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Beach Recreationalists' Willingness to Pay and Economic Implications of Coastal Water Quality Problems in Hawaii

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ABSTRACT

The economic value of water quality is poorly understood in Hawaii. Quantifying the economic value of coastal water quality would inform policy decisions that impact the coast and help justify expenditures in water quality improvements. We conducted a non-market valuation of beach recreationalists' preferences and willingness to pay for water quality and associated attributes at Oahu beaches. Using a discrete choice experiment analyzed by a conditional logit model, results suggest individuals were willing to pay $11.43 per day at the beach to reduce days of bacterial exceedance from 11 to 5 per year, a further $30.72 to reduce it to no bacterial exceedances at all. WTP to move from 15 ft to 30 ft of underwater visibility was $35.71, a further $14.80 to increase from 30 ft to 60 ft. Respondents were also willing to pay $15.33 to improve coral reef cover from 10% to 25%, a further $4.89 to improve to 45% cover. WTP for moving from 9 fish species to 18 species was $7.14, a further $2.47 to increase that to 27 fish species. These environmental improvements can improve Oahu recreationalists' welfare by $205 million, $550 million, $639 million, $265 million, $274 million, $88 million, $128 million, and $44 million per year, respectively. Welfare gains may justify increased spending in management and restoration of coastal ecosystems.

1. Introduction

Land-based pollution and other human activities degrade coastal water quality worldwide (Ahn et al., 2005; Biao et al., 2004; Morrice et al., 2008; Re et al., 2011; Tsatsaros et al., 2013). Yet coastal water quality is also the basis for a host of economic activities important to society and local economies, including tourism, coastal recreation, fisheries, and property values. It is also critical to the habitat of many marine species (Freeman, 1982, 1995). Water quality degradation presents real and serious costs to the environment and human welfare (Kreitler et al., 2013; Verhougstraete et al., 2010; Vesterinen et al., 2010), and coastal water quality problems in destinations important for beach tourism could threaten an industry contributing $6.3 trillion to the global GDP in 2011 (Houston, 2013).

As a place where the economy and local wellbeing is tightly associated with coastal environments, Hawai'i illustrates some of these challenges (Paul et al., 1997; Ringuet, 2003). In this paper, we value the economic benefits of improving the water quality (measured by bacteria and visibility) and associated environmental attributes of the coastal zone. We analyze a choice experiment using multinomial logistical regressions to derive beach recreationalists' preferences along with willingness to pay (WTP) for environmental attributes at varying levels of quality. Strongest preferences were found for water clarity and quality, with WTP increasing at different rates. This information can be used to help set policy management priorities.

The remainder of this paper proceeds as follows. We provide background on the coastal water quality problem in Hawai'i, describe the non-market valuation methods we used, present results from a survey administered to 263 people recreating on the beaches of the island of Oahu, and discuss the implications for management.

1.1. Coastal Water Quality Problems in Hawaii

Coastal water quality issues are common in Hawai'i. Across the state, 302 bacterial exceedances occurred in 2009 (Environmental Protection Agency, 2010b), a situation where bacteria levels are considered unsafe per US EPA guidelines (Environmental Protection Agency, 2004). In such events, the state Department of Health may issue advisories or even close beaches to certain activities. Swimming and fishing may no longer be permitted, shellfish may be contaminated, and marine habitat could become inhospitable for other species (Kakesako, 2013; Magin, 2006; Schaefers, 2011). Limited sampling in 2012 resulted in a six-day closure of most Waikiki-area beaches — perhaps some of the most popular beaches in the world (Environmental Protection Agency, 2013). Expanded sampling would likely have closed more beaches and for a

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longer period (Cocke, 2012). More recently in 2015, Waikiki and other South Shore beaches were closed following a storm event that overloaded stormwater runoff systems and lead to a large-scale sewage spill (Davis, 2015; Solomon, 2015; Uyeno, 2015).

The BEACH Act (2000) enacted new pathogen control and reporting requirements for coastal waters (Environmental Protection Agency, 2012). State governments comply by making monitoring records and notices of pathogen exceedances available to the public. The Hawai'i Department of Health collects data including temperature, salinity, *Enterococcus*, *Clostridium perfringens*, turbidity, pH, and dissolved oxygen. Yet data describing the full extent of coastal water quality problems in Hawai'i are scarce. Statewide water quality monitoring is constrained by a lack of funding and is largely compliance- and complaint-driven. The Hawai'i Department of Health is responsible for the monitoring of some 723 miles of coastline statewide. As of 2012, 290 miles of coast across all eight main Hawaiian Islands had been assessed at least once (State of Hawai'i Environmental Health Administration, 2012).

1.2. Causes of Land Based Coastal Pollution in Hawaii

In Hawai'i, point source pollution such as sewage discharges (Glenn et al., 2012; Laws et al., 2004) and cesspools (Whittier and El-Kadi, 2014; Whittier et al., 2009) and non-point source pollution such as agricultural runoff (De Carlo et al., 2004) and urban effluents (Andrews and Sutherland, 2004) all contribute to coastal water quality degradation.

Point sources include sewage outfalls, injection wells, and cesspools. Sewage discharge has introduced fecal-oral viral pathogens in Mamala Bay, O'ahu (which includes Waikiki and surrounding beaches) that may have led to gastrointestinal, respiratory, and eye, nose, ear, and skin infections for individuals coming into contact with contaminated waters (Griffin et al., 2003). Injection wells pump treated sewage underground as a method of disposal, but the wastewater may eventually seep into coastal waters further downstream (Koizumi, 1966; Peterson and Oberdorfer, 1985; Whittier and El-Kadi, 2014). Along with wastewater, nutrients and pharmaceuticals are also being introduced to coastal waters because of poor sewage disposal practices (Atkinson et al., 2003; Dailer et al., 2010; Mokiao-Lee, 2012). A cesspool tank or pit holding untreated human waste can contaminate ground water, drinking water, and coastal waters with pathogens, nutrients, and other substances (State of Hawai'i Department of Health Wastewater Branch, 2015). Hawai'i leads the nation in cesspools, with the dubious distinction of being the only state that still allowed new construction up until 2016 (Givens, 2014). The state recently banned construction of new cesspools (Hawai'i State Department of Health, 2015), but only a temporary tax credit to incentivize upgrading cesspools to septic has been enacted by the state legislature (The Maui News, 2015).

