Economic Impacts of Catch Allocation from Commercial Fishery to Recreational Fishery in Hawaii

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Abstract. The recent expansion of the longline commercial fishery has heightened the conflicts among various fisheries in Hawaii, especially between longliners and non-longline commercial (troll and handline) and recreational fishing boats. The recent court ruling against longline fishing on some waters around Hawaiian islands may provide an impetus for the expansion of the non-longline commercial activities, which in turn may give rise to conflicts between non-longline commercial and recreational fisheries. This study examines the economic impacts of the allocation of catch from one non-longline commercial fishing trip to recreational fishing using the 1992 input-output model of the state of Hawaii. The results show that the total impact on value added per unit of fish landed is greater for recreational fishing than commercial fishing, while total impacts on income and employment are greater for commercial fishing. When forward-linked trade and distribution services of final demands are also included, total value added, income, and employment impacts are all higher for commercial fishing and hence net impacts of allocation of the commercial fishery to the recreational/expense fishery are all negative. Furthermore, when the effects of an equivalent decrease in personal consumption expenditures (PCE) of other sectors due to an increase in expenditures in recreational fishing are also included, total losses on value added, income, and employment become more significant. However, relative to direct impacts indirect impacts on value added, income and employment are higher for recreational fishing than for commercial fishing such that the corresponding net indirect effects are positive in all cases.

Keywords: Commercial fishery, recreational fishery, economic impacts, catch allocation, input-output model, Hawaii

1. Introduction

Marine fisheries have a long history in Hawaii, and they have both economic and cultural significance to the state. Fisheries are important to the state economy in terms of their contributions to the local seafood supply, income, and employment. The mild and tropical climate and short distance from shore to deep water make Hawaii one of the world's finest recreational fishing destinations throughout the year. Fishing activities attract tourists to Hawaii and they provide local residents with an opportunity for commercial, subsistence and recreational fishing activities.

During the last two decades, Hawaii's commercial fishery has experienced rapid and significant growth. Most of the growth can be attributed to the expansion in the longline fishery. The expansion of fisheries activities has brought with it significant biological, economic, and social impacts. This has heightened the conflicts among various fisheries and user groups and intensified competition for use of the limited resource. In addition, concern over impacts of endangered species (e.g., sea birds, sea turtles and marine mammals) and the possibility of localized over-fishing has led fishery managers to introduce tighter regulations in the early 1990s and to consider further measures in recent years. These include introduction of limited entry for the longline vessels in 1991 and the closure of nearshore waters also in 1991. Currently, measures aiming to reduce the impacts of longline activities on endangered species (viz., sea birds and sea turtles) are being considered. However, there has been a lack of information on potential economic implications of these regulations.

Broadly speaking, Hawaii's marine fisheries activities can be divided into three major components. They are commercial, charter, and recreational/expense fisheries. Commercial fisheries include longliners, troll and handline, aku (skipjack tuna), bottomfish, lobster, and other commercial boats. In this study, troll and handline, aku, bottomfish, lobster and other commercial fleets are grouped into one non-longline commercial fishery sector as some of these fisheries (such as aku, bottomfish, and lobster) are too small to treat them as separate sectors. The conflict between recreational/expense and longline fisheries has been attenuated after the closure of nearshore waters for longliners in 1991. The recent concern over impacts of longline activities on endangered species and consequent court ruling against longline fishing on certain Hawaiian waters may provide an impetus for the expansion of non-longline commercial activities. This may give rise to the conflict between recreational/expense and non-longline commercial fisheries not only because they fish in the same area but also they use similar gears. We believe this will become a potentially important management issue in the future as the non-longline commercial fishery expands, demands for recreational fishing increases, and fish stock becomes scarce. Thus, in this study the economic tradeoffs of increased allocation from the non-longline commercial fishery to the recreational/expense fishery are estimated. Information presented here reveals the differences between the nature of the two fisheries and their impacts on the economy and hence will be useful in considering future measures relating to management of these fisheries.

