature. For example, Loomis (2005) has determined that trout fisheries in the intermountain west to be roughly equal to $50 per day. The 2005 net annual economic value of Lake Davis resource to visitors is the product of the annual number of visitor days and consumer surplus per visit. Since the range of visitor days derived by the USFS, DFG, and CED varies from 17,101 to 26,170, the estimated net economic value falls somewhere between $1,024,008 and $1,567,060, with a probable value of $1,425,743 (based on 23,810 visitor days).

The Impacts on the Value of the Lake Davis Fishery Resource for the Preferred Alternative and No Action Alternative Scenarios

Table A3 includes the impacts on the net resource value of Lake Davis of both successful and failed eradication using the method under the preferred alternative, scenario 1, and the no action alternative, scenario four. We once again assume that visitors respond to changes in fishery quality, with a 100% increase in catch rate leading to a 63.2% increase in visitor days. It as also assumed that angler visitor days will always lag the peak catch rate by one year. For simplicity, we also assume that net WTP per visitor day, $59.88, does not vary as fishery quality varies.[14]

Table A3: The Value of the Lake Davis Fishery Resource under Scenarios 1 and 4

	Visitor Days with Population Growth			*Resource Value*		
	Scenario 4: Management Only	*Scenario 1: Eradication*		*Scenario 1: Eradication*		*Scenario 4: Management Only*
Years		**Successful**	**Failed**	**Successful**	**Failed**	
1	23,810	0	0	$0	$0	$1,425,743
2	23,245	24,055	24,055	$1,440,428	$1,440,428	$1,391,892
3	22,693	27,460	27,460	$1,644,329	$1,644,329	$1,358,845
4	22,154	31,348	31,348	$1,877,094	$1,877,094	$1,326,582
5	21,628	35,785	35,785	$2,142,808	$2,142,808	$1,295,086
6	21,115	40,851	40,851	$2,446,136	$2,446,136	$1,264,337
7	20,467	41,271	37,429	$2,471,331	$2,241,266	$1,225,568
8	19,839	41,696	34,294	$2,496,786	$2,053,554	$1,187,987
9	19,231	42,126	31,422	$2,522,503	$1,881,564	$1,151,559
10	18,641	42,560	28,791	$2,548,484	$1,723,979	$1,116,248
11	18,070	42,998	26,379	$2,574,734	$1,579,591	$1,082,020
12	18,256	43,441	0	$2,601,253	$0	$1,093,165
13	18,444	43,889	26,925	$2,628,046	$1,612,298	$1,104,424
14	18,634	44,341	30,737	$2,655,115	$1,840,529	$1,115,800
15	18,826	44,797	35,088	$2,682,463	$2,101,067	$1,127,293
16	19,020	45,259	40,055	$2,710,092	$2,398,486	$1,138,904
17	19,216	45,725	45,725	$2,738,006	$2,738,006	$1,150,635
18	19,414	46,196	41,895	$2,766,208	$2,508,692	$1,162,486
19	19,614	46,672	38,386	$2,794,700	$2,298,583	$1,174,460
20	19,816	47,152	35,172	$2,823,485	$2,106,071	$1,186,557
21	20,020	47,638	32,226	$2,852,567	$1,929,682	$1,198,778
22	20,226	48,129	29,527	$2,881,948	$1,768,067	$1,211,126
			Total	$52,298,517	$40,332,230	$26,489,494
Net Present Value (3% Real Discount Rate)				$36,353,285	$28,461,815	$19,395,526

[14] It should be noted that there is a vast literature that indicates that WTP estimates are positively related to improvement in catch rates (see Loomis (2005) Kerkvliet and Nowell (2000)). Thus, the estimates of economic value of the Lake Davis Resource will be understated in scenarios in which catch rate improves and overstated in scenarios in which catch rate worsens.

Scenario 1: The Preferred Alternative

Once again, whether the treatment method is successful or the fails the lake is unavailable for one year and thus for that year visitor days are assumed to be zero. In the second year visitor days return to their pretreatment levels, growing at a 13% annual rate (baseline values). The actual annual growth rate for visitor days is higher than 13% and continues beyond year 6 due to growth in population in those areas from which visitors are drawn.