Non-point sources of pollution include agricultural runoff and urban runoff. Toxic chemicals, such as lead, zinc, and copper from urban areas (Andrews and Sutherland, 2004) and arsenic and cadmium from agricultural zones (De Carlo et al., 2004), pollute Hawaii's nearshore environments. Poor agricultural and land use practices have caused sediment plumes after storm events, which severely reduce visibility and damage nearshore ecosystems (Oki and Brasher, 2003). Many sediments are also loaded with chemicals and pathogens (Oki and Brasher, 2003). Feral ungulates compound the problem by disturbing vegetation and soil, thereby increasing erosion and sedimentation (Dunkell et al., 2011; Ragosta et al., 2010). The fecal matter produced by these feral animals also contributes to bacterial contamination of the coast.

1.3. Impacts of Poor Coastal Water Quality

Poor water quality can have direct impacts on human wellbeing. For human health, bacterial exceedance increases the risks of infections amongst swimmers, surfers, body boarders, and any other people participating in an activity that involves contact with water. In terms of aesthetics, algae blooms and brown water plumes severely impact the ability of recreationalists to see underwater, degrade water views from coastal homes and hotel accommodations, and are generally unpleasant. Snorkelers and divers are especially impacted when visibility is reduced by sediments and other land-based pollutants in the water. Stand-up paddle boarders and boaters may experience pollution and sedimentation as aesthetically unpleasing or hazardous and be deterred from paddling out.

Ecologically, land-based pollutants generally degrade the quality of coastal waters and marine habitats and negatively impact species in those areas. Poor water quality can lead to coral disease and reduced coral recruitment, which in turn reduces coral cover and available habitat for fish (Fabricius, 2005). These ecological consequences have indirect impacts on human wellbeing, as snorkelers and divers enjoy seeing healthy marine environments (Grafeld et al., 2016).

While anyone using Hawai'i's beaches may be affected by poor water quality, a major concern is the potential impact on tourism, one of the largest sectors of the economy in Hawaii. Generating $15 billion annually, Hawai'i is a leading tourism destination globally (Hawai'i Tourism Authority, 2015). A major draw for visitors to Hawai'i is beach-related recreational activities. If erstwhile Hawai'i visitors substitute another destination with more pristine coastal conditions, there may be negative effects from decreased consumer spending, tax receipts, revenue for local businesses, and employment. The result is declining economic welfare across the state.

1.4. Study Aim

Changes in water quality can have serious economic consequences, and few if any studies have explored the non-market value of water quality and associated environmental condition changes in Hawai'i. As a result of this gap in knowledge, public policy formulation related to coastal pollution is ill-informed and potentially suboptimal. This study aims to inform policy in Hawai'i by estimating the potential benefits of improvements in coastal water quality and associated ecological conditions. Beach conditions are important for the benefits that beach users derive, but because beaches and coasts are open access in Hawai'i, there is no formal market mechanism that we can use to estimate the relative value of different conditions. Instead, we turn to non-market valuation methods – specifically a discrete choice experiment – to discover consumer preferences for coastal water and ecological quality. In this way, we can quantify an environmental good which may otherwise be ignored in traditional decision making.

2. Methods

2.1. Non-market Valuation

The economic value of goods and services not traded in conventional markets can be assessed by non-market valuation. The most commonly used non-market valuation methods in beach valuation studies are contingent valuation (Bell and Leeworthy, 1990; Binkley and Hanemann, 1978; Bishop et al., 2011; Logar and van den Bergh, 2012), travel cost (Ariza et al., 2012; Lew and Larson, 2005; Moncur, 1975; Parsons et al., 2009), and choice experiments (Beharry-Borg and Scarpa, 2010; Huang et al., 2007; Loomis and Santiago, 2013). Comparing stated-choice methods (Loomis and Santiago, 2013), and combining stated and revealed preference data can confirm validity (Cameron, 1992; Huang et al., 1997).

The choice experiment is a stated preference method. Respondents are given multiple choices and forced to make trade-offs between them, revealing the marginal utility for specific attributes, which makes it useful in determining the value of multiple characteristics and their relative importance to participants (King and Mazzotta, 2000). Some have suggested choice experiments as a superior valuation method to contingent valuation (Hanley, 2002), but the method is more cognitively burdensome for participants (Hanley, 2002) because the same question is asked

Table 1
Mean percentage of people ($n = 263$) undertaking each beach activity by region.

	Enter water	Swim	Surf	Body board	Stand-up paddle	Boat	Snorkel	Dive
All beaches	88.8%	87.3%	12.8%	8.8%	11.6%	4.4%	21.1%	3.6%
North shore	87.5%	71.9%	15.6%	9.4%	12.5%	9.4%	18.8%	3.1%
South shore	90.4%	90.4%	10.7%	5.7%	9.6%	2.3%	20.3%	2.3%
Waianae coast	87.5%	87.5%	16.7%	8.3%	12.5%	0.00%	16.7%	4.2%
Windward coast	77.8%	83.3%	22.2%	38.9%	27.8%	22.2%	38.9%	16.7%

multiple times (Petrolia and Interis, 2013), though good design can help comprehension (Carson and Louviere, 2011).

