A Method For Estimating Benefits To Fishermen Of A Channel Dredging Project

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Considerable discussion has already taken place regarding the limitations of benefit-cost analysis. The purpose of this paper is not to engender further debate concerning the merits of benefit-cost analysis, but rather to present a framework and example of application of benefit-cost analysis to a problem facing the fishing industry.

Often benefits of a proposed project are estimated by calculating some average benefit per consumer and then multiplying times the number of beneficiaries. In the analysis of a river dredging project the degree of benefit will be directly related to the size of boat using the river, and the depth to which the channel is dredged. To estimate benefits based on an average vessel draft and one channel depth, though more easily calculated, would be less representative of the actual benefits.

The proposed dredging of a channel in the Folly River in South Carolina would result in two categories of benefits. First an increase in the amount of fishing time and thus increased catch, and secondly a reduction in accidental hull damages presently sustained by vessels attempting to transit shoals without sufficient under-keel clearances. Implicit in the analysis of the first category of benefits is the assumption that with increased fishing time, the boats will be able to maintain existing catch-rates, and that the resource (shrimp) is not being fully utilized so that increased catches by Folly River boats do not in fact decrease the catch of other boats.

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The boats using the Folly River inlet presently have to time their departures and returns with the tidal changes. The deeper the draft of a boat the greater the delay and also the greater the likelihood of hull damage.

In the analysis that follows, benefits of a channel dredging were estimated for each boat using the inlet. The benefits for each boat were differentiated based on the draft of the boat, catch rates and variable costs for different size boats, and number of days per trip. The analytical framework summarizes the benefit calculations for each boat.

The Analytical Framework

Benefits = net value of increased catch + value of reduced hull damage

Net value of increased catch = increase in time available for fishing times a utilization factor times catch rate times price minus variable cost per hour times hours utilized

Value of reduced hull damage = hull damage without channel minus hull damage with channel

Increase In Time Available And Utilized

The increase in time available for fishing will equal the difference between the time available with the channel improvement and time available without it. For each boat using the Folly River inlet the static draft and number of days per trip were obtained. (Table 1) With an existing channel depth of approximately four feet, larger boats

TABLE 1

INCREASE IN ACTUAL TRAWLING TIME
FOR
IMPROVED CHANNEL WITH 10 FOOT DEPTH

- 1 -	- 2 -	- 3 -	- 4 -	- 5 - Depth Required 3/		- 6 - Rise of Tide Required 4/		- 7 - Total Possible Time At Sea 5/		- 8 -	- 9 -	- 10 -
Vessel Number	Vessel Length (feet)	Static Draft 1/ (feet)	Mode of Operation 2/ (Days/Trip)	Hazardous Operation (feet)	Safe Operation (feet)	Hazardous Operation (feet)	Safe Operation (feet)	W/O Project Haz. Cond. (Hrs/Mo.)	W/Project Safe Cond. (Hrs/Mo.)	Increased Time At Sea Due To Channel Improvement 6/ (Hrs/Mo)	Utilization Factor 7/	Actual Increase in Trawling Time 8/ (Hours/Year)
1	26	2.0	1	3.0	5.0	0	0	330	330	0	1.99	0
2	25	2.5	1	3.5	5.5	0	0	330	330	0	1.77	0
3	26	2.5	1	3.5	5.5	0	0	330	330	0	2.57	0
4	28	3.0	1	4.0	6.0	0.0	0	326	330	4	2.25	9
5	33	3.0	1	4.0	6.0	0.0	0	326	330	4	2.57	10
6	30	3.5	1	4.5	6.5	0.5	0	313	330	17	2.25	38
7	33	3.5	1	4.5	6.5	0.5	0	313	330	17	2.57	43
8	33	3.5	1	4.5	6.5	0.5	0	313	330	17	2.57	43
9	40	3.5	1	4.5	6.5	0.5	0	313	330	17	2.84	48
10	35	4.0	1	5.0	7.0	1.0	0	300	330	30	2.57	77
11	39	4.0	1	5.0	7.0	1.0	0	300	330	30	2.84	85
12	40	4.0	1	5.0	7.0	1.0	0	300	330	30	2.84	85
13	40	4.0	1	5.0	7.0	1.0	0	300	330	30	2.84	85
14	47	4.5	1	5.5	7.5	1.5	0	285	330	45	3.01	135
15	45	5.0	1	6.0	8.0	2.0	0	270	330	60	3.01	180
16	48	5.0	1	6.0	8.0	2.0	0	270	330	60	3.15	189
17	50	5.5	1	6.5	8.5	2.5	0	243	330	87	3.15	274
18	52	6.0	2	7.0	9.0	3.0	0	319	375	56	3.15	176
19	55	6.0	2	7.0	9.0	3.0	0	319	375	56	3.25	182
20	59	6.5	2	7.5	9.5	3.5	0	302	375	73	3.35	244
21	60	6.5	2	7.5	9.5	3.5	0	302	375	73	3.35	244
22	63	6.5	2	7.5	9.5	3.5	0	302	375	73	3.42	249
23	65	7.0	3	8.0	10.0	4.0	0.0	316	390	74	3.42	253
24	65	7.0	3	8.0	10.0	4.0	0.0	316	390	74	3.47	257
25	63	7.0	3	8.0	10.0	4.0	0.0	316	390	74	3.47	257
26	71	7.0	3	8.0	10.0	4.0	0.0	316	390	74	3.47	257
27	80	7.0	3	8.0	10.0	4.0	0.0	316	390	74	3.56	263