The central political issue facing the Hawaii's fishery management is how to balance conflicting interests of different fisheries (Pooley 1993). As noted by Skillman et al. (1993), existing information on distributive issues among different fisheries is inadequate to support fisheries management. Due to the lack of quantitative information and analytical tools on the relative economic importance of the various fisheries components, each regulation is undertaken with a high degree of uncertainty concerning its effects on fishermen and the economy (Pooley 1993). Therefore, to improve fisheries management it is imperative to develop appropriate analytical tools capable of providing fishery managers with reliable and comparable measures of economic impacts of alternative management options from the perspectives of entire fishery as well as of each fishery sector individually. Quantitative models capable of revealing tradeoffs in terms of net economic contributions to the entire economy as well as to each individual fishery sector under different management objectives or under different policy scenarios can be particularly useful in determining appropriate policies for the Hawaii's fisheries management.

Against this backdrop, two analytical tools have been developed recently in order to assist Hawaii's fishery management in determining appropriate regulatory measures and in predicting their economic impacts. The first one is a multilevel and multiobjective mathematical programming model (Pan et al. 1999), while the second one is the modification of the Hawaii state input-output (I-O) model to estimate the economic contributions of Hawaii's fisheries (Sharma et al. 1999). The objective of this study is to examine value added, income, and employment tradeoffs of allocation of catch from non-longline commercial fishery to recreational/expense fishery using the 1992 Hawaii state I-O table. The year 1992 was selected to correspond to the most recent Hawaii state I-O table which depicts the economic conditions in 1992.

2. Input-output Analysis in Fisheries Management

An input-output (I-O) model depicts a comprehensive and detailed set of accounts of sales and purchases of goods and services among producers (industries), final consumers (households, visitors, exports, government, etc.), and resource owners (labor, capital, land) in an economy during a specified time period (usually a year). One of the most important functions of I-O analysis is to assess the economic impacts of changes that are exogenous to the economy, such as those arising from the introduction of new fishery regulations. The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (as amended through 1996) and other Federal Statutes (in particular, Executive Order 12866 [1993] and Economic Analysis of Federal Regulations and the Regulatory Flexibility Act [1996]) require comprehensive economic analyses of any new fisheries management regulations. Consequently, the analysis of economic impacts of fishery regulations has become an essential part of public policy formulation. Economists have used several methods for measuring relative economic value of various fisheries, namely I-O analysis, benefit-cost analysis, travel cost, and contingent valuation. When the analysis involves the measurement of relative importance of fisheries in terms of their actual economic contributions, I-O analysis is perhaps the most appropriate method to use. Edwards (1990), Herrick et al. (1994), and Hushak (1987) describe the use of I-O analysis in the context of fisheries management.

Several studies have applied I-O models in determining the overall economic value of fisheries. Harris and Norton (1978) illustrated the use of an I-O model to examine the income and employment effects of commercial fisheries. Briggs et al. (1982) applied the I-O framework in an economic analysis of Maine's fisheries. King and Shellhammer (1982a, 1982b) employed the I-O model to describe interdependencies between California fisheries and the rest of the state's economy and to determine the economic value of fishing industries in California. Hushak et al. (1986) applied an I-O model of Northern Ohio to examine the economic impacts of increased reallocation of Ohio's Lake Erie fishery from commercial fishing to sport fishing as well as to analyze the relative economic impacts of sport fishing and commercial fishing. The impacts of the North Pacific Fishery Management Council's (NPFMC) proposal of shifting a portion of walleye pollock and pacific cod quotas from the offshore to inshore harvesting sector in waters off Alaska were estimated using both I-O and B-C approaches (NPFMC, 1991; Herrick et al., 1994). More recently, Storey and Allen (1993) conducted I-O analysis to estimate the economic impact of marine recreational fishing in Massachusetts. Several other applications of I-O models to fisheries can be found in Andrews and Rossi (1986) and Hushak et al. (1986). To our knowledge, however, except for Hushak et al. (1986), I-O models have not been applied to measure the net economic contributions of reallocation between recreational and commercial fisheries. As noted by

Berman et al. (1997), the literature estimating the net economic impacts of reallocation between recreational and commercial fisheries using other methods is also limited.

3. Methodology and Data

The 1992 Hawaii state I-O table (DBEDT 1998 and Sharma et al. 1997) originally contained 118 sectors, including one commercial fishing sector (sector # 14) capturing all commercial fisheries production activities, except for fishery services which, following the previous I-O tables, were included in agricultural, forestry, and fishery services (sector # 17) and charter fishing, which was contained in the miscellaneous amusement services (sector # 97). For the purpose of this study, the original model was first aggregated to 69 sectors, including the original commercial fishing sector which was subsequently disaggregated to two different sectors: longline fishery and non-longline commercial fishery (i.e., comprising troll and handline, aku boats, bottomfish, lobster, and others). Aku, bottomfish, and lobster fisheries were combined with troll and handline fishery because of being too small to be analyzed as separate sectors in themselves. Since these fisheries are believed to have fairly similar sales and expenditures patterns as troll and handline boats, it is sensible to combine them as one sector. Besides these two commercial fisheries, two new fishery sectors, namely the charter and recreational/expense fisheries were inserted in the table. Recreational and expense fishing activities were combined into one sector, since the primary motive for both recreational and expense fishing is recreational and their expenditure patterns are quite similar. Thus, the modified I-O table used in estimating the economic tradeoffs between recreational/expense and commercial fisheries include 72 sectors, including 4 fishery and 68 non-fishery sectors. Since the I-O multipliers in the original and modified I-O model were very similar, the aggregated model was adopted for computational convenience.

The most of the data needed to incorporate the four fishery sectors into the 1992 I-O model came from the recent cost-earnings surveys of various fishing boats. These include the cost-earning survey of longline vessels conducted in 1994 (Hamilton et al. 1996), the survey of small commercial, recreational and expense boats (troll and handline) in 1996 (Hamilton and Huffman 1997), and the survey of charter boats during 1997–98 (Hamilton 1998). The sample in cost-earnings analyses included 95 longliners, 569 small boats (including 184 commercial boats, 227 expense boats, and 158 recreational boats), and 63 charter boats. The total number of active boats was 122 for the longline fleet and 188 for the charter fleet. Similarly, following Pan et al. (1999) total numbers of other boats was estimated to be 3,823 (including 381 non-longline commercial, 952 expense, and 2,490 recreational boats). Total statewide economic activities (outputs, input purchases, labor income, and employment) of each of these fisheries were estimated based on corresponding sample averages from the cost-earning surveys and total fleet size. Additionally, to cross-check the estimates based on the cost-earning surveys and to estimate exports and intermediate fish sales, as well as the leakage from fishery sectors, i.e., their imports, 27 fishing suppliers (2 wholesalers and 25 retailers), six repair and dry-dock facilities, and seven fish seafood dealers and brokers in the state were also surveyed. For example, based on information obtained from fishery dealers and suppliers survey only 10% of expenditures on fishing supplies, gears, baits, and boat and equipment was attributed to Hawaii industries and remaining 90% was attributed to imports.

Since the I-O model The inter-industry transactions and technical coefficients for longline and non-longline commercial fishery sectors were estimated based on recent cost-earnings surveys, information obtained from fishery dealers and suppliers surveys, and information on the commercial fishing sector in the original I-O table. The production and sales patterns for the charter boat fishery were estimated using the information contained in the charter boat cost-earnings survey. Since charter boat activities were subsumed under the miscellaneous amusement services sector in the original model, inputs and outputs thus estimated for charter boat fishery were deducted from the amusement sector in the modified table. These procedures are presented in greater detail in Sharma et al. (1999).

Unlike commercial and charter fisheries, the construction of the recreational/expense fishery sector was less straightforward. Expense boats do sell some of their catch to recover part of their fishing expenses, but relative to their total expenditures their total sales are smaller compared to commercial boats. Furthermore, recreational boats do not sell any catch and hence only incur expenses. Similar to Hushak et al. (1986), various expenses (e.g., fuel, bait, supplies, etc.) incurred by local residents on recreational/expense fishing may be thought of as personal consumption expenditures (PCE) on goods and services produced from other industries (such as petroleum refinery and products, manufacturing, trade, etc.). However, this approach poses two problems. First, the intermediate sales of the expense fishery in the form of fish sales cannot be accounted for. Second, treating fishing expenses as final demands precludes the possibility of estimating I-O multipliers for the recreational/expense fishery. Therefore, in this study recreational/expense fishery was defined as a producing sector. The column entries of the sector are the input purchases of goods and services by recreational/expense fishermen from various row sectors. To eliminate double counting, final demands in the original model were adjusted by subtracting these quantities from the PCEs of industries supplying inputs to the recreational/expense fishery. The row shows the intermediate and final sales of fish output and a lump sum of PCE in recreational/expense fishing.

4. Economic Impacts of Hawaii's Fisheries

In 1992, Hawaii's fisheries generated a total of US$98.15 million of output, $37.14 million of value added, $33.16 million of labor income, and 1,426 jobs (Table 1). Non-longline commercial fishery accounted for 14.2% of total fishery output, 16.4% of total labor income, and 25% of total employment generated by total fisheries. The recreational/expense fishery accounted for about one-fourth of total output of fisheries. Likewise, recreational/expense and non-longline commercial fisheries respectively accounted for 37.8% ($18.78 million) and 13.5% ($6.67 million) of total fisheries' input purchases from Hawaii's industries ($49.81 million).

Table 1. Outputs, inputs, and employment of Hawaii's fisheries

	Longline fishery	Non-longline commercial fishery	Charter fishery	Recreational/ expense fishery	Total fishery
Outputs (million of 1992 US$)	43.88	13.92	16.46	23.89	98.15
Intermediate demand	22.41	6.51	0.68	3.06	32.66
Final demand	21.47	7.41	15.79	20.83	65.49
Inputs (million of 1992 US$)	43.88	13.92	16.46	23.89	98.15
Intermediate input	15.44	6.67	8.91	18.78	49.81
Value added	23.74	6.20	7.19	0.00	37.14
Labor income	21.24	5.53	6.39	0.00	33.16
Other value added	2.50	0.68	0.80	0.00	3.98
Imports	4.70	1.04	0.36	5.11	11.21
Employment (number of jobs)	652	357	417	0	1,426

Source: Sharma et al. (1999).

Since the non-longline commercial fishery contributes to direct income and value added in the economy besides purchases from various industries and, by definition, the recreational/expense fishery makes no direct contributions to income and value added, expenditure patterns of the two fisheries are quite different (Table 2). For example, industry purchases account for about two-thirds (78.6%) of total inputs for the recreational/expense fishery compared to less than half (47.8%) for the non-longline commercial fishery. In other words, shares of industry purchases in total inputs are higher for the recreational/expense fishery. Because of value added, including payments to households (i.e., labor income) total input requirements for a non-longline commercial fishery trip ($344.7) are more than twice as those for a recreational/expense trip ($162.4). On a per trip basis, total intermediate input requirements are about 30% higher for the former ($164.7) than those for the latter ($127.7). These differences in total intermediate inputs are attributed to higher oil/fuel and food/ice requirements for the non-longline fishing trips. Important sectors supplying inputs to both of these fisheries include petroleum refinery and products, food processors, transportation equipment, wholesale trade and finance and insurance (Table 2).

In 1992, Hawaii's fisheries accounted for $65.5 million worth of final demand of goods and services, of which 31.8% ($20.83 million) was contributed by the recreational/expense fishery and 11.3% ($7.41 million) by the non-longline commercial fishery. Non-longline commercial and recreational fisheries accounted respectively for $6.51 million and $3.06 million worth of intermediate sales to Hawaii's industries, which are about 20% and 10% of total intermediate sales of the entire fishery. Thus, fishery sectors are linked to the economy both as purchasers of outputs from various Hawaii's industries to support fishery final demands and as suppliers of outputs to support non-fishery final demands. These linkages of Hawaii's fisheries and their output, value added, income, and employment contributions to the economy are examined in detail in Sharma et al. (1999).

5. Economic Impacts of Fishery Reallocation

Of $98.2 million of total output of entire Hawaii's fishery in 1992, the ex-vessel value of fish sold was estimated at $63.1 million. The direct revenue from charter patrons ($15.1 million) and expenditures on recreational/expense fishery ($20.0 million) accounted for the remainder of total fishery output (i.e., $35.1 million). Of total ex-vessel value in 1992, $43.9 million was attributed to longliners, $13.9 million to non-longline commercial boats, $3.9 million to expense boats, and $1.4 million to charter boats.

According to the recent cost-earning survey of troll and handline boats (Hamilton and Huffman 1997), total annual catch of recreational/expense boats in Hawaii was estimated to be 6.4 million lbs and that of non-longline commercial boats to be 4.6 million lbs, with an average per vessel catch of 1,864 lbs and 11,992 lbs, respectively (Table 3). Likewise, total number of annual fishing trips was estimated to be about 147,100 for recreational/expense fleet and about 40,400 for non-longline commercial fleet, with an average per trip catch of 44.4 lbs. and 110.7 lbs., respectively. Thus, in terms of the amount of catch one non-longline commercial trip was equivalent to 2.49 recreational/expense trips. In other words, in terms of present catch rates, reducing one non-longline commercial trip would increase the number of recreational/expense trips by 2.49. Such reallocation would increase the recreational/expense expenses and related activities in the economy and would reduce the activities associated with non-longline commercial fishing. These changes would ultimately translate into changes in each sector's final demand. Due to differences in inter-industry sale and purchase patterns between the two sectors, a given change in final demand in each sector would result in different impacts on the economy. For example, as shown in Table 1 earlier, total final demand accounted for more than 87% of output of the recreational/expense fishery as compared to 53% for non-longline commercial fishery.

Table 2. Input purchases from recreational/expense and non-longline commercial fisheries in Hawaii (in 1992 US$)

Sector	Recreational/expense fishery: Total annual ($ million)	Average/trip ($)	Percent	Non-longline fishery: Total annual ($ million)	Average/trip ($)	Percent
Total intermediate inputs	18.78	127.67	78.6	6.65	164.66	47.8
Food products and ice	2.75	18.70	11.5	1.65	40.86	11.9
Petroleum refining and products	6.20	42.15	26.0	2.13	52.74	15.3
Transportation equipment	3.44	23.39	14.4	0.83	20.55	6.0
Misc. manufacturing products	0.18	1.22	0.8	0.06	1.49	0.4
Transportation	0.60	4.08	2.5	0.15	3.71	1.1
Wholesale trade	2.42	16.45	10.1	0.77	19.07	5.5
Eating and drinking	0.52	3.54	2.2	0.16	3.96	1.1
Retail trade	0.69	4.69	2.9	0.22	5.45	1.6
Finance and insurance	1.98	13.46	8.3	0.68	16.84	4.9
Value added	0.00	0.00	0.0	6.20	153.52	44.5
Labor income	0.00	0.00	0.0	5.53	136.93	39.7
Other value added	0.00	0.00	0.0	0.68	16.84	4.9
Imports	5.11	34.74	21.4	1.04	25.75	7.5
Total inputs	23.89	162.41	100.0	13.92	344.67	100.0

Source: Sharma et al. (1999).

In 1992, total final demands (i.e., including PCEs, exports, and visitors' expenditures) for recreational/expense and non-longline commercial fisheries were estimated to be $20.83 million and $7.41 million, or equivalently $141.6/trip and $183.5/trip, respectively (Table 3). Fishery final demands also create demands for services of various trade and distribution sectors involved in forward sales of the seafood products from harvest to final consumers. These forward-linked services or margins for recreational/expense and non-longline commercial fisheries were estimated to be $0.41 million ($2.8/trip) and $3.49 million ($86.4/trip), respectively. Thus, including forward-linked margins, per trip final demands of recreational/expense and non-longline commercial fisheries were estimated to be $144.4 and $269.9, respectively (Table 3).

Let us assume the allocation of catch of one non-longline commercial trip to the recreational/expense fishery. This would increase the number of recreational/expense trips by 2.49. This would be equivalent to an increase in final demand of recreational/expense fishery by about $353.1 without forward-linked trade and distribution services and $360.0 with trade and distribution services. This will be associated with a decrease in final demand of the non-longline commercial fishery by $183.5 without and $269.9 with forward-linked margins.

Table 3. Estimation of the changes in final demands and related forward-linked margins in recreational and other commercial fisheries due to the reallocation of commercial fishery catch to recreational fishery

	Recreational/expense	Non-longline commercial
Number of total boats in Hawaii	3,442	381
Average catch/boat/year (lbs)	1,864	11,992
Total catch/year (million lbs)	6.4	4.6
Average number of trips/boat/year	42.0	108.3
Average catch/trip/vessel (lbs)	44.4	110.7
Total number of trips/year	147,098	40,386
Total final demand ($ million)	20.83	7.41
Final demand plus trade and distribution services/trip ($)	144.39	269.90
Final demand/trip ($)	141.60	183.48
Forward-linked trade and distribution services/trip ($)	2.79	86.42

These changes in final demands and related forward-linked margins can be used in conjunction with output, value added, income, and employment I-O multipliers to estimate the direct, indirect, and total economic impacts of catch allocation from other commercial fishery to recreational/expense fishery. Output, value added, income, and employment multipliers (Type I) for recreational/expense and non-longline commercial fisheries are presented in Table 4. Also presented in Table 4 are corresponding impacts of changes in PCEs of all sectors other than the recreational/expense fishery. This information will be used in computing net economic impacts of the increase in recreational/expense fishing expenditures vis-à-vis the corresponding decrease in PCEs of other sectors in the economy. Similar to expenditure patterns, I-O multipliers are also quite different between the two fisheries. For example, as shown in Table 4, the output multiplier that shows a change in output resulting from a $1 change in final demand is higher for the recreational/expense fishery, while value added, income, and employment multipliers (i.e., changes in value added, income, and employment due to a change in final demand) are higher for the non-longline commercial fishery. The output multiplier is higher for the recreational/expense fishery due to higher shares of inter-industry purchases in its total input requirements, while value added, income, and employment multipliers are lower due to the absence of direct value added and payments to households.

Table 4. Output, income, and employment multipliers for recreational/expense fishery, non-longline commercial fishery and non-recreational/expense PCE in Hawaii

Multipliers	Recreational/ expense fishery	Non-longline commercial fishery	Non-recreational/ expense fishery PCE
Output ($/$ final demand)	1.98	1.61	1.32
Value added ($/$ final demand)	0.39	0.68	0.83
Income ($/$ final demand)	0.25	0.54	0.49
Employment (jobs/$million of final demand)	8.52	30.89	18.48

Estimated direct, indirect and total value added, income, and employment impacts of the allocation of catch from one non-longline commercial fishery to the recreational/expense fishery are presented in Table 5. These estimates are presented both with and without including the forward-linked trade and distribution services. With present catch rates and expenditures patterns and with no forward-linked trade and distribution services, the allocation of catch from one non-longline commercial trip to the recreational/expense fishery would increase total value added by $13.0, reduce income by $12.4 and reduce total employment by 2.7 jobs per 1000 commercial trips. When forward-linked trade and distribution services are also included, the net impacts of the allocation would include a loss of value added and income by $59.2 and $57.8, respectively and a loss of employment by 4.6 jobs for every 1000 non-longline commercial trips. The direct net value added, income and employment effects of the allocation of non-longline commercial fishery to recreational/expense fishery are all negative simply because, as mentioned earlier, the recreational/expense fishery makes no direct contributions to value added, income and employment. However, indirect net impacts of the proposed reallocation on value added, income, and employment are all positive both with and without forward-linked distribution services, although these impacts are smaller when the forward-linked services are included. This is not only due to a larger change in final demand of recreational/expense fishery than non-longline commercial fishery, but also due to higher indirect effects relative to direct effects in the former. The above analysis represents a situation where increased expenditures involved in additional recreational/expense fishing would have no effect on existing PCEs of other sectors in the economy. The allocation of out-of-state vacation expenses by local residents for additional recreational fishing trips in Hawaii can be an example. Another likely scenario would be the allocation of PCEs of other sectors to expenses for additional recreational fishing. Thus, the allocation of the non-longline fishery to the recreational fishery would be associated additional impacts due to the allocation of other PCEs to increased recreational fishing activities. Thus, the economic impacts of fishery allocation including the effects through other PCEs are presented in Table 6. Accordingly, when the effects through other PCEs are also considered both direct and total net economic impacts of the proposed allocation are negative. The increase in recreational fishing at the expense of one non-longline commercial fishing trip would result in a loss of total income and value added by $185.4 and $280.1, respectively and loss of employment by 9.2 jobs per 1000 commercial trips. However, it should be noted that net indirect effects are all positive.

Table 5. Economic impacts of the reallocation of non-longline commercial fishery catch to recreational/expense fishery in Hawaii

	Direct		Indirect		Total	
	Without margins	With margins	Without margins	With margins	Without margins	With margins
Income ($/commercial trip)						
Recreational/expense fishery	0.00	3.22	87.12	87.80	87.12	91.02
Non-longline commercial fishery	-72.80	-111.67	-26.74	-37.14	-99.54	-148.81
Net impact	-72.80	-108.45	60.38	50.66	-12.42	-57.79
Value added ($/commercial trip)						
Recreational/expense fishery	0.00	5.08	137.29	138.48	137.29	143.56
Non-longline commercial fishery	-81.71	-143.86	-42.59	-58.93	-124.30	-202.79
Net impact	-81.71	-138.78	94.70	79.55	12.99	-59.23
Employment (number of jobs/1000 commercial trips)						
Recreational/expense fishery	0.00	0.14	3.02	3.04	3.02	3.19
Non-longline commercial fishery	-4.70	-6.44	-0.97	-1.36	-5.67	-7.80
Net impact	-4.70	-6.30	2.05	1.68	-2.65	-4.61

