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The economic value of the recreational red abalone fishery in northern California

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There is a long tradition of recreational red abalone (*Haliotis rufescens*) fishing in northern California. The fishery is enjoyed by tens of thousands of fishers along Sonoma and Mendocino counties, but little is known about its economic value. Recreational fisheries are difficult to value because the catch is not sold commercially and the activity is dispersed along the coastline. For this study, we estimated the value to the fishers of the recreational red abalone fishery using the travel-cost estimation method, a non-market valuation approach. Using data for the 2013 season at more than 50 sites, we find that approximately 31,000 fishers derived between \$24M and \$44M per year of recreational value from the fishery. The lower figure was estimated based solely on fishers' driving costs, while the larger estimate results when also considering the time fishers spent on the activity. Examination of site-level variables influencing the choice made by fishers among the sites shows that key site selection criteria included 1) impacts of a harmful algal bloom in Sonoma County, 2) protection from northwest ocean swell, and 3) presence of amenities such as boat launches and restrooms. We show that the value of the fishery declined nearly \$12M after stricter regulations were imposed in 2014 following a harmful algal bloom that killed thousands of abalone in Sonoma County. The economic value of the fishery clearly warrants investment in both the biological and economic sustainability of this important resource.

Key words: Economic Impact, *Haliotis rufescens*, Non-Market Value, Socioeconomics, Sport fisheries, Travel Cost Method

California has the largest ocean economy in the United States with a gross state product of nearly \$42B estimated for the year 2000 (Kildow and Colgan 2005). Recreational fishing is the third most popular water related activity after beach going and swimming. More than 2.7M people enjoy recreational ocean fishing annually in California (Leeworthy 2001). In California, it is estimated that recreational fishing generates an estimated \$230M-\$610M in direct expenditures per year (2010) (Pendleton and Rooke 2006). Estimates of the total non-market use value of recreational fishing is much higher and ranges between \$342M -\$2B for the year 2010 (Pendleton and Rooke 2006). As California grows in population, the number of people that participate in recreational fisheries is forecast to increase by 12% per decade (Leeworthy 2001) putting greater pressure on marine resources. Despite the importance of recreational fishing, estimates of market (money anglers contribute through spending) and non-market values (value fishers place on the resources they use) for individual recreational fisheries are scarce.

Red abalone (*Haliotis rufescens*) forms the basis for a recreational fishery in northern California yet little is known about the magnitude of its economic importance. Approximately 35,000 fishers (2000-2014), take 245,000 red abalone (2002-2014) per year (California Department of Fish and Wildlife [CDFW] unpublished data). The majority of the catch (95%) comes from Sonoma and Mendocino counties (Kashiwada and Taniguchi 2007). The recreational red abalone fishery in northern California is the only abalone fishery remaining open in the state. In 1997, commercial fishing was closed statewide and recreational fisheries for abalone were closed south of San Francisco due to declines in stocks (Karpov et al. 2000). The north coast fishery has been restricted to recreational users since 1949 and permits skin (breath-hold) diving only. The fishery is managed for sustainability under the Abalone Recovery and Management Plan (CDFW 2005), which aims to maintain abalone population densities to ensure productivity and consequently the economic viability of the fishery. The Marine Life Management Act (MLMA 1999) supports the management of California's fisheries to sustain, conserve and protect California's marine life including those with economic value.

Despite the recreational, cultural and economic importance of the red abalone fishery, little work has been done to estimate its economic value. Valuation of recreational fisheries is difficult since it is illegal to sell recreationally caught red abalone (aka illegal commercialization) in California (Rogers-Bennett and Melvin 2007). Commercial fisheries, on the other hand, are more easily valued by calculating income from ex-vessel landings. In this paper, the non-market economic value of the recreational red abalone fishery to the fishers, is estimated using the travel-cost method. The relative importance of site attributes at more than 50 sites is examined to determine site qualities used in site selection and the potential losses from a site closure. The non-market value of the fishery is estimated for eight years from 2003 to 2014. The gender and age of the fishery questionnaire respondents is reported to give an indication of demographics in this fishery. Finally, the economic value of the fishery is examined in light of prioritizing funding needs to sustain both the fishery and its economic benefits.