Coastal recreation can be valued in two ways, either by specific activity type (e.g., swimming, boating, fishing, etc.) (Freeman, 1982, 1995, 2003), or as one aggregated willingness to pay for beaches and their associated activities. Beach valuation studies have commonly estimated recreational use values. Studies focus on beach users' preferences for beach attributes such as congestion (Logar and van den Bergh, 2012), water quality (Beharry-Borg and Scarpa, 2010; Dharmaratne and Brathwaite, 1998; Logar and van den Bergh, 2012), erosion (Huang et al., 2007; Logar and van den Bergh, 2012; Shivlani et al., 2003; Whitehead et al., 2008), or for the beach in general (Blakemore and Williams, 2008; Dixon et al., 2012; Oh et al., 2008). Many studies (Ariza et al., 2012; Beharry-Borg and Scarpa, 2010; Dharmaratne and Brathwaite, 1998; Lew and Larson, 2005), though not all (Bell and Leeworthy, 1990; Loomis and Santiago, 2013) deal with water quality. Some focus on issues like wastewater (Kontogianni et al., 2003), others focus on specific activities such as snorkeling (Cesar and Beukering, 2004; Cesar et al., 2002), and some estimate a total economic value (Bishop et al., 2011) but do not have a value for recreation that can be disaggregated.

2.2. Survey

Our survey consisted of a section on socioeconomics and attitudes then a choice experiment. Socioeconomic data collected included residency, mode of transportation, time in transit to beach, primary purpose of the trip, frequency of visit, size of group, and annual income range. Participants were asked to provide a background of their activities at the beach, which was useful for segregating groups of respondents who may have vastly different preferences, such as those between snorkelers and non-snorkelers for water clarity (Beharry-Borg and Scarpa, 2010). Participants were also asked about the length of their stay at the beach and perceptions of beach quality. We gauged attitudes by

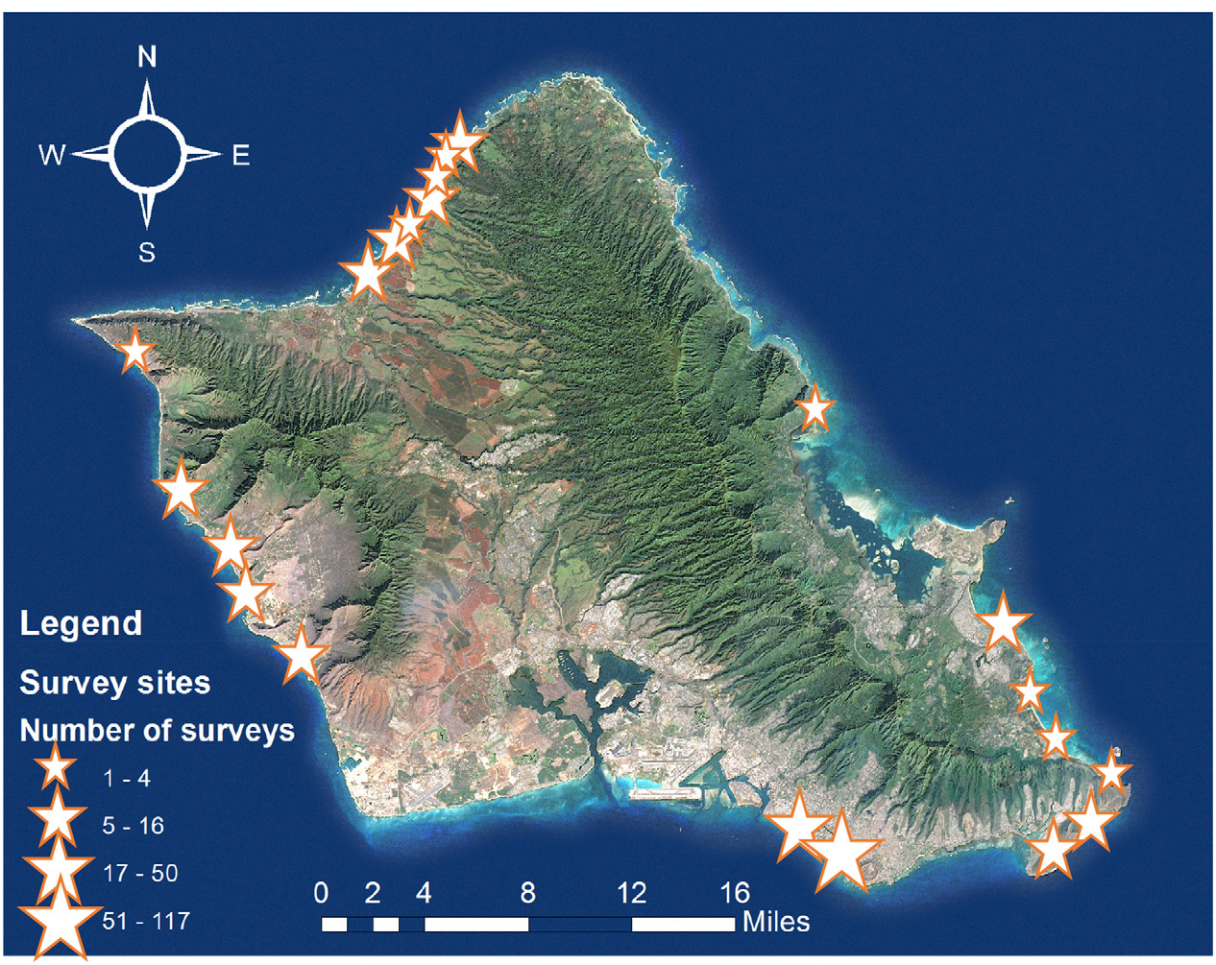


Fig. 1. Survey sites and number of surveys administered at lifeguarded beaches on Oahu. The size of the dot represents the number of surveys conducted, which were proportional to annual attendance (see Table SI-1).

posing a series of questions, and we asked two questions ("I will not enter the water if bacteria is over the safe limit" and "I judge how clean the water is by how clear it is") to determine if respondents conflated water quality and clarity.

Our sampling strategy distributed sampling according to beach visitation rates derived from data collected by the City and County of Honolulu at lifeguard-protected beaches (City and County of Honolulu, 2014) (Table 1). We walked up to potential respondents on the beach and asked them to participate. The distribution of surveys across O'ahu beaches is presented in Fig. 1.

2.3. Choice Experiment Design

We designed a five-attribute survey (Figure 2). Our focus was on water quality and associated ecological impacts, and attributes were chosen for their relevance to Hawai'i beach users: water quality (bacteria), water clarity, coral cover, and fish diversity. In each of the first four attributes except for water quality, the three levels were determined by biological data with input from state health, conservation officials, and University of Hawai'i researchers. For water quality, we used Department of Health data to determine annual probabilities of water quality exceedances. Alternate choices from the base level were designed with differences that the average recreationalist was able to perceive. The fifth attribute was the bid, which had eight levels based on pre-tests with a payment card at a representative sample of O'ahu beaches.

An optimal set of 1458 combinations of attributes was derived from the full factorial design of ($3^5 \cdot 8 = 1458$) using SSI Web 7.0 (Sawtooth Software, 2011). The minimum number of surveys required was 225. All attributes except for the bid amount were represented by photos,

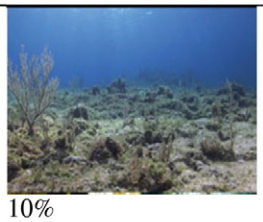
	Base condition (Low levels)	**Alternative beach 1 (Moderate levels)**	**Alternative beach 2 (High levels)**
Beach advisory	 11 days a year when bacterial count over safe limit	 5 days a year when bacterial count over safe limit	 Bacterial count always within safe limit
Water clarity	 15 feet visibility	 30 feet visibility	 60 feet visibility
Coral reef cover	 10%	 25%	 45%
Fish diversity	 Low	 Medium	 High
Additional cost to get to alternative beach	**$0**	$2, $5, $10, $20, $50, $75, or $100	$2, $5, $10, $20, $50, $75, or $100
I would choose to visit	☐	☐	☐

Fig. 2. Low, moderate, and high attribute levels presented as a choice scenario from the survey instrument. Each survey had eight choice scenarios where participants were confronted with a unique choice of one of three beaches to visit. In all cases, the base condition attributes were "Low", as above, representing the typical beach in Oahu. The two alternatives presented randomly selected levels for all five attributes that spanned low, moderate, and high, and all non-zero payment levels.

which were created using Photoshop and vetted by subject matter experts for accurate representation of ecological conditions.

Respondents were presented one of ten versions of the survey instrument, each of which had eight choice scenarios. Participants were then asked to choose between three beaches with hypothetical conditions. In all cases, the base beach was the same: 11 days per year with water quality events, 15 ft. visibility, 10% coral cover on the ocean floor, and 9 species of fish. State conservation officials and University of Hawai'i researchers confirmed the reasonableness of these conditions for Oahu, where the coastal environment is degraded compared to other islands. The conditions at the two alternate beaches were randomized and differentiated from the base level and randomly assigned a non-zero bid amount. More information on the levels is provided below.

Water quality

We estimated bacteriological exceedance rates from DOH data and EPA water quality standards. We downloaded data reported by DOH to the EPA under the BEACH Act and compared those to the EPA standards (Table 2) to determine the number of O'ahu water quality events. On average, beaches exceeded these levels 11 days per year (2006–2012), which we used as the baseline in our choice experiment.

2.3.1. Water Clarity

Water clarity is defined as visibility underwater. Clearer water has less sediment and pollutants present that impair visibility. The Hawaiian Institute of Marine Biology includes clarity as part of their monitoring indicators (Jokiel et al., 2001), and describes visibility between 50 ft to about 85 ft in their statewide assessment reports (Brown, 1998). Expert interviews at the state Department of Land and Natural Resources, Division of Aquatic Resources, set visibility of 2 ft to be poor, 10 ft to be moderate, 30 ft to be good, and 50 ft to be excellent. According to feedback from snorkelers and divers in interviews, the distance that made a "significant difference" in visibility was 25 ft, below which they felt it was too low to see anything, while over 25 ft was generally acceptable. In our survey 15, 30, and 60 ft represented perceptible differences for respondents.

2.3.2. Coral Cover

We categorized levels according to percentage coral cover on the ocean floor. Statewide, coral cover averages 22% (Hawai'i Coral Reef Assessment & Monitoring Program, 2008b). On Oahu, Hanauma Bay (a Marine Protected Area) average coral cover is 12% (Hawai'i Coral Reef Assessment and Monitoring Program, 2011a), and elsewhere on O'ahu reefs have a low of 5% and a high of 46% (Hawai'i Coral Reef Assessment and Monitoring Program, 2011b). In our survey, 10%, 25%, and 45% represented ecologically valid, distinct differences that respondents could clearly perceive.

2.3.3. Fish Diversity

We define fish diversity as the number of species found during a species count at a particular location. On Oahu, the Hanauma Bay protected area had an average of 27 species, and Waikiki had 8.8 species (Coral Reef Assessment and Monitoring Program, 2008a). In our survey, 9, 18, and 27 species represented ecologically grounded, perceptible differences for respondents.

2.3.4. Payment Vehicle

The payment vehicle was an additional cost to move from the base beach to a superior beach. This design avoided the issue of protest bids, as no fee is collected. All beaches in Hawai'i are open access, and no user fees are charged. A pilot test was conducted on O'ahu beaches interviewing recreationalists on the beach on what they considered reasonable prices to travel to an alternative beach where attributes are better. From these results we determined eight price points ($0, $2, $5, $10, $20, $50, $75, and $100). A typical question included a $0 bid to stay at the base beach and two randomized bids to move to an alternative.

Our method set a base condition where attributes were at their lowest levels while also having a $0 price. Respondents then chose between that option or superior alternative conditions. This can be compared to an approach allowing all conditions to fluctuate, including the base. Although statistically less efficient (Loomis and Santiago, 2013), our approach is common and justified by a sense of realism (Boyle et al., 1993; Johnston et al., 2011; Loomis and Ng, 2012). It also reduces the cognitive burden on respondents, as the base condition is repeated in each choice.

To assess whether the base condition matched perceived reality, after being presented with the choice scenario of which beach to visit, participants were asked to identify water quality, clarity, coral, and fish characteristics of the site where they were interviewed.

Table 2
Comparison of conditional and mixed logit model results.

		Conditional logit			Mixed logit			
n		263			263			
Attribute		Coef.	SE	P > |z|	Coef.	SD Coef.	SE	P > |z|
Water quality								
	5 days over safe limit	0.33	0.09	0.00	0.59	0.27	0.11	0.00
	Always within safe limit	1.22	0.09	0.00	1.44	1.05	0.13	0.00
Water clarity								
	30 ft.	1.03	0.09	0.00	1.18	0.01	0.11	0.00
	60 ft.	1.43	0.09	0.00	1.50	1.03	0.13	0.00
Coral reef cover								
	25%	0.45	0.09	0.00	0.53	0.39	0.10	0.00
	45%	0.59	0.09	0.00	0.72	0.77	0.13	0.00
Fish diversity								
	Medium	0.21	0.09	0.02	0.41	0.52	0.11	0.00
	High	0.25	0.09	0.01	0.48	0.44	0.10	0.00
Price		−0.03	0.00	0.00	−0.04		0.00	0.00
ASC		0.31	0.06	0.00	0.22	0.52	0.07	0.00
Water clarity (60 ft) × Diver		0.62	0.38	0.10				
Fish diversity (High) × Diver		0.91	0.43	0.04				
Log likelihood		−2571.02			−1431.96			
BIC		5246.49			3029.28			
AIC		5166.05			2901.91			
AICc		5166.09			2901.95			

We also estimated a latent class model, but did not make use of those results. While several classes can be estimated, the vast majority of respondents were always grouped together, revealing very little about preferences and suggesting preferences are largely homogenous.

2.4. Model Selection and Analysis

Random Utility Theory (McFadden, 1974) defines utility as the combination of a rational choice and a random one. The conditional logit model (McFadden, 1974) assumes the choice is solely rational, while the mixed logit model incorporates the randomness into the assumption. Conditional logits are often used and assume fixed effects where the respondent choice is completely reflected in the coefficients, whereas a mixed logit model is a more robust design. In a mixed logit, random effects can be incorporated (Hoyos, 2010) and the model is not constrained by the distribution of its errors (Train, 2003). The latent class analysis, a variation of the mixed logit model, breaks the respondent population into groups or classes to highlight homogeneous preferences.

Using STATA (StataCorp, 2013), we estimated three types of models: conditional logit, mixed logit, and latent class logit. The latent class model is implemented as *gllamm* (Rabe-Hesketh and Skrondal, 2012) and as *lclogit* (Pacifico, 2012) in STATA (Hole, 2013). The ultimate results were determined by a conditional logit model, chosen based on characteristics of the sample population (preference homogeneity). This choice is justified in the Results section.

The random utility model is described as:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \tag{1}$$

where n devotes the decision maker, j is the alternative chosen, V_{nj} is a function of observable attributes, and ε_{nj} is random and unknown. Assuming errors follow an IID type I extreme value distribution, we have the conditional logit probability:

$$\mathrm{P_{ni}} = \frac{\exp(\sigma_n V_{ni})}{\sum_{j=1}^{J} \exp(\sigma_n V_{nj})} \tag{2}$$

where n devotes the decision maker, i is the alternative chosen, and implemented in STATA as *clogit*. The mixed logit choice probability is described as:

$$\mathrm{P_{ni}} = \int \frac{\exp(x'_{ni}\beta)}{\sum_{j=1}^{J} \exp(x'_{nj}\beta)} \mathrm{f}(\beta|\theta)\mathrm{d}\beta \tag{3}$$

where $\mathrm{f}(\beta|\theta)$ is the density function of β, implemented in STATA as *mixlogit* (Hole, 2007). The mixed logit model allows for errors that do not follow the IIA property. A variation of the mixed logit model is the latent class model, which allows for the assumption that coefficients in the model are non-continuous. We make use of the model:

$$\mathrm{Sn} = \sum_{\mathrm{q}=1}^{\mathrm{Q}} H_{nq} \prod_{t=1}^{T} \prod_{j=1}^{J} \left[\frac{\exp\left(x'_{njt}\beta_{\mathrm{q}}\right)}{\sum_{j=1}^{J} \exp\left(x'_{njt}\beta_{\mathrm{q}}\right)} \right]^{y_{njt}} \tag{4}$$

The probably of belonging to class q is described as:

$$\mathrm{H_{nq}} = \frac{\exp(z'_n \gamma_{\mathrm{Q}})}{\sum_{\mathrm{q}=1}^{\mathrm{Q}} \exp(z'_n \gamma_{\mathrm{Q}})} \tag{5}$$

where $\gamma_{\mathrm{Q}} = 0$, and the log-likelihood for the model being:

$$\mathrm{Sn} = \sum_{n=1}^{\mathrm{N}} \ln \left\{ \sum_{q=1}^{\mathrm{Q}} H_{\mathrm{nq}} \prod_{t=1}^{\mathrm{T}} \prod_{j=1}^{\mathrm{J}} \left[\frac{\exp\left(x'_{\mathrm{njt}}\beta_{\mathrm{q}}\right)}{\sum_{j=1}^{J} \exp\left(x'_{\mathrm{njt}}\beta_{\mathrm{q}}\right)} \right]^{y_{\mathrm{njt}}} \right\} \tag{6}$$

2.5. Welfare Change Estimate

To determine aggregate values for welfare changes in society as a whole, we multiply the most current annual O'ahu beach attendance (17,894,730 person days/year in 2013) by the per person WTP amount for an attribute improvement.

3. Results

A total of 263 successful in-person interviews were conducted between June to November 2014, distributed across beaches in proportion to visitation statistics. The refusal rate was 11% (Table 1). Results suggest recreationalists are by far most interested in having water clarity at least at medium level, and were interested in moving to a high level of visibility at a slighter lower rate (slope). At a close second, participants were interested in removing all days of water quality events from 11 days to 5 days, then to none altogether along a fairly linear demand curve. Recreationalists also prefer higher levels of coral cover and fish diversity, but at a level much less then water quality or clarity. Participants are willing to pay little for improving beyond the medium levels for both attributes.

3.1. Recreationalist Sample

In total, 59% of respondents were female, 41% were male. Amongst all respondents, 62% were Hawai'i residents, and of the 38% visiting, 78% were from the US, 8% from Australia, 5% from Canada, and 3% from Japan. Nearly a quarter (24%) of respondents had an annual income of $24,999 or less, 23% earned between $25,000–$49,999, 20% $50,000–$74,999, 13% $75,000–$99,999, 5% $100,000–$124,999, 5% $125,000–$149,999, and 8% $150,000 or more. Participants had on average 2.8 persons in their party and spent 216 min on the beach. We did not attempt to ascertain trip frequency (Loomis, 2007) amongst respondents.

Respondents participated in a variety of recreational activities, including swimming, surfing, body boarding, stand-up paddling, boating, snorkeling, or diving. Activities at the windward beaches were different than all the other beaches (Table 1). At all beaches combined, 11% of participants did not enter the water. Of the remaining 89% of respondents who entered the water, 87% went swimming, 13% surfing, 9% body boarding, 12% stand-up paddling, 4% boating, 21% snorkeling, and 4% diving, while 14% took part in some other activity. Windward beaches had higher participation for all activities outside of only entering the water and swimming.

Participants held attitudes that generally valued water quality a great deal and supported government initiatives in protecting the coastal zone from anthropogenic damage. While over 80% of respondents agreed or strongly agreed that they would not enter the water if the bacterial levels are over the safe limit, 60% of respondents then went on to agree or strongly agree that they judge water cleanliness using the proxy of clarity. Over 95% of respondents agreed or strongly agreed that coastal resources should be protected for future generations and that remote areas should be protected, while slightly fewer people (90%) agreed or strongly agreed with government initiatives to protect coastal waters.

For each of the water quality, clarity, coral, and fish characteristics, participants were asked to select if actual conditions they observed corresponded to the "base" assumptions we made about O'ahu beaches (high chance of bacterial exceedance, low visibility, low coral cover, and low fish diversity). For most participants, our base conditions matched what they observed that day. Waikiki and Ala Moana beaches, where the vast majority of respondents were interviewed, were perceived to be very close to the baseline assumption. Parts of North Shore and the Waianae coast reported slightly better conditions then the baseline. Overall, 75.3% agreed with 15 ft. visibility, 78.3% agreed with 10% coral cover, and 84.0% agreed with low fish diversity (9 species or less).

3.2. Model Results

3.2.1. Model Fit

We fit various multinomial logistical regression models: conditional logit with an alternative specific constant (ASC), mixed logit, and latent class logit. Model selection was based on BIC, AIC, and AICc values. We deemed the latent class logit model unsuitable, however, in describing the data. Regardless of the number of classes estimated, the class split always consisted of one very large group that described over 75% of respondents. When examined closely, even with multiple classes, the groups' preferences were largely homogenous with the same significant independent variables. The conditional logit model was determined to be the best choice, given the relative homogeneity of the preferences and possibility of a status quo bias.

3.2.2. Multinomial Model Results

As expected, the multinomial logit (MNL) model (Table 2) had negative and significant bids indicative of a downward sloping demand curve. For the sample as a whole, all other explanatory variables had positive coefficients and were also significant as indicated by a $P > |z|$ of less than 0.05 for O'ahu as a whole. A small proportion (14.8%) of respondents chose the base condition, while 85.2% picked one of the improved beaches.

The strongest preference exhibited by recreationalists was to move from medium (30 ft. visibility) to high (60 ft. visibility) water clarity (coeff: 1.43). Moving from poor water clarity (15 ft. visibility) to medium (30 ft. visibility) was also strong (coeff: 1.03). Water quality was the next highest ranking attribute. Preferences for moving from 11 days of water quality events to 5 days (coeff: 0.33) was moderate, and moving to eliminate water quality events altogether (coeff: 1.22) was stronger. Preferences for coral cover and fish diversity lagged behind water quality and clarity. Both had much lower coefficients for moving from low (10% cover, 9 species) to medium levels (25% cover, 18 species), and only marginal increases when moving from medium (25% cover, 18 species) to high levels (45% cover, 27 species).

3.2.3. Interaction Effects

Our MNL model is based on whether respondents agree to pay some cost to visit a location where water attributes are improved. We tested interactions between variables using different conditional logit models. Positive interactions indicate the two variables together led to the respondent agreeing to pay more for an improvement in water attributes. A negative interaction term means that the two variables together led to the respondent to pay less for an improvement in water attributes. The positive or negative sign of the interaction term is found in the coefficient, and deemed significant when $P > |z|$ is less than 0.05 (Table 3). We had a number of hypotheses for some expected interactions, such as divers preferring high levels of water clarity. Other interactions were found by interacting the independent variables and socioeconomic background data together.

Table 3
Notable significant interactions between respondent activity, opinion, socioeconomic data, and independent variables. Negative interaction effect highlighted in italics, positive interaction effect in roman.

Interaction effects	Coeff	se	P > |z|
Activity			
Enter water × Fish 1	*−0.530*	*0.266*	*0.046*
Body board × WC1	0.707	0.307	0.021
Body board × WC2	0.656	0.313	0.036
Stand-up paddle × WC2	0.585	0.275	0.034
Stand-up paddle × Coral 2	*−0.629*	*0.281*	*0.025*
Boat × WQ2	1.296	0.511	0.011
Boat × WC2	1.101	0.508	0.03
Dive × WC2	1.057	0.488	0.03
I judge how clean the water is by how clear it is			
Disagree × WQ1	*−1.69*	*0.772*	*0.028*
Disagree × WQ2	*−1.92*	*0.779*	*0.014*
Neutral × WQ1	*−1.57*	*0.769*	*0.041*
Neutral × WQ2	*−1.69*	*0.776*	*0.03*
Disagree × WC1	1.661	0.766	0.03
Neutral × WC1	1.531	0.764	0.045
Agree × WC1	2.091	0.751	0.005
Agree × WC2	1.603	0.787	0.042
Strongly agree × WC1	1.649	0.775	0.033
Education			
College × WC1	0.492	0.212	0.02

3.2.4. Willingness to Pay

Using the coefficients for each of the attributes and levels (Table 2), we estimated marginal WTP values for moving from the baseline "low" levels of water quality, water clarity, coral reef cover, and fish diversity (Table 4). On average, across all beaches surveyed, participants were willing to pay $11.43 to reduce days of bacterial exceedance from 11 to 5 per year, and a further $30.72 to reduce it to no bacterial exceedances at all. WTP to move from 15 ft. to 30 ft. of underwater visibility was $35.71, and a further $14.80 to increase from 30 ft. to 60 ft. Respondents were willing to pay $15.33 to improve coral reef cover from 10% to 25%, and a further $4.89 to improve to 45% cover. WTP for moving from nine species in the environment to 18 species in terms of fish diversity was $7.14, and a further $2.47 to increase that to 27 fish species. Willingness to pay values were highest for North Shore, followed by Waikiki and Ala Moana in decreasing order. Non-residents had slightly higher WTP than residents in water quality, clarity, and coral cover Table 5).

4. Discussion

4.1. Context

This study's WTP results should be viewed in the context of Hawai'i's tourism sector and its contributions to the economy. Over eight million tourists visited Hawai'i in 2014, for a combined 75 million visitor-days (Hawai'i Tourism Authority, 2015). Out-of-state Americans spent on average $182 a day, and Japanese nationals on average $257 a day (State of Hawai'i Department of Business Economic Development and Tourism, 2014). Should these visitors decide not to travel to Hawai'i as a result of coastal water contamination events, the economic impact could be disastrous for the state economy where tourism comprised 29% ($15 billion) of the economic output in 2012 (State of Hawai'i, 2011). Many of these visitors come to Hawai'i to go to the beach. A 2011 study found that more than 80% of American visitors to Hawai'i participate in beach-related recreational activities, more than 25% surf, over 50% snorkel and dive, and 5% jet-ski and/or windsurf (Hawai'i Tourism Authority, 2011). Over 50% of state park visitors enjoy the state's beaches and coastal waters (Hawai'i Tourism Authority, 2007). In this sense, Hawai'i is an example of tropical tourism-based economies around the world that are dependent on their beaches to attract tourism dollars. Recreationalists have been documented to prefer specific levels of environmental conditions (Beharry-Borg and Scarpa, 2010; Gill et al., 2015; Loomis and Santiago, 2013).

The study should also be viewed in the context of the importance of beaches and the nearshore environment for the quality of life of local residents, who spend significant time at the beach. Coastal recreation is an important part of life in Hawaii. Many people swim, surf, and bodyboard. Others boat, stand-up paddle, or paddle out on iconic outrigger canoes. People fish from the shore, while other cultural practices take place at local beach parks (ranging from family celebrations to traditional practices). The extensive recreational use of the coastal zone by the resident population is deeply intertwined into local values and lives.

Hawai'i is an example of a global trend: coastal systems degrading from local and global stressors. Around the world, coastal ecosystems

Table 4
Conditional logit WTP values for all O'ahu beaches (and regions). Mean values highlighted in italics, followed by lower and upper bounds. "–" indicates non-significant results. "–" indicates a non-significant coefficient. 95% confidence interval, variance estimated by delta method.

	All O'ahu beaches			North Shore beaches			Ala Moana beaches			Waikiki beaches		
n	263			33			50			117		
Attribute	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
Water quality												
5 days over safe limit	*$11.43*	$5.18	$17.68	–	–	–	–	–	–	*$14.33*	$4.96	$23.71
Always within safe limit	*$42.15*	$35.93	$48.36	*$43.89*	$27.13	$53.18	*$38.86*	$26.62	$51.10	*$44.73*	$35.25	$54.21
Water clarity												
30 ft.	*$35.71*	$29.47	$41.96	*$40.37*	$23.04	$57.69	*$26.20*	$13.86	$38.54	*$34.50*	$25.14	$43.85
60 ft.	*$50.51*	$43.90	$57.13	*$49.76*	$31.62	$67.91	*$37.99*	$25.37	$50.60	*$49.84*	$39.92	$59.76
Coral reef cover												
25%	*$15.33*	$9.51	$21.15	*$20.48*	$4.59	$36.38	*$12.43*	$0.54	$24.32	*$14.08*	$5.35	$22.82
45%	*$20.22*	$13.93	$26.50	–	–	–	*$17.01*	$4.40	$29.61	*$24.75*	$15.18	$34.31
Fish diversity												
Medium	*$7.14*	$1.24	$13.04	–	–	–	–	–	–	–	–	–
High	*$9.61*	$3.79	$15.44	–	–	–	–	–	–	*$10.49*	$1.63	$19.35

are under severe threat from anthropogenic activities. In Hawai'i, land-based pollution takes a serious toll on the health of the coastal zone (Dugan, 1977; Fabricius, 2005). What were previously forests, grasslands, and wetlands on many parts of the Main Hawaiian Islands have since been transformed by humans into agricultural land laced with pesticides (Knee et al., 2010) or urban and suburban subdivisions leaching toxic chemicals and human waste (Andrews and Sutherland, 2004; Koizumi, 1966). These land-based pollutants enter coastal waters in the form of point and non-source pollution (De Carlo et al., 2004; De Carlo et al., 2007; Environmental Protection Agency, 2010a).

Finally, the study should be considered in the local policy context. Coastal environmental degradation is a real and serious problem, and while many government policies and management efforts are in place, they are often underfunded and poorly resourced. A general lack of information to set policy priorities, set management budgets, or to devise innovative conservation finance mechanisms underscores the need for robust and defensible economic valuations. Local policy, including Hawaii's Ocean Resources Management Plan (2013), recognizes the importance of a vibrant and healthy nearshore environment for local quality of life and visitor experience. In response to ever-increasing human pressures on nearshore ecosystems (Ahn et al., 2005; Biao et al., 2004; Morrice et al., 2008; Re et al., 2011; Tsatsaros et al., 2013), the plan sets out broad management priorities to manage land and sea in an integrated manner, preserve the ocean heritage, and promote collaboration and stewardship. The goals are expansive – ranging from minimizing the spread of invasive species to improving coral reef health to preserving cultural heritage.

4.2. Implications

This study quantified the benefits to recreationalists of improving coastal water quality and associated ecosystems. Combining beach attendance, individual recreationalist WTP, and bacterial exceedance data reveals insight into the gain in total consumer surplus from a reduction in frequency of water quality events. In 2012, based on 17,737,954 beach visitation days in 2013 derived from Honolulu lifeguard beach attendance records, recreationalists could have gained $205 million in consumer surplus if the 84 days of water quality events reported that year to the EPA were halved, and an additional $550 million if eliminated entirely. Improved (moving from low to medium) water clarity is worth $639 million to recreationalists, and an additional $265 million for further improvement (moving from medium to high). Improved coral cover from 10% cover to 25% cover improves consumer surplus by $274 million, and a further $88 million when cover is increased from 25% to 45%. Improved fish diversity from low to medium

Table 5
Conditional logit WTP values for O'ahu beaches by Hawai'i resident and non-resident. Mean values highlighted in italics, followed by lower and upper bounds. "–" indicates non-significant results.

	All respondents			Hawai'i residents			Non-residents		
n	263			163			100		
Attribute	Mean	Lower	Upper	Mean	Lower	Upper	Mean	Lower	Upper
Water quality									
5 days over safe limit	*$11.43*	$5.18	$17.68	*$9.32*	$0.82	$17.82	*$13.78*	$4.55	$23.01
Always within safe limit	*$42.15*	$35.93	$48.36	*$39.41*	$31.04	$47.76	*$45.42*	$36.12	$54.72
Water clarity									
30 ft.	*$35.71*	$29.47	$41.96	*$33.23*	$24.90	$41.56	*$38.70*	$29.25	$48.15
60 ft.	*$50.51*	$43.90	$57.13	*$47.52*	$38.66	$56.39	*$54.33*	$44.38	$64.28
Coral reef cover									
25%	*$15.33*	$9.51	$21.15	*$13.68*	$5.92	$21.44	*$17.58*	$8.78	$26.38
45%	*$20.22*	$13.93	$26.50	*$17.14*	$8.71	$25.57	*$24.34*	$14.87	$33.80
Fish diversity									
Medium	*$7.14*	$1.24	$13.04	–	–	–	–	–	–
High	*$9.61*	$3.79	$15.44	*$10.74*	$2.84	$18.65	–	–	–

diversity is worth $128 million, and a further $44 million when improved from medium to high.

Information on beach recreationalists' preferences and WTP can be insightful for setting policy objectives. Assigning a monetary value to non-market goods and services increases their visibility in policy discussions. Without monetary value estimates, conventional cost-benefit type trade-off analyses neglect non-market services, to the detriment of society as ecosystems are destroyed in favor of other things which have more obvious market signals. With appropriate values placed on these natural resources, society is better equipped to make optimal tradeoff decisions. For instance, in Guam, a choice experiment revealed the benefit to the economically important dive sector from fisheries management (Grafeld et al., 2016).

WTP studies can also provide critical information to justify management responses and allocate budgets. The WTP results reveal the gain to society from environmental improvements. In an era of scarce public resources, quantifying the social benefit of environmental management can help leverage budgets dedicated to preserving and restoring ecosystems crucial to the delivery of economically important ecosystem services. Information on social preferences can help reveal where, specifically, to dedicate effort. The agencies responsible for meeting priority goals require information that can help them set priorities and allocate budgets. For example, in Hawai'i, the non-market value of forest watersheds (Kaiser and Roumasset, 2002) and the non-market value of coral reefs (Cesar and Van Beukering, 2004; Cesar et al., 2002) were used to justify conservation efforts.

Finally, resource user WTP can be leveraged to finance conservation and management, for instance, through user fees which capture the consumer surplus and use it to deliver higher quality experiences. Hanauma Bay on O'ahu is such an example where user fees were used to fund conservation and control tourist access (Cesar and Van Beukering, 2004; Moncur and Mak, 1998). Other options might include a departure tax (Jensen and Wanhill, 2002) or voluntary donation (Stithou and Scarpa, 2012) as employed in Palau, Europe, and elsewhere around the world.

Our results demonstrate respondents clearly valued water clarity, water quality, coral reef, and fish, in that order, with diminishing marginal utility except for water quality where no chance of bacteria was greatly preferred. This implies that one focus of management should be on water clarity, which is a function of land management and natural processes (runoff as well as waves that churn up particles in the nearshore environment). The best conditions (visibility of 60 ft) may not be possible everywhere, but reducing land-based source pollution could improve conditions in many places.

Bacteriological water quality, however, *is* largely controlled by humans – with anthropogenic degradation being the primary (and often sole) driver of poor water quality. Specifically in Hawai'i, inadequate regulations of cesspools, aging infrastructure, and poor choice of wastewater disposal sites (injection wells) continue to cause water quality events. Not only is Hawai'i legally required to meet EPA standards for wastewater disposal and nearshore water quality, but it is in the state's best economic interest as well. Continued beach closures like the recent water quality events along the South Shore (Davis, 2015; Solomon, 2015; Uyeno, 2015) not only have serious impacts now, but may lead to fewer tourists over the long term.

Ecological attributes (coral reef and fish) are of less, but still sizable, concern to beach recreationalists. It is not completely surprising as many beach users are not snorkeling or diving and do not necessarily experience reefs and fish. Some respondents may have assumed that by preferring water clarity and water quality, they would see associated impacts on reef health and fish assemblages (Jarvis et al., 2016), or may have felt that without water clarity, ecological variables didn't matter because they wouldn't see them (i.e., preferences were based solely on the resource's use value).

4.3. Specific Results

The WTP values we found are in the same ballpark with other beach and ocean attribute valuation studies (Beharry-Borg and Scarpa, 2010; Loomis and Santiago, 2013; Whitehead et al., 2008) but more conservative than others (Gill et al., 2015), perhaps because this survey was not directed towards a snorkeling or diving respondent population but rather generic beach users. In Trinidad and Tobago, Beharry-Borg and Scarpa (2010) reported WTP of up to $35 for up to 60 fish, $50 for up to 45% coral cover, and $40 for vertical visibility up to 10 m amongst snorkelