

APPENDIX I: An Economic Analysis of the Catch Composition in a “Light-Touch” Trawl Gear Survey Targeting California Halibut in the Monterey Bay, California

May 7, 2014

An Economic Analysis of the Catch Composition in a “Light Touch” Trawl Gear Survey Targeting California Halibut in Monterey Bay, California

*Naresh C. Pradhan*¹

Executive Summary:

An economic analysis was carried out on the catch composition resulting from experimental trawls targeting California halibut in the Monterey Bay with a vessel using “light touch trawl” gear (i.e., a modified “bottom trawl” gear). The analysis examined the economic feasibility of using the modified gear to target California halibut in the Monterey Bay during the normal commercial fishing season (June to August). It evaluated the differential economic returns for fishing halibut in the Monterey Bay versus other fishing zones in California where halibut trawl fishing occurs. The data used for the analysis included catch data from the experimental trawl surveys, cost earnings survey information from a bottom trawl fisherman who participated in the study, and information from another fisherman with a long history of involvement in the California halibut fishery. To assess the economic feasibility of using the modified trawl gear in the Monterey Bay, the economic profits were estimated using a standard economic approach after deducting all variable and fixed costs from the gross revenue. The initial economic estimates from the experimental results were normalized to enable comparison with existing commercial halibut trawl fisheries by linear standardization for the amount of fishing effort. The performance measure was initially estimated on a per trip basis and then aggregated to the fleet level for the season by taking into account the monthly catch rates and distribution of fishing effort inside Monterey Bay (both historic and from the 2013 trawl experiment) and current fishing effort in more southern areas of the state. The analysis considered the catches of primary target and marketable incidentally-caught species from the study.

¹ Regional Economist (Contractor), NOAA Fisheries, West Coast Region, 501 W Ocean Blvd Suite 4200, Long Beach, CA 90802
E-mail: naresh.pradhan@noaa.gov and Tel: (562) 508-5452.

The results of this analysis show that targeting California halibut in the Monterey Bay generates an economic profit of about \$972 per trip during the halibut season. This profit level is substantially higher than the economic profit of about \$241 in other fishing zones for the same target species and during the same season. The economic return or profit after paying for the opportunity costs of all resources including the owner-operator's estimated value of labor constitutes about 47 percent of revenue while fishing in the Monterey Bay, but only about 18 percent of revenue in other fishing grounds. The owner operator's wage represents about 25 percent of the fishing revenue in the Monterey Bay area, but about 38 percent of the fishing revenue goes as wage to the owner operator when fishing outside the area, indicating that the Monterey Bay offers higher potential entrepreneurial incentives and income to fishermen if this area were open to fishing. The lower profit margin in fishing zones south of Monterey Bay primarily reflects that bottom trawlers in that area catch less halibut per tow and other marketable non-target species.

About seven fishermen from either south of Monterey Bay or local to the Bay could be expected to travel to or remain in the Monterey Bay area should it be re-opened to trawl fishing for about three months during the June to August period. The fleetwide revenue in the Monterey Bay area would be expected to be about \$863,906 with an economic profit of about \$408,101 during the halibut season at high effort level, i.e., 20 trips per month per vessel. The fleetwide economic profit for the fishing season in the Monterey Bay area would be expected to be about \$306,771 higher compared to fishing for halibut in more southern grounds for the same but high effort level as in the Monterey Bay. The resulting incremental return by halibut fishing in the Monterey Bay relative to more southern fishing grounds would be expected to be about \$43,824 per vessel at high effort level. In the other hand, for the very conservative scenario or low fishing effort inside and outside of the Monterey Bay, the fleetwide economic profit in the Monterey Bay area is expected to be about \$153,510 higher than in more southern fishing grounds. The resulting incremental return per vessel in the Monterey Bay area is expected to be about \$21,930 in economic profit in one halibut season at low effort level. Thus, the economic return differential largely depends on the number of trips for halibut in these fishing grounds.