1/ Loaded draft of a stationary vessel.
2/ Mode of operation is the number of days a vessel usually remains at sea each trip.
3/ Depth required to transit shoals under dynamic conditions. For the inside channel, the depth required equals static draft plus one foot for hazardous operation and static draft plus three feet for safe opera
4/ Rise of Time Required is for present conditions, the difference between the depth required for hazardous conditions and the present controlling depth (4 feet inside, 6 feet outside) or for an improved channel, the difference between the depth required for safe operating conditions and the proposed improved channel depth.
5/ Time available at sea from tidal cycle analysis.
6/ Difference between times available with and without channel improvement.
7/ Utilization factor converts the monthly increase in time available at sea to the amount of time per year which a trawler that size will actually utilize for trawling.

$$U.F. = 7\ mo/yr \times \frac{No.\ of\ Days\ of\ Operation}{210\ Days\ Available\ per\ season} \times \frac{8\ hrs\ trawling}{11\ hrs\ at\ sea}$$

8/ Column 8 times column 9.

have to wait for the tide to rise to enter or exit. Also depending on the number of days per fishing trip each boat is more or less impeded by the lack of a deep channel. With this information an estimate of the total possible time at sea with and without channel improvement was derived. The increased time available at sea was then multiplied times a utilization factor (U.F.) to estimate the increase in trawling time to the Folly River boats. (Table 1, Column 10)

$$\text{U.F.} = 7\ \text{mo/yr}^{*} \times \frac{\#\ \text{days of operation}}{\#\ \text{days per season}} \times \frac{8\ \text{hrs trawling}}{11\ \text{hrs at sea}}$$

Increase In Catch And Net Revenues

The increase in catch is determined by multiplying the increase in trawling time by the likely catch rate. The rate of catch is a function of many variables: stock available, captain's skill and judgment, equipment employed and size of vessel. Many of these variables are interrelated. With only limited catch versus effort data available for South Carolina Shrimp boats it was decided to use length of vessel as a measure of effort. The estimated catch rate times the increase in trawling time equals the increase in catch. (Table 2, Column 4)

The ex-vessel price of shrimp was determined by taking a weighted average of monthly figures for the Central District for South Carolina. This price ($2.10 per lb.) was multiplied times the increase in catch to estimate the increase in gross revenues. (Table 2, Column 5)

Variables costs per hour were then estimated as a function of vessel size and multiplied by increase in trawling time to determine change

* The shrimp season is regulated in South Carolina approximately seven months per year.

1/ From Tidal Cycle Analysis
2/ From Marine Business Aids
3/ Column 2 times Column 3
4/ Column 4 x 2.10 $$/lb
5/ From Marine Business Aids
6/ Column 2 times Column 6
7/ Column 5 minus Column 7

TABLE 2

BENEFIT CALCULATIONS FOR 10' PROJECT DEPTH

- 1 - Vessel Number	- 2 - Increase in Trawling Time 1/ (Hrs/Yr)	- 3 - Effective Catch Rate 2/ (Lbs/Hr)	- 4 - Increase in Catch 3/ (Lbs/Yr)	- 5 - Increase in Gross Revenues 4/ ($$/Yr)	- 6 - Effective Rate of Variable Costs 5/ ($$/Hr)	- 7 - Increase in Variable Costs 6/ ($$/Yr)	- 8 - Increase in Net Revenues 7/ ($$/Yr)
1	0	15.5	0	0	7.00	0	0
2	0	15.0	0	0	6.00	0	0
3	0	17.0	0	0	9.00	0	0
4	9	16.0	144	302	8.00	72	230
5	10	17.0	170	357	9.00	90	267
6	38	16.0	608	1,276	8.00	304	972
7	43	17.0	731	1,535	9.00	387	1,148
8	43	17.0	731	1,535	9.00	387	1,148
9	48	18.0	864	1,814	10.00	480	1,334
10	77	17.0	1,309	2,748	9.00	693	2,055
11	85	18.0	1,530	3,213	10.00	850	2,363
12	85	18.0	1,530	3,213	10.00	850	2,363
13	85	18.0	1,530	3,213	10.00	850	2,363
14	135	19.5	2,632	5,527	11.00	1,485	4,042
15	180	19.5	3,510	7,371	11.00	1,980	5,391
16	189	21.0	3,969	8,334	12.00	2,263	6,066
17	274	21.0	5,754	8,335	12.00	3,288	8,795
18	176	21.0	3,696	7,761	12.00	2,112	5,649
19	181	23.0	4,163	8,742	12.00	2,353	6,389
20	244	25.5	6,222	13,066	14.00	3,416	9,650
21	244	25.5	6,222	13,066	14.00	3,416	9,650
22	249	28.5	7,096	14,901	15.00	3,690	11,166
23	252	28.5	7,182	15,082	15.00	3,780	11,302
24	256	32.0	8,192	17,203	16.00	4,096	13,107
25	256	32.0	8,192	17,203	16.00	4,096	13,107
26	256	32.0	8,192	17,203	16.00	4,096	13,107
27	263	37.5	9,862	20,710	18.00	4,734	15,976
			TOTAL - 94,0[illegible]				TOTAL - 147,640

in variable costs. Crew share and non-owner captain's share were not included as variable costs. The crew and non-owner captain are generally paid a share of the value of the catch (usually around 40% of total). The Tax Reform Act of 1976 changed the status of crew members of fishing vessels with fewer than ten members who are paid a share of the catch, to self-employed. The value of the catch payed to crew members was then considered a benefit rather than a variable cost.

Benefits of channel dredging from increased trawling time were then calculated by simply subtracting total variable costs from the value of increased catch for each boat. (Table 2, Column 8)

Value Of Reduced Hull Damage

The second category of benefits, those stemming from reduction of accidental hull damages can be estimated by determining the frequency and amount of yearly damages and comparing them with annual damages which could be expected with an improved channel. The difference between these figures provides an estimate of the yearly benefit from vessel damage reduction.

For each vessel, the yearly cost of repairs necessitated by groundings will be dependent on two main factors, frequency of grounding and the dollar cost of repairs for each incident. The frequency of groundings will depend on how much clearance is provided under the keel to account for dynamic conditions. Deeper draft vessels which are forced to operate with little or no keel clearance will run aground more often than those which because they require less depth, can allow more clearance. The cost of repairs will generally be a function of vessel size.

Table 3 contains estimates of the relationship between repair costs

TABLE 3

ANNUAL REPAIR COSTS INCURRED

BY

FOLLY RIVER SHRIMP BOATS

Vessel Length (In Feet)	Approximate Annual 1/ Cost of Hull Repairs Necessitated by Groundings (In Dollars)
20	100
25	150
30	200
35	250
40	300
45	400
50	500
55	600
60	700
65	800
70	900
75	1,000
80	1,100

1/ This is an approximation of vessel damages incurred by vessels transiting shoals with only 1-foot keel clearnace as reported in reponses to fishermans questionnaire.

and vessel size. This information was developed from estimates of repair costs incurred by vessel operators who responded to a questionnaire soliciting information on the navigational difficulties of Folly River.