MATERIALS AND METHODS

The travel-cost method (TCM) (Phaneuf and Smith 2005) is an economic approach used to assign monetary value to non-market goods such as recreational activities or resources. The model's premise is that travel costs are a proxy for the value of unpriced recreational sites, and that people for whom travel costs are lower will visit a site more frequently, mirroring the basic relationship between price and quantity demanded for normal goods. The TCM takes into account the various costs paid by a participant to engage in the activity. These include direct costs such as fees, and other costs such as the opportunity cost of time and vehicle operating costs. Using this information, a travel cost function and demand curve (Figure 1) can be estimated where the consumer surplus is representative of the economic value of the resource to the recreational users. Parsons (2003) provides a detailed overview of the method.

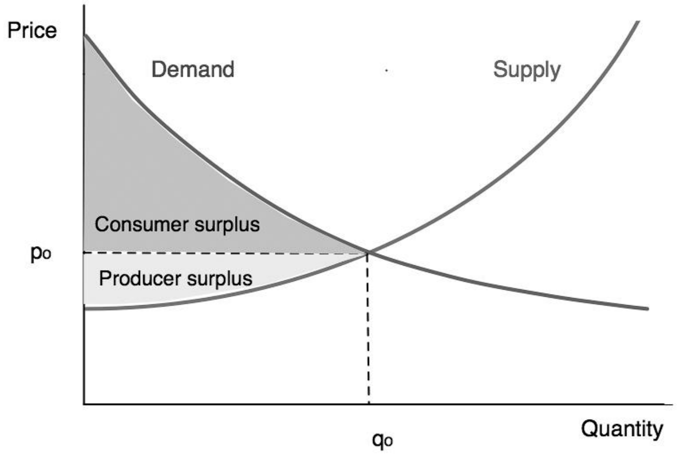

FIGURE 1. - Demand curve showing the marginal willingness to pay (WTP), with the area under the curve representing the total WTP.

Travel-cost studies follow one of two basic approaches: single-site models and multi-site models. Single-site models construct a demand curve based on the relationship between the cost of visiting a site and the frequency of visits. Multi-site models add in the element of choice from among a set of alternative sites for the same recreational purpose, and isolate the impact of site characteristics on the choice of sites, while also estimating the overall value of recreation. Given that abalone is taken at more than 50 different sites along the coast, a multi-site model was adopted for this study.

Data were drawn from the 2013 season CDFW database of 30,768 abalone report card holders, which represents the population of licensed harvesters, and a telephone survey of a random sample of this population. CDFW conducted the telephone survey of this group in 2014, with 516 responses regarding the 2013 fishing season. Information on the response rate to the telephone survey was unavailable. Respondents to the telephone survey provided demographic information and data on their fishing histories and habits. Of these 516 respondents, 392 also provided detailed catch information (which is not collected in the telephone survey) to the CDFW via its reporting system. Because we had both demographic and catch data from these 392 respondents, they were used as our sample for the travel-cost analysis.[1]

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[1] A representative sample (*n*) size is commonly obtained by solving $n=(Z^2pq)/e^2$ where *n* is sample size, *Z* is the value obtained from a normal curve at the desired confidence level (95%), e is the desired level of A representative sample *(n)* size is commonly obtained by solving $n=(Z^2 pq)/e^2$ where *n* is sample size, *Z* is the value obtained from a normal curve at the desired confidence level (95%), *e* is the desired level of precision, *p* is the estimated proportion of an attribute that is present in the population, and *q* is *1-p*. A conservative approach assumes the maximum variance implying $p = q = 0.5$ with a confidence interval of 95% and a maximum sample error of 5%, then the optimal sample is 385 observations. Furthermore, the unit of analysis here is recreational trips and 392 individuals account for 1,520 trips.

There is a risk that this group is not representative of the overall population; those reporting may collect more or less than the average number of abalone, prefer certain kinds of sites, be demographically distinct or in some other relevant way diverge from the population. We do not have any information to indicate specific ways in which our sample may differ from the population at large.

In order to construct a database of trips, the unit of analysis in a travel-cost study, we examined respondents' reported abalone catch by date and fishing site from the report card database and cross-referenced the information with the number of trips they reported in the telephone survey. Analysis was performed on the resulting 1,537 trips.

The site attributes were chosen based on consultation with CDFW staff experts. Attributes selected were those perceived to impact where fishers choose to fish, to vary across sites and for which information exists for all sites. Some attributes found to be important in previous research, such as abundance and size (Chen et al. 2013), have not been measured systematically for all 51 sites (or even a significant subset of the most important sites), so we could not compare sites with respect to those variables. The two most important variables studied by Chen et al. (2013) and in this study were the ease of access to the water and the protection of sites from swells. While most of the site attributes (Table 1) were specific to that site and independent of neighboring sites (e.g., parking, bathroom facilities), two of the attributes influenced multiple neighboring sites. Protection from wave exposure by a headland may influence the number of days of accessibility to a number of neighboring sites. Also, a harmful algal bloom (HAB) in 2011 caused significant declines in abalone density within all of the Sonoma County area sites (Porzio 2014).

Table 1.—Site characteristics used for travel-cost analysis

Attributes	Variable name	Description	Type
Access	ACC	Difficulty of access to the water from parking area, often determined by steep terrain.	Category: 1-3 1 = easy, safe access 3 = most difficult or dangerous access
Boat launch	BL	Existence of a boat launch.	Dichotomous: 0 = no 1 = yes
Parking	Parking	The availability of parking.	Category: 1-3 1 = abundant parking 3 = very limited parking
Bathrooms	Bath	Existence of public bathrooms.	Dichotomous: 0 = no 1 = yes
Exposure to ocean swell	PROTEC	The degree of protection afforded by geographic features to prevailing NW swells.	Category: 1-3 1 = least exposed 3 = most exposed
Harmful algae bloom	HAB	Site affected by 2011 harmful algae bloom.	Dichotomous: 0 = no 1 = yes
Pay for parking	PAY	Whether parking requires payment of a fee.	Dichotomous: 0 = no 1 = yes

We assume that the welfare obtained by an individual *i* from a trip to the site *j* on decision occasion *t* is given by the following utility function:

$$U_{ijt} = \beta_1 \, TC_{ij} + \beta_2 \, ACC_j + \beta_3 \, BL_j + \beta_4 \, Parking_j + \beta_5 \, Bath_j + \beta_6 \, PROTEC_j + \beta_7 \, HAB_j + \beta_8 \, PAY_j + \mu_{ijt}$$

In this equation TC*ij* is the travel cost from each *i*-th individual´s origin to the destination *j*. Travel cost includes the cost of operating a vehicle, for which we used the federally specified rate of $0.565 per mile for 2013. Distances and travel times were calculated with Google Maps (V2), using respondents' home zip code as trip origin and the coordinates of the abalone site visited as the destination. To this we added the opportunity cost of time traveling and spent at the recreation site. Common practice (Cesario 1976; Parson 2003) is to use a fraction, which we set at 0.5, of the person's wage. We encountered a gap in the data because many of the respondents to the telephone survey declined to provide income information and no income data is contained in the report card database. The model was therefore estimated with two variants on the definition of travel cost. For those respondents without income data, we used the average income for their zip code of residence. We ran one regression using only the driving cost (TC1) in order to use the whole sample with consistent data for every trip. This approach underestimates the travel cost and, consequently, recreational value, representing therefore a lower bound. TC2 uses income data (both individual and zip code) and adds four hours spent at the dive site (in and out of the water) to calculate the travel cost.

Calculating willingness to pay (WTP) is complex with this kind of model and ours is especially involved since there are over 50 alternative choices for sites to collect abalone. The generic formula for WTP is known as the "log-sum" formula and is given by:

$$WTP = \frac{1}{\theta}\left[\hbar \sum_{j=0}^{J} e^{V_j^1} - \hbar \sum_{j=0}^{J} e^{V_j^0}\right]$$

Where j represents the recreation site, *j*=1, 2 ... J, and superscripts 0,1 represent the initial and final situations, respectively. θ is the coefficient on travel cost (in absolute value). The final situation is characterized by whatever policy (or, generically, change) we are evaluating, which could include a change in a site's attributes, that is, in elements of every V*j*, or elimination of one or more sites. In this latter case, the site(s) in question simply disappear from the sum of values of all the sites.[2]

On the other hand, if the quality of an attribute changes for all sites, the WTP is:

$$WTP = \frac{\beta_1 \Delta X}{\theta}$$

The coefficients *βi* capture preferences for various levels of the attribute. A positive and significant coefficient (*βi* > *0)* means that the increase in the attribute results in a higher likelihood that the site is selected. The other relevant coefficient for calculating the WTP is θ, which captures the reduction in an individual's utility as the travel cost rises (or the marginal utility of income in absolute value). Regressions were run in the Stata software package (V12) using

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[2] In other words, we replace $\sum_{j=0}^{J} e^{V_j^1}$ with $\sum_{j=0}^{J_k} e^{V_j^1}$ in which $J_k < J$.

a conditional logit model. An additional regression to test the validity of results was run on the travel-cost-only data with a mixed logit model, which accounts for the possible independence of irrelevant alternatives (IIA) and captures the unobserved heterogeneity of the sample.

In addition, to gain an understanding of the trajectory of recreational value over the years, we applied the per-trip value calculated for 2013 to the years 2000-2012 and 2014. Total fishing trips for these years was calculated by multiplying the number of report card holders by the average trips per report card holder as reported in the telephone surveys for each year, including respondents who took no trips. Average trips figures were available for 2003-2006, 2008, 2012 and 2014, so these are the years for which total values were calculated. This extrapolation provides only a very coarse approximation; per-trip values can be expected to vary year to year with changes in regulations, abalone abundance, weather, economic conditions and other factors. Future research should use trip values specific to each year, work that was beyond the scope of this study.

Results

The per-trip recreational value of each site was estimated by two travel cost models (Table 2). The values appear as negative numbers because they refer to the loss that would result if a particular site were closed or otherwise no longer available. The sites for which the values are greatest are largely clustered between Albion and Fort Bragg on the Mendocino coast, with losses in the range of $2.50-$5.00 per trip. The modest figures are explained by the fact that divers can simply opt for another of the long list of sites if only one is closed; sites are partially substitutable. The impact of closing all sites simultaneously is a loss $219-$406 per trip, depending on the model chosen. The 2013 telephone survey reports 30,678 fishers take on average 3.6 trips per year. The total net recreational value estimated for the fishery in 2013 was between $24M based on the driving cost alone (TC1), and $44M when considering both driving cost and the time spent on the trip (TC2) (Figure 2).

Travel cost is shown to be significant at the 99.9 percent confidence level in all three models (Table 3). The results of the two regressions runs to generate the value estimates, plus, in the rightmost column, the mixed logit regression run as an additional test of the validity of the analysis are shown revealing the concordance of the 3 models (Table 3). Of the site characteristics, impact from the 2011 HAB, bathrooms, boat launch and exposure to swell (listed in descending order of their coefficients) were all significant at this level in all models and had the expected signs (negative or positive impact on utility). Ease of access to the water was significant at the 95 percent confidence level in the TC1 and TC2 models but not in the mixed logit. The requirement to pay for parking, on the other hand, was significant (99 percent confidence level) for the mixed logit only. The HAB attribute, which is associated lower abalone abundance, has by far the largest coefficient (impact on site choice). The affected Sonoma County sites received less visitation despite their closer proximity to the major population centers around San Francisco.

Extrapolating the per-trip values for 2013 to other years, we show an initial period of steady recreational values (2003-2005) near $40M, followed by a peak in value in 2006 of just under $50M (Figure 2). The values for 2008 and 2012 were similar to the estimate for 2013 ($44M). The slightly lower values in the early 2000s were due to a lower average number of trips taken per report-card holder. The value dropped dramatically in 2014 (~$32M) as report card sales fell by 16 percent, to their lowest levels within the 15 years for which we have data. Trips per fisher also declined, by 13 percent, in the 2014 season.

Table 2. —Recreational value by site shown as the economic wellbeing reduction per trip, in dollars, that would result from closing each fished site individually. Cs = consumer surplus; wtp = willingness to pay). Sites appear in order from north to south.