Table 6. Economic impacts of the reallocation of non-longline commercial fishery catch to recreational/expense fishery in Hawaii including the effects on other PCEs in the economy

	Direct	Indirect	Total
Income ($/commercial trip)			
Recreational/expense fishery	0.00	87.12	87.12
Non-longline commercial fishery	-72.80	-26.74	-99.54
Other PCE	-130.63	-42.37	-173.00
Net impact	-203.43	18.01	-185.42
Value added ($/commercial trip)			
Recreational/expense fishery	0.00	137.29	137.29
Non-longline commercial fishery	-81.71	-42.59	-124.30
Other PCE	-225.96	-67.08	-293.04
Net impact	-307.67	27.62	-280.05
Employment (number of jobs/1000 commercial trips)			
Recreational/expense fishery	0.00	3.02	3.02
Non-longline commercial fishery	-4.70	-0.97	-5.67
Other PCE	-5.06	-1.47	-6.52
Net impact	-9.76	0.59	-9.18

6. Discussion and Conclusions

Similar to most previous I-O applications to fisheries, using I-O multipliers for recreational/expense and non-longline commercial fisheries (troll, handline, aku, lobster, and bottomfish fisheries) in conjunction with changes in their final demands we have estimated the economic tradeoffs of allocating the catch of one non-longline commercial fishing trip to the recreational/expense fishery. As discussed above, relative to non-longline commercial fishing activities, recreational/expense fishing have generally lower impacts in terms of value-added, lower income and employment, especially when impacts of decrease in other PCEs due to increase in expenditures for recreational fishing are also considered. This information can be useful in considering new fishery regulations with respect to their overall impacts on the economy as well as on the affected fisheries themselves. While the traditional benefit-cost analysis (BCA) focuses on the net benefits in terms of economic welfare taking into account both the market and non-market nature of the benefits (as in recreational fishing), it does not provide an economy-wide impact assessment. In other words, only the net benefits to the constituents of the fishery sector are assessed in traditional BCA. In addition, traditional BCA measures only the net benefits in terms of the single criterion of economic efficiency. While maximizing economic efficiency is generally considered to be an important goal for fishery management, maximizing economy-wide or regional income and employment can also be equally important. In this paper, we argue that in evaluating the allocation of catch from commercial to recreational fishery, I-O analysis can provide an added dimension in terms of economy-wide assessments of outputs, value-added, income and employment not available through traditional BCA. This is by no means to imply that BCA is not useful but rather to point out that additional information for fishery management can be furnished using I-O analysis as demonstrated in this paper. An expanded BCA incorporating the multitudes of fishery management objectives and economy-wide assessments can be a fruitful framework for further research.

However, the results presented here pertain to the special case that the allocation of commercial catch is fully exploited by increasing the number of recreational/expense trips without altering the catch rates and expenditure patterns. In reality, the behavior of fishermen may be quite different with different impacts on the economy. The recreational catch rates may increase due to the allocation of commercial fishery to recreational fishery, thus requiring fewer than 2.49 additional recreational trips to fully exploit the harvest of one commercial trip. It is also possible that recreational/expense boats may not fully exploit the allocation from the commercial fishery. For example, recreational/expense fishers do not necessarily catch the same composition of species as the non-longline commercial fishers. In both cases, increases in expenditures or final demands of the recreational/expense fishery would be smaller than those anticipated under the model and hence economic losses due to proposed allocation would be higher. Similarly, economic losses of the allocation of the non-longline commercial fishery to the recreational fishing also would depend on whether the increased expenditures for recreational fishing would come externally (e.g., substitution of out-of-state vacation expenses for recreational fishing) or internally (i.e., allocation of PCEs from the other sectors in the economy to recreational fishing activities). For these reasons, the results provide a range of economic impact estimates of the proposed fishery allocation. Furthermore, it should be noted that the impact estimates presented here are based solely on actual expenditures allocated to recreational fishing by Hawaii's residents without considering non-market values of recreational fishing.

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