Table 4 projects the amount of damages which could be expected for channel improvements of increasing depth. For vessels operating with one foot or less keel clearance (K.C.), the damage experienced is 100% of that found in Table 3 for a vessel that size. If three feet of keel clearance is available, the damage is reduced to zero. Between these figures, it is assumed that damages expected will be 25% of Table 3 values for 2.5 feet of clearance, 50% for 2.0 feet and 75% for 1.5 feet. Thus, for a 50' long, 6' draft vessel, the damage under present conditions will be 100% x $500 = $500; if a seven-foot channel is provided, the keel clearance will still be only one-foot and 500 dollars worth of hull damage could be expected. If, however, an eight-foot channel is provided, the keel clearance becomes two feet and the expected damage is 50% x $500 = $250. Likewise, if a 9' channel is provided, K.C. = 3 feet and damages are reduced to zero. Table 4 shows these projections for the entire Folly River Fleet. The vessel damage reduction benefit is the difference between the total for each proposed depth and that for present conditions. Results of this analysis are shown in Table 4.

Summary Of Benefits

Using this method of benefits calculation, it was estimated that dredging the Folly River inlet to a depth of ten feet would result in: an annual net increase in shrimping returns of $147,600 and a vessel damage reduction of $12,600. The estimated annual cost of channel

TABLE 4

VESSEL DAMAGE REDUCTION CALCULATION

Vessel Number	Length (Ft)	Static Draft (Ft)	Present Keel Clearance (Ft)	Present Damage Estimate ($$/Yr)	Expected Damages [1] For Different Inner Channel Depths			
					7'	8'	9'	10'
1	26	2.0	2.0	75	0	0	0	0
2	20	2.5	1.5	75	0	0	0	0
3	36	2.5	1.5	188	0	0	0	0
4	28	3.0	1.0	200	0	0	0	0
5	33	3.0	1.0	250	0	0	0	0
6	30	3.5	0.5	200	0	0	0	0
7	33	3.5	0.5	250	0	0	0	0
8	33	3.5	0.5	250	0	0	0	0
9	40	3.5	0.5	300	0	0	0	0
10	35	4.0	0	250	0	0	0	0
11	39	4.0	0	300	0	0	0	0
12	40	4.0	0	300	0	0	0	0
13	40	4.0	0	300	0	0	0	0
14	47	4.5	0	400	100	0	0	0
15	45	5.0	0	400	200	0	0	0
16	48	5.0	0	500	250	0	0	0
17	50	5.5	0	500	375	125	0	0
18	52	6.0	0	500	500	250	0	0
19	55	6.0	0	600	600	300	0	0
20	59	6.5	0	700	700	525	175	0
21	60	6.5	0	700	700	525	175	0
22	63	6.5	0	800	800	600	200	0
23	65	7.0	0	800	800	800	400	0
24	68	7.0	0	900	900	900	450	0
25	68	7.0	0	900	900	900	450	0
26	71	7.0	0	900	900	900	450	0
27	80	7.0	0	1,100	1,100	1,100	550	0
HULL DAMAGES				12,638	8,825	6,925	2,850	0
DAMAGE REDUCTION (BENEFIT)				0	3,183	5,713	9,788	12,638

[1] Expected damage = Cost for vessel of that length x
100% for keel clearance = 1.0
75% for keel clearance = 1.5
50% for keel clearance = 2.0
25% for keel clearance = 2.5
0% for keel clearance = 3.0

dredging was approximately $100,000, which then yields a benefit-cost ratio of 1.6.

By allocating benefits, according to the degree boats are impeded by the existing conditions, a more representative estimate of benefits was derived. Not included in the calculations were the recreational benefits of the channel dredging. Few recreational boaters presently use the Folly River inlet, though a major sea island resort is being developed nearby. Present law requires that one half of the recreational benefits be re-captured, which would be difficult to accomplish in this case. Using the framework presented in this paper, a more representative estimate of the benefits to the fishing industry of a channel improvement can be derived.