		Model 1: Driving costs only		Model 2: Driving costs and time	
COUNTY	**SITE**	Mean	Standard deviation	Mean	Standard deviation
Del Norte	Crescent City	-0.33	2.83	-0.54	3.44
Del Norte	Other Del Norte County	-0.25	0.88	-0.53	1.91
Humboldt	Trinidad	-0.54	1.93	-1.22	4.73
Humboldt	Punta Gorda	-0.20	0.37	-0.43	0.70
Humboldt	Shelter Cove	-0.88	1.07	-1.75	1.74
Humboldt	Other Humboldt County	-1.07	1.41	-2.14	2.28
Mendocino	Usal	-0.94	0.49	-1.86	0.88
Mendocino	Hardy Creek	-0.79	0.31	-1.51	0.56
Mendocino	Abalone Point	-1.03	0.38	-1.99	0.70
Mendocino	Westport	-0.73	0.27	-1.39	0.50
Mendocino	Bruhel Point	-0.27	0.10	-0.52	0.18
Mendocino	MacKerricher State Park	-1.37	0.45	-2.61	0.84
Mendocino	Glass Beach	-1.47	0.48	-2.78	0.89
Mendocino	Georgia Pacific Mill	-1.68	0.54	-3.14	0.99
Mendocino	Todd’s Point	-1.30	0.41	-2.41	0.74
Mendocino	Hare Creek	-1.62	0.51	-3.06	0.95
Mendocino	Mitchell Creek	-0.64	0.15	-1.21	0.27
Mendocino	Jughandle State Reserve	-1.05	0.21	-1.95	0.39
Mendocino	Caspar Cove	-1.52	0.29	-2.88	0.55
Mendocino	Russian Gulch State Park	-2.70	0.49	-5.04	0.89
Mendocino	Jack Peters Gulch	-0.75	0.13	-1.41	0.23
Mendocino	Mendocino Headlands	-2.31	0.40	-4.29	0.73
Mendocino	Gordon Lane (Spring Ranch)	-0.46	0.07	-0.88	0.14
Mendocino	Van Damme State Park	-2.61	0.41	-4.86	0.77
Mendocino	Dark Gulch	-1.05	0.16	-1.97	0.29
Mendocino	Albion Cove	-2.99	0.45	-5.54	0.82
Mendocino	Salmon Creek	-0.83	0.12	-1.53	0.22
Mendocino	Navarro River	-1.98	0.30	-3.67	0.53
Mendocino	Elk	-2.45	0.42	-4.53	0.73
Mendocino	Point Arena Lighthouse	-0.90	0.19	-1.68	0.33
Mendocino	Point Arena (Arena Cove)	-3.60	0.84	-6.58	1.44
Mendocino	Moat Creek	-3.14	0.76	-5.74	1.32
Mendocino	Schooner Gulch	-1.03	0.26	-1.89	0.46
Mendocino	Anchor Bay	-1.14	0.33	-2.18	0.62
Mendocino	Robinson Point	-0.21	0.07	-0.40	0.12
Sonoma	Gualala Point	-0.34	0.11	-0.63	0.20
Sonoma	Sea Ranch	-0.58	0.19	-1.09	0.36
Sonoma	Black Point	-0.42	0.14	-0.79	0.27
Sonoma	Stewart’s Point	-0.49	0.17	-0.93	0.33
Sonoma	Rocky Point	-0.22	0.08	-0.42	0.15
Sonoma	Horseshoe Cove	-0.60	0.21	-1.13	0.42
Sonoma	Fisk Mill Cove	-1.10	0.42	-2.07	0.81
Sonoma	Salt Point State Park	-1.07	0.41	-2.00	0.81
Sonoma	Ocean Cove	-1.11	0.43	-2.09	0.86
Sonoma	Stillwater Cove	-1.53	0.61	-2.87	1.20
Sonoma	Timber Cove	-0.99	0.39	-1.86	0.79
Sonoma	Fort Ross	-0.99	0.40	-1.85	0.80
Sonoma	Reef Campground (Pedotti)	-0.79	0.32	-1.47	0.65
Sonoma	Jenner	-0.41	0.17	-0.76	0.35
Sonoma	Bodega Head	-1.57	0.68	-2.92	1.47
Marin	Tomales Point	-0.92	0.41	-1.69	0.91
Sum CS per site		-58.97	0.85	-110.64	1.04
Total WTP for closure of all visited sites		-218.71	24.12	-405.84	43.36

Table 3. —Regression results.

	Model 1	Model 2	Model 3
	TC1	TC2	TC1 mixed logit
TC1	-0.0173***		-0.0221***
	(-18.73)		(-19.93)
TC2		-0.00919***	
		(-18.56)	
Access	0.114*	0.105*	-0.0815
	(2.41)	(2.23)	(-0.99)
Boat launch	0.574***	0.575***	0.692***
	(7.94)	(7.95)	(4.18)
Parking	0.0764	0.0847	0.0679
	(1.40)	(1.55)	(0.87)
Bathrooms	0.627***	0.626***	0.817***
	(7.40)	(7.38)	(6.47)
Exposure to ocean swell	-0.377***	-0.373***	-0.374***
	(-8.03)	(-7.99)	(-4.54)
Harmful algal bloom	-1.470***	-1.421***	-2.932***
	(-15.90)	(-15.58)	(-10.30)
Pay for parking	0.0758	0.0755	-0.516**
	(1.08)	(1.08)	(-2.85)
Number of tripstrips	15201520	15131513	15131513

t statistics in parentheses $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

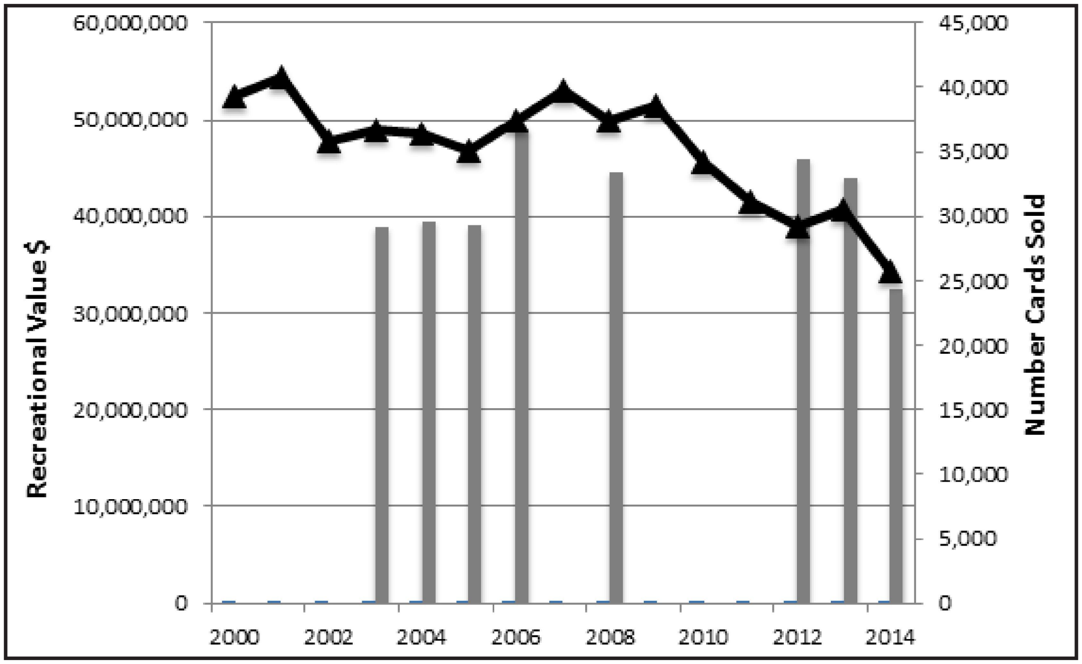

Figure 2.—Recreational value of the red abalone fishery in northern California for the years with data on the number of trips extrapolating the per-trip value from 2013 to the other years (2003, 2004, 2005, 2006, 2008, 2012, 2014) shown using the height of the bars. The second Y axis shows the total number of abalone report cards sold per year from 2000-2014 shown using the solid triangles. Note: the automated license system went into effect in 2010 reducing the possibility of illegally purchasing two cards in one year.

The 2014 fishing season was the first year marked by the full impact of the HAB event and associated regulation changes, such as the reduction in the annual bag limit, the new late start time (8:00AM) and the closure of the historically most heavily used site in the fishery – Fort Ross State Park.