The additional economic contribution to the California economy through backward linked economic activities due to halibut fishing in the Monterey Bay was estimated. The halibut fishery in the Monterey Bay could contribute an additional economic output to the California

economy in the range of one-half to one million dollars depending upon the level of effort for halibut and/or other targets in other fishing grounds during the halibut fishing season. The economic contribution from the forward linked economic activities at the restaurant or consumer's end will be an additional contribution to the economic impacts of backward linked activities. The economic analysis suggests that the economic return from the halibut fishery in the Monterey Bay area using the modified trawl gear is quite attractive to fishermen relative to same fishery in more southern fishing zones. The gear is economically feasible to provide a lucrative alternative source of income to fishermen in this fishery.

An Economic Analysis of the Catch Composition in a “Light Touch” Trawl Survey Targeting California Halibut in the Monterey Bay, California

Introduction

An economic analysis was carried out on the marketable composition of catch resulting from an experimental trawl study targeting California halibut in the Monterey Bay² with a vessel using “light touch trawl” gear (i.e., a modified “bottom trawl” gear). The analysis examined the economic feasibility of using the modified gear to target California halibut in the Monterey Bay during the halibut season (June to August). The analysis evaluated the differential economic returns of trawl fishing for halibut in the Monterey Bay versus more southern fishing zones in California where halibut fishing occurs. The following sections discuss the economic methods and the analysis of the catch experimental and survey results.

Data and Methods

The data used for the analysis included catch data from the experimental trawls, cost earnings survey information from a fisherman who participated in the project, and information from another fisherman with a long history of involvement in the California halibut fishery. Cost-earnings data along with the information on the halibut fishery in general were collected from the participant fisherman. This economic study did not survey all the bottom trawlers engaged in halibut fishing in California since only a limited number of boats from the vicinity of the Monterey Bay area were expected to resume fishing in the area if the current prohibition were lifted. Moreover, the key informants were very well knowledgeable about the fishery as well as other fishermen for their typical fishing behavior and performances, etc.

To assess the economic feasibility of using the modified trawl gear in the Monterey Bay, gross profits³ in terms of the economic profits were estimated using a standard economic approach after deducting all variable and fixed costs from the gross revenue. Accounting profits were also estimated in the present analysis. Economic profit is more relevant for a rational decision, as it provides a better measure for the fishermen whether to stay in the business in the

² Monterey Bay has been closed to bottom trawling since 2006 summer.

³ Gross profit is the return before interest and taxes. Net profit was not estimated, as this requires information on tax and interest expenses.

long term. While economic profit takes into account explicit and implicit costs of all resources used in producing a good, accounting profit may leave out some of the major resource cost items such as owner's own labor or physical space for a business, etc. Accounting profit in this analysis is before the opportunity cost of owner operator's labor.

The data on variable costs were collected for the duration of experimental trawls, but estimates of other fixed cost items were collected for the recent past year. The variable cost items incurred during the fishing trips were labor (crew and captain), fuels and lubrications, foods, repair and maintenance of vessel/gear/equipment, and vessel monitoring system (VMS) operation costs. The fixed costs incurred for the vessel were the moorage fees, fishing association fees, permit fees, vessel safety equipment cost and depreciation charges. The annual fixed costs and the variable expenses for the duration of catch experiment were distributed so as to derive a trip level data.

The experimental trawls occurred over four consecutive days with five tows each day (30 minutes each tow). Therefore, the net time for fishing in this experiment was 2.5 hours per trip day. However, the normal fishing for halibut under normal circumstances is usually four tows per trip day (one hour each tow) or a net time of four hours per trip (or day). The initial economic estimates from the experimental results were, hence, normalized to enable comparison with existing commercial fisheries by linear standardization for the amount of fishing effort (i.e., for the tow hours) by a multiple factor of 1.6. Standardizing effort for "light trawl" and "bottom trawl" gears itself were not considered, as these gears, as used in trawl fisheries to the south, are similar on their operational characteristics and possibly on catch performances in many ways. Moreover, the state has required the use of modified trawl gear to target California halibut in the California Halibut Trawl Grounds (CHTG) since 2008. The performance measure was initially estimated on a per trip basis and then aggregated to the fleet level for the season by taking into account of the monthly catch rates and distribution of fishing effort both in the Monterey Bay and other California halibut trawl grounds south of the area.