The scenario 1 impacts on the value of the Lake Davis fishery resource are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenario. The total net economic value of the Lake Davis resource for the 22 years is $52.30 million for the successful eradication case and $40.33 million for the failed eradication case. Discounting at a 3% real discount rate results in a total net present value for the net economic value of the Lake Davis resource of $36.35 million and $28.46 million for the successful and failed eradication cases, respectively

Scenario 4: No Action Alternative

Under scenario 4 there are no years for which visitor days are zero, however the postulated declining catch rate attracts fewer visitors each year through year 11. After year 10 it is assumed that the ongoing pike management program successfully halts the decline in the catch rate, but not until the quality of the fishery has declined by 50% from current levels. As is the case for all of the eradication scenarios, population growth in the areas from which Lake Davis visitors are drawn leads to an increase in annual visitor days, in this case after the minimum is reached in year 11.

The total net economic value of the Lake Davis resource with scenario 4 for the 22 years is $26.49 million in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the net economic value of the Lake Davis resource of $19.40. Scenario 4, the no action alternative, clearly yields the smaller value to the Lake Davis resource compared to either a successful or failed attempt of eradication under scenario 1.

Appendix B

Center for Economic Development, California State University Chico
Mailing Address: CSU. Chico, Chico, CA 95929-0765, Phone: 898-4598

The Center for Economic Development at California State University, Chico, is conducting an economic impact study, funded by the California Department of fish and Game, of Lake Davis recreational activities on the Plumas County economy. All responses to questions will be kept strictly confidential.

1. Where is your place of residence?

   City, State, ZIP ______________________________

2. What is the primary purpose of your visit to this area?

   a) Business ________
   b) Tourism or visiting friends ________
   c) Fishing ________
   d) Other recreation ________

3. Approximate travel time (one-way)? ________

4. Are you staying locally? Yes ________ No ________

5. Length of stay (days)? ________

6. Annual number of trips to Lake Davis? ________

7. If you will (or did) stay overnight where will (or did) you stay?
(Check as many as applicable with the number of days at each)

   a) Hotel/motel ________
   b) Friends/relatives ________
   c) Camping ________
   d) Other (Please Specify) ________

8. If Lake Davis were unavailable would you have traveled to the area?

   a) Definitely yes ________ c) Unlikely ________
   b) Probably ________ d) Definitely not ________

9. What are (will be) your total local expenditures on your trip to this area?

   a) Restaurant Meals $__________ d) Fishing related $__________
   b) Lodging $__________ e) groceries $__________
   c) Transportation $__________ f) Other local retail $__________

10. Are you aware of the presence in Lake Davis of the Northern-Pike, a non-native, predatory fish?

    Yes ________ No ________

11. If yes, does that knowledge affect the number of trips you make to Lake Davis Annually?

    Yes ________ No ________ Decrease? ________ Increase? ____________

12. Do you usually catch your daily limit? Yes ________ No ________

13a. If your answer to the previous question was no, would you fish here more often if you caught twice as many fish daily?

    Yes ________ No ________

13b. How many additional trips would you make each year? ________

14a. If you answer to question 12 is yes, would you fish here less frequently if you caught one-half as many fish daily?

    Yes ________ No ________

14b. If so, how many fewer trips per year? ________

Appendix C

Summary of Portola Business Surveys

When Surveys Were Conducted
Surveys of Portola businesses were conducted in late April and early May over a total of three days including attempts at contacting those business owners not responding to the first round of calls

Businesses Surveyed
Businesses were surveyed in the lodging, eating and drinking places, and grocery and other retail sectors. A total of 23 businesses were included in the survey.

Response Rate
Of the 23 businesses included in the surveys, 13 did not respond either because there was no answer, they refused to answer, or phone numbers were changed and no new numbers were available. Of the 10 responding, two were in business only one year and therefore could offer no information on the effects of the 1998 eradication effort. Only five of the contacted businesses were able to answer all of the questions in the survey but eight of the respondents provided enough information for the surveys to be of some use. The description of the results includes those eight responses.

Results
The average length of time the respondents were in business was 19 years and currently they have an average of 6.45 employees. In 1998 they had an average of 4.83 employees. They estimate that 13.2% of their sales are to individuals whose primary destination is Lake Davis. During the 1998 eradication effort the average decrease in sales for those eight businesses was 8.75% with the duration of the loss averaging 9.66 months. Of the affected concerns only one laid off employees at the time with one full-time worker and three part-time workers losing their jobs. None of the surveyed businesses reported closing for any part of the year.