Finally, we report descriptive statistics of the fishers from a sample to give a sense of respondent characteristics. We find that 95 percent of the sample was from California and 92 percent were male. The age distribution shows 73 percent over the age of 35, with an average of 15 years of abalone fishing experience (Figure 3). As noted above, the average number of trips was 3.6 and the average days fishing was just over 4.0, with an average of 8.4 abalone caught during the season. Note that these figures include respondents who purchased report cards but did not end up fishing.

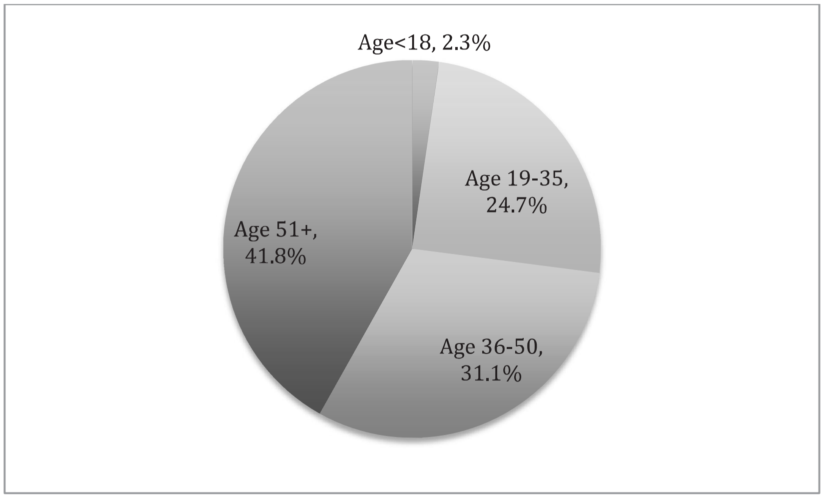

Figure 3.—Age distribution of 2013 abalone fishers included in sample.

Discussion

The red abalone fishery is worth \$24-\$44 M in annual non-market benefits to recreational fishers (Figure 2). We consider these conservative estimates of the value of the fishery because they are based on travel and time costs alone, excluding other trip related costs (lodging and meals), as well as associated gear (e.g. wetsuits, abalone floats, irons and licenses). These results are based on the 392 respondents many of whom (>40%) are more than 50 years old. Chen et al. (2013) found, that abalone fishers spent an average of \$193 on dive equipment, \$167 on lodging and camping and \$140 on food and beverages from stores, which adds up to 50 percent of overall expenditures. Transportation expenses (excluding the opportunity cost of time, accounted for 28 percent of spending). While their study was based on only 90 respondents, the results do suggest that collecting additional data for a fuller accounting of travel costs is warranted in future years to get a fuller picture of the economics of this fishery.

We recommend some modest changes in the routine annual data collection effort that would permit creating a more robust time-series of economic value for the fishery. The travel-cost estimation method as applied here requires data on trips taken by individual fishers, including the destination, associated spending and number of people traveling together for each trip, as well as demographic information on the fishers. We recommend that this sort of data on fisher trips (rather than fishing day) be collected directly through the annual telephone survey of report card holders. To date, surveys have not collected data on individual trips. As a result, in this analysis, we reconstructed a profile of each trip based on location and date information reported on the capture of individual abalone, cross-referenced with the number of trips each respondent reported. Collecting specific trip data would save substantial time on analysis and permit inclusion of costs beyond driving expenses and the opportunity cost of time, allowing for a more comprehensive estimate of fishery value. This would avoid the strategy employed in this analysis, using per-trip values from 2013 and extrapolating these to other years. Finally, the recommendation we are making to collect trip data would facilitate an economic impact analysis.

The multi-site travel-cost estimation method is useful when weighing the economic effects of management actions which would open or close one specific fishing site or a group of sites. Multi-site information can be used to estimate the specific economic losses (or gains) from closing (or opening) sites, based on their attributes and levels of use. In this case the site information was useful in understanding the economic impacts of the regulation changes made following the HAB. The full impacts of the HAB and the associated regulation changes, including a reduction in the annual bag limit, the later start time, and the closure of Fort Ross took effect in the 2014 season. In 2014, the total value of the fishery dropped by $12M from $44M to $32M coincident with a 16 percent decline in report card sales and a 13 percent drop in average annual fishing days per fisher. Although we cannot assign causality, the figures do give managers a quantitative indication as to the economic dimensions of the HAB event and subsequent regulation changes.

Because similar valuations are lacking for other major marine recreational fisheries in California, we have little basis for comparisons. Most economic analyses of California fisheries have consisted of estimates of recreational expenditures or gross commercial revenue to fishers. These estimates are not comparable to the figures we have generated with the TCM, which is the net benefit–the consumer surplus–accruing to fishers of the fishery. Expenditures for the recreational spiny lobster (*Panulirus interruptus*) fishery in southern California, was calculated at $37M per year (Hackett et al. 2013). While, the two largest commercial fisheries in California (by ex-vessel value) are market squid (*Doryteuthis [Loligo] opalescens*) ($58M) and Dungeness crab (*Metacarcinus [Cancer] magister*) ($46M) from 2008-2012 (Rogers-Bennett and Juhasz 2014). Without venturing any speculations about the economic value of these fisheries–which is equal to the producers' profits plus consumer surplus–we simply note that their gross expenditures are of a similar magnitude as the economic value of the red abalone fishery. While these are apples-and-oranges comparisons, we can look at additional calculations to estimate comparable economic impact figures for red abalone. The total economic impact of red abalone recreational fishing from previous work was found to be $26.7M for the 2014 season (Reid et al. 2016). Direct expenditures, the figure most similar to the $37M estimated by Hackett et al. (2013) for spiny lobster, were found to be $18.6M for red abalone in California (Reid et al. 2016) (Figure 4).

Conclusions

The loss of both the recreational and commercial abalone fisheries in southern California in 1997 makes it clear that this resource is vulnerable to depletion and collapse. The economic value estimates presented here demonstrate that there are tens of millions of dollars in recreational benefits at stake if the North Coast recreational fishery were to suffer the same fate. The economic importance of the fishery provides policy-

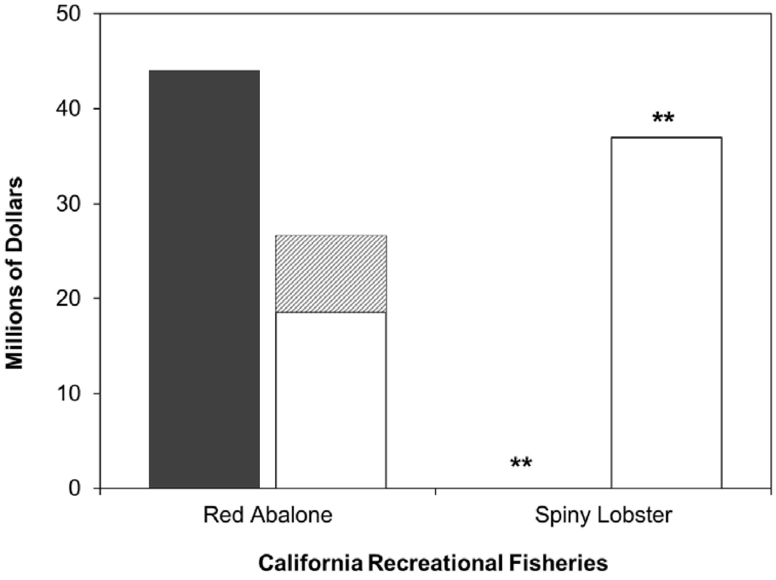

Figure 4.—Economic Value And Economic Impact Of Northern California Red Abalone Recreational Fishery Compared to spiny lobster economic impact. Black bar = Economic value from travel-cost method (this study); white bar = economic impact: direct expenditures (red abalone – (Reid et al. 2016); spiny lobster - (Hackett et al. 2013)); patterned bar = economic impact: indirect + induced costs (Reid et al. 2016). "**" = no comparable analyses available for spiny lobster other than for direct expenditures.

makers and managers an indication of the high priority of investing in science and law enforcement to sustain the resource. Analyses such as this one have yet to be done for many recreational California fisheries and are desperately needed to inform management. Quantifying the economic importance of a fishery reveals that an investment in resource management can enhance the long term economic benefits derived from the fishery.

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