Results and Discussion

Descriptive Statistics from the Catch Experiment and Survey:

In the study, California halibut composed 16 percent of catches by weight. The variability on the share of the halibut weight relative to all catches ranged from no catches to as much as 41 percent in a tow (Table 1). Table 2 provides the aggregates of the marketable catch composition during the study where halibut catches consisted of 61 percent of all marketable catches by weight (Table 3). Southern California trawl fishermen usually sell their halibut catches live when possible for reasons of a good market and the premium price paid for live halibut. About 75 percent of the halibut catches are sold live except very large halibut which are sold as dead.⁴ The expected prices per pound at the time of study were \$7 for live and \$5 for dead halibut, thus, a weighted average price of \$6.50 per pound was used in the event a live halibut fishery developed in Monterey Bay. The marketable incidental catches are all sold dead. Marketable incidental catch composed about 12 percent of the total incidental catches and 10 percent of all species catches by their weight (Table 3). Table 4 presents the detailed distribution of expected sales revenues from halibut and marketable incidental catches for each tow during the catch experiment. The outcome from the study is linearly extrapolated to the real fishing like scenario by normalizing the experimental outcome by a factor or multiple of 1.6. Therefore, the adjusted revenue from fishing in the Monterey Bay was estimated to about \$2,057 per trip (Table 4). The trip level revenue derived from the experimental outcome was used for further economic analyses.

⁴ Personal communication with a Santa Barbara based halibut fisherman Mr. Mike McCorkle on January 22, 2014.

Table 1. Catches of California Halibut during the "Light Touch" Trawl Gear Catch Experiment in Monterey Bay, August 10-13, 2013

Trip Day	Tow # (each tow of 30 minutes)	Total Catches from all species		Total Incidental Catches		Halibut Catch		Halibut Catch (%)	Average Percent of Halibut Catch per Trip
		No.	Pounds	No.	Pounds	No.	Pounds		
1	1	456	376	456	376	0	0	0%	11%
	2	254	238	250	202	4	36.4	15%	
	3	273	157	270	127	3	30.1	19%	
	4	160	175	158	151	2	24.2	14%	
	5	238	446	236	426	2	19.7	4%	
2	1	130	206	129	189	1	17.5	8%	14%
	2	58	193	56	175	2	18	9%	
	3	57	59	55	35	2	23.8	40%	
	4	116	203	112	179	4	24.4	12%	
	5	119	133	119	133	0	0	0%	
3	1	85	176	81	113	4	62.8	36%	23%
	2	131	152	130	146	1	6.7	4%	
	3	93	189	92	164	1	25	13%	
	4	105	130	103	94	2	36.5	28%	
	5	77	199	71	129	6	70.4	35%	
4	1	266	252	263	204	3	48.4	19%	27%
	2	101	223	97	174	4	48.8	22%	
	3	79	182	73	108	6	74.2	41%	
	4	148	156	144	119	4	36.7	24%	
	5	376	130	372	89	4	40.7	31%	
Total	20	3,322	3,976	3,267	3,332	55	644.3	-	-
Avg.		166.1	198.8	163.4	166.7	2.8	32.2	16%	-

Table 2. Primary Target (California halibut) and Marketable Incidental Catch from the Catch Experiment and their Expected Prices

Catches	No. of Fishes	Catches (Pounds)	Estimated Price (\$/Pound)		
			If sold live*	If sold dead	Weighted Average Price**
California Halibut	55	644	\$7.00	\$5.00	\$6.50
Incidental Catches (Marketable***):					
Starry Flounder	69	241	n/a	\$3.00	\$3.00
Sand sole	37	34	n/a	\$1.00	\$1.00
Petrale Sole	71	66	n/a	\$2.00	\$2.00
Pacific sanddab	235	55	n/a	\$1.00	\$1.00
Turbots (Curlfin, Hornyhead)	42	14	n/a	\$1.00	\$1.00
Subtotal Incidental Catches	454	409			

*Price estimates are by the fisherman involved in the catch experiment.

**Weightage average price is based on a general practice of 75% of California halibut sold as live.

*** Incidental catches considered here are marketable fish other than halibut as identified by the fisher in the research experiment.

Table 3. Study Outcome on the Proportion of Halibut Catches Relative to Other Marketable Catches

Species	Catch Number		Catch Weight			
	No. of Fishes	Percent	Catch Pounds	Percent Out of Total Marketable Catches	Percent Out of All Species Catches	Percent Out of All Incidental Catches
CA Halibut	55	11%	644	61%	16%	-
Marketable Incidental Catches	454	89%	409	39%	10%	12%
Total Marketable Catches	509	100%	1,053	100%	26%	-
All Incidental Catches	3,267	-	3,332	-	84%	100%
All Species Catches	3,322	-	3,976	-	100%	-

Table 4. Expected Revenues from the Experimental Trawls in the Monterey Bay (August 10-13, 2013)

Tows	Catch Number		Catch Pounds		Weightage Average Revenue \$ (if halibut were sold at 25:75 dead:live)		
	CA Halibut	Marketable Incidental Catches	CA Halibut	Marketable Incidental Catches	CA Halibut \$	Marketable Incidental Catches \$	Total \$
1	0	81	0.0	68.25	\$ 0.00	\$ 173.00	\$ 173.00
2	4	47	36.4	10.5	236.60	11.00	247.60
3	3	29	30.1	16.1	195.65	35.10	230.75
4	2	15	24.2	14.1	157.30	33.60	190.90
5	2	58	19.7	70	128.05	177.00	305.05
6	1	37	17.5	37	113.75	84.00	197.75
7	2	9	18.0	7.8	117.00	11.30	128.30
8	2	10	23.8	12.25	154.70	31.00	185.70
9	4	15	24.4	14.75	158.60	32.00	190.60
10	0	14	0.0	27.95	0.00	77.35	77.35
11	4	15	62.8	15.4	408.20	33.80	442.00
12	1	9	6.7	11.5	43.55	26.00	69.55
13	1	20	25.0	20.6	162.50	43.70	206.20
14	2	13	36.5	10.5	237.25	26.50	263.75
15	6	14	70.4	8.5	457.60	11.50	469.10
16	3	7	48.4	9.5	314.60	26.50	341.10
17	4	11	48.8	17.5	317.20	45.00	362.20
18	6	9	74.2	10.25	482.30	24.25	506.55
19	4	25	36.7	11.5	238.55	17.50	256.05
20	4	16	40.7	15.25	264.55	34.25	298.80
Study Outcome (Unadjusted):							
Total	55	454	644	499	\$ 4,187.95	\$ 954.35	\$ 5,142.30
Per Trip	14	114	161	102	\$1,046.99	\$238.59	\$1,285.58
Expected Outcome (Adjusted for Study Outcome by 1.6x):							
Total	88	726	1,031	655	\$ 6,700.72	\$1,526.96	\$8,227.68
Per Trip	22	182	258	164	\$1,675.18	\$ 381.74	\$2,056.92

Note: Weighted average revenues are based on ratios of dead and live halibut expected to be sold.

Returns at Trip Level

Tables 5 and 6 summarize the economics of California halibut for the “light touch” trawl gear both in Monterey Bay and other halibut fishing grounds south of the area. The results of this analysis show that targeting California halibut in Monterey Bay generates an economic profit of about \$972 per trip during the halibut season. This profit level is substantially higher than the economic profit of \$241 in more southern fishing zones for the same target species and season. The economic return or profit after paying for the opportunity costs of all resources including the owner-operator’s estimated value of labor constitutes about 47 percent of the fishing revenues in the Monterey Bay area, but only about 18 percent of revenue in more southern fishing grounds. The owner operator’s wage represents about 25 percent of the fishing revenue in the Monterey Bay area, but about 38 percent of the fishing revenue goes as wage to the owner operator when fishing south of the area, indicating that the Monterey Bay offers higher potential entrepreneurial incentives and income to fishermen if this area were open. The vessel owner operator’s wage or the opportunity cost of his labor which was set at \$500 per trip day, i.e., twice the amount of wage paid to a crew (Table 5).

The lower profit margin in the more southern halibut fishing zones primarily reflects the fact that less halibut and other marketable incidentally-caught species are caught in these zones. Bottom trawlers in the more southern fishing grounds catch only about 70 percent of the halibut caught per trip in the Monterey Bay (i.e., the average catch rate per trip is about 180 pounds of California halibut during June-August as compared to the catch rate of 258 pounds in the Monterey Bay). Further, the revenues from marketable incidental catches are also lower south of the Monterey Bay area. Higher valued marketable incidental catches such as starry flounders are largely caught in the Monterey Bay, but they are not common in the other fishing grounds. The revenue from marketable incidental catch is about \$382 per trip (i.e., 19 percent of the total revenue) in the Monterey Bay area, but it is about \$157 (i.e., 12 percent of the total revenue) in other fishing grounds (Table 6).

Table 5. Costs and Earnings (trip level) of a "Light Touch" Trawl Gear for California Halibut in the Monterey Bay (August 10-13, 2013)

Description of Cost and Earnings	Total \$ Value (4-days trip)		\$ Value (Per trip day)	
	Experiment (Unadjusted)	Normal Fishing (Adjusted)	Experiment (Unadjusted)	Normal Fishing (Adjusted)
Expected Earnings from:				
Sales-- California halibut (75/25 live : dead)	\$ 4,186.00	\$ 6,697.60	\$1,046.50	\$1,674.40
Sales-- incidental catches	956.00	1,529.60	239.00	382.40
Sub-total-- Expected Sales	5,142.00	8,227.20	1,285.50	2,056.80
Variable Costs:				
Wages-- Owner or Captain	2,000.00	2,000.00	500.00	500.00
Wages--Crew	1,000.00	1,000.00	250.00	250.00
Fuels	500.00	800.00	125.00	200.00
Food and crew provisions	200.00	200.00	50.00	50.00
Lubrications	25.00	25.00	6.25	6.25
Repair & maintenance of vessel, gear & equipment	109.59	109.59	27.40	27.40
VMS Operation Cost	6.58	6.58	1.64	1.64
Sub-total-- Variable Costs (with Owner's wage)	3,841.16	4,141.16	960.29	1,035.29
Sub-total-- Variable Costs (without Owner's wage)	1,841.16	2,141.16	460.29	535.29
Fixed Costs:				
Morage fees	142.47	142.47	35.62	35.62
Fishing association dues	1.64	1.64	0.41	0.41
Purchase of permit	16.44	16.44	4.11	4.11
Other fixed costs-- Safety Equipment	2.74	2.74	0.68	0.68
Depreciation	36.53	36.53	9.13	9.13
Sub-total--Fixed Costs	199.82	199.82	49.95	49.95
Gross Profits:				
Accounting Profit (without Owner's wage)	3,101.02	5,886.22	775.25	1,471.55
Economic Profit (with Owner's wage)	1,101.02	3,886.22	275.25	971.55
Gross Profit Margin:				
Accounting Profit Margin			72%	
Economic Profit Margin			47%	

Table 6. Summary of Costs and Earnings (trip and fleet level) of a “Light Touch” Trawl Gear for California Halibut Inside and Outside of the Monterey Bay Area, August 2013

Fishing Zones and Efforts	No. of Fishes		Catch (Pounds)		Revenue \$			Fixed Costs	Variable Costs \$		Total Costs \$		Gross Profits \$	
	CA Halibut	Incidental Catches	CA Halibut	Incidental Catches	CA Halibut (75:25 Live:Dead)	Incidental Catches	Total		Without Owner's wage	With Owner's wage	Without Owner's wage	With Owner's wage	Accounting Profit	Economic Profit
Inside the Monterey Bay:														
Catch Experiment (Unadjusted):														
4-days trip	55	454	644	409	\$4,188	\$954	\$5,142	\$200	\$1,841	\$3,841	\$2,041	\$4,041	\$3,101	\$1,101
Per trip	14	114	161	102	\$1,047	\$239	\$1,286	\$50	\$460	\$960	\$510	\$1,010	\$775	\$275
Normal Fishing (Adjusted):														
4-days trip	88	726	1031	655	\$6,701	\$1,527	\$8,228	\$200	\$2,141	\$4,141	\$2,341	\$4,341	\$5,887	\$3,887
Per trip	22	182	258	164	\$1,675	\$382	\$2,057	\$50	\$535	\$1,035	\$585	\$1,085	\$1,472	\$972
Outside the Monterey Bay:														
Normal Fishing:														
Per trip	<22 or =24	154 ^a	180	67 ^a	\$1,170	\$157	\$1,327	\$50	\$535	\$1,035	\$585	\$1,085	\$741	\$241

^a Incidental catch is adjusted for starry flounder, as the species is not generally caught outside the Monterey Bay.

Returns at Fleet Level

Trip level economic data was aggregated to the fleet level for the fishing season (June-August) in the Monterey Bay and the more southern fishing zones. It is assumed that around seven fishermen from other fishing grounds could be expected to trawl the Monterey Bay should the area be opened for California halibut fishing during the June to August period. These fishermen would most likely be originating from Ventura, Santa Barbara, Morro Bay, and Monterey Bay area ports. It is expected that each vessel usually would take on average, about five trips per week or 20 trips per month targeting California halibut in the area. There would be no incentive for these vessels to fish lesser trips after making the effort to travel to Monterey Bay area. However, weekly number of fishing trips during halibut season at the more southern fishing grounds is variable ranging from two to five trips per week or about 10 to 20 trips per month depending upon sea conditions favorable for targeting halibut⁵. Fleetwide revenue and gross profits for the halibut season (Jun-Aug) were estimated for both Monterey Bay area and the more southern fishing grounds (Table 7) by using the information derived from catch experiment and costs-earnings survey. The fleet effort level south of the Monterey Bay area is set at par with the

⁵ Personal communication with California halibut fisherman Mr. Mike McCorkle, and based on the information from the survey data.

effort level in the Monterey Bay (i.e., 20 trips per month targeting California halibut) for the comparison of fishing income between these two fishing grounds even if fishermen in other fishing grounds are more likely to take less than 20 trips per month targeting halibut during the halibut season.⁶ The fleetwide revenue in the Monterey Bay area is expected to be about \$863,906 with an economic profit of about \$408,101 during a regular halibut season (Figure 7). In contrast, fleetwide revenue from the halibut target alone could be expected to range from \$278,568 to \$557,136 during the same time period in halibut fishing grounds south of Monterey Bay. The corresponding economic profits are expected to range from \$50,665 to \$101,331 in these other fishing grounds. Thus, the fleet level economic return from the Monterey Bay may be four to eight times higher relative to fishing in the more southern fishing grounds.

The gross profits were further decomposed to examine what share of the revenue from halibut fishing accounted for the opportunity costs of owner operator's labor. The owner operator's wage represents about 25 percent of the fishing revenue in the Monterey Bay area, but it is about 38 percent south of the area indicating that the Monterey Bay area offers higher entrepreneurial incentives and income to fishermen if this area is opened (Table 7).

Table 7. Fleetwide Simulation of Profit by Targeting California Halibut (June – August, 2013)

Fishing Zones	No. of trips per month per vessel	Total trips (Jun-Aug)	Fleet size	Revenue (\$ per trip)	Gross Profit (\$ per trip)		Fleet wide Revenue (Jun-Aug)	Gross Profit (Fleetwide \$)		Gross Profit Margin (%)		Owner Operator's wage as % of revenue
					Accounting Profit	Economic Profit		Accounting Profit	Economic Profit	Accounting	Economic	
Inside Monterey Bay	20	60	7	\$2,057	\$1,472	\$972	\$863,906	\$618,101	\$408,101	72 %	47 %	25 %
Outside Monterey Bay	10	30	7	\$1,327	\$741	\$241	\$278,568	\$155,665	\$50,665	56 %	18 %	38 %
	15	45	7	1,327	741	241	417,852	233,498	75,998			
	20	60	7	1,327	741	241	557,136	311,331	101,331			

⁶ The survey data reveals that the trawl vessel that participated in the in the halibut catch experiment typically takes about 275 fishing trips in a year of which 175 trips (or 64%) are directed for California halibut. Fishing trips in other fishing grounds during June to February range between 15-20 trips per month, but 10-15 trips during March to May.

Table 8. Simulated Comparison of Annual Returns to Owner by Fishing California Halibut Inside and Outside the Monterey Bay Area (June-August)

Scenario	Effort Level	Fishing Area and Differences in Returns	Fleet Size	Trips per month by a fisher (Jun-Aug)	Total trips by a fisher during (Jun-Aug)	Annual Return to Vessel Owner Operator (Jun-Aug)				
						Accounting Profit (\$ per trip)	Economic Profit (\$ per trip)	Accounting Profit (\$ fleetwide)	Economic Profit (\$ fleetwide)	
1	High or Equal Effort	Inside Monterey Bay	7	20	60	\$1,472	\$972	\$618,101	\$408,101	
		Outside Monterey Bay	7	20	60	741	241	311,331	101,331	
		<i>Differences in Annual Fleet Returns</i>							306,771	306,771
		<i>Annual Incremental Return per Vessel by fishing in Monterey Bay</i>							43,824	43,824
2	Medium Effort	Inside Monterey Bay	7	20	60	1,472	972	618,101	408,101	
		Outside Monterey Bay	7	15	45	741	241	233,498	75,998	
		<i>Differences in Annual Fleet Returns</i>							384,603	332,103
		<i>Annual Incremental Return per Vessel by fishing in Monterey Bay</i>							54,943	47,443
3	Low Effort	Inside Monterey Bay	7	20	60	1,472	972	618,101	408,101	
		Outside Monterey Bay	7	10	30	741	241	155,665	50,665	
		<i>Differences in Annual Fleet Returns</i>							462,436	357,436
		<i>Annual Incremental Return per Vessel by fishing in Monterey Bay</i>							66,062	51,062
4	Medium Effort in Both Zones	Inside Monterey Bay	7	15	45	1,472	972	463,680	306,180	
		Outside Monterey Bay	7	15	45	741	241	233,415	75,915	
		<i>Differences in Annual Fleet Returns</i>							230,265	230,265
		<i>Annual Incremental Return per Vessel by fishing in Monterey Bay</i>							32,895	32,895
5	Low Effort in Both Zones	Inside Monterey Bay	7	10	30	1,472	972	309,120	204,120	
		Outside Monterey Bay	7	10	30	741	241	155,610	50,610	
		<i>Differences in Annual Fleet Returns</i>							153,510	153,510
		<i>Annual Incremental Return per Vessel by fishing in Monterey Bay</i>							21,930	21,930

Table 8 summarizes pairwise comparison of fleetwide return when fishing halibut inside and south of the Monterey Bay area for various effort levels. As indicated earlier, per vessel effort level in the Monterey Bay area is fixed at 20 trips per month (i.e., 60 trips during the fishing season), but it ranges from about 10 to 20 trips per month (i.e., 30 to 60 trips during the fishing season) in the other fishing grounds depending upon availability of halibut or sea conditions for fishing. Scenario 1 (best case scenario) is for a high level of fishing effort for California halibut in fishing grounds south of the Monterey Bay. The effort level for halibut is also set at par with the effort level of that in the Monterey Bay. In the other hand, Scenario 3 is for a low level of effort (i.e., 10 trips per month) by a vessel south of the Monterey Bay. A typical or medium fishing effort for halibut south of the Monterey Bay (i.e., Scenario 2) would be about 15 trips per month (i.e., 45 trips in a fishing season) by a vessel.⁷ Scenario 4 and 5 are lower effort levels in the Monterey Bay, i.e., lower than 20 trips per month per vessel. Lower effort levels in more southern fishing grounds could be either due to less availability of halibut or unfavorable sea conditions for fishing.

⁷ The data for the effort levels in the Monterey Bay area and outside the area is from the survey of California halibut fishermen and personal communication with Mike McCorkle.

The incremental revenues for halibut fishing in Monterey Bay relative to more southern fishing grounds are estimated to be about \$585,338 for a low level of effort; \$446,054 for medium level of effort; and \$306,770 for a high level of effort in these other fishing grounds (Table 7). For the best case scenario⁸ or high fishing effort (Scenario 1) south of the Monterey Bay, the fleetwide economic profit in the Monterey Bay area is expected to be about \$306,771 higher than in the more southern fishing grounds. The resulting incremental return per vessel in the Monterey Bay area is expected to be about \$43,824 in economic profit in one halibut season (Table 8). In the other hand, for the very conservative scenario or low fishing effort (Scenario 5) inside and south of the Monterey Bay, the fleetwide economic profit in the Monterey Bay area is expected to be about \$153,510 higher than in the more southern fishing grounds. The resulting incremental return per vessel in the Monterey Bay area is expected to be about \$21,930 in economic profit in one halibut season at low effort level. Thus, the economic return differential largely depends on the number of trips for halibut in these fishing grounds.

Economic Impact

The potential additional economic contribution to the California economy through backward linked economic activities due to halibut fishing in the Monterey Bay was estimated using the secondary data from an economic study by the California Department of Fish and Wildlife in 2009.⁹ The economic output multipliers for the trawlers operating in southern California were used to assess the economic impact of halibut fishing in the Monterey Bay area. It is expected that the value addition from the incremental catches associated to fishing activities in the area would add to California's economy by the multiple of 1.766 on the incremental revenues.¹⁰ A potential halibut trawl fishery in the Monterey Bay is estimated to contribute an additional economic output to the California economy in the range of one half million to one million dollars depending upon the level of fishing effort by the bottom trawlers in more

⁸ Although effort level in other fishing grounds is more likely to be lower than in Monterey Bay, but setting the effort level in other fishing grounds at par with Monterey Bay (i.e., 20 trips per month) will make the comparative economic return more conservative one.

⁹ S. Hackette, D King, M Hansen, and E Price, "The Economic Structure of California's Commercial Fisheries". California Department of Fish and Wildlife (June 3, 2009). A Report in Fulfillment of Contract P0670015, California Department of Fish and Wildlife (<https://www.dfg.ca.gov/marine/economicstructure.asp>). (Reference date: March 24, 2014)

¹⁰ The regional economic output multiplier is for the Trawl gear for the county of Monterey Bay. Please refer to the [California Ocean Fish Harvester Economic \(COFHE\) Model, Excel Lookup Tables](https://www.dfg.ca.gov/marine/economicstructure.asp) in the link <https://www.dfg.ca.gov/marine/economicstructure.asp> (Reference date: March 24, 2014)

southern fishing grounds during the halibut season. The economic contribution from the forward linked economic activities at the restaurant or consumer's end will be an additional contribution to the economic impacts of backward linked activities.

Conclusion

The economic analysis suggests that the economic return from re-opening the halibut fishery in the Monterey Bay using the modified trawl gear could be quite profitable to fishermen relative to the same fishery occurring in other fishing grounds in the Central or Southern California waters. The gear is economically feasible to provide a lucrative alternative source of income to fishermen in this fishery.

Acknowledgement

Special thanks go to fishermen Morgan Castagnola and Mike McCorkle who took time to fill survey form and shared their long experiences on commercial fishing of California halibut in southern California. The author would like to thank to Travis Tanaka and Paul Reilly of the California Department of Fish and Wildlife for their helpful comments and suggestions to improve this paper. The author would also like to thank to Lyle Enriquez and Craig D'Angelo for data supports; and Mark Helvey, Stephen Stohs, Tonya Wick and Stephen Freeze for their valuable inputs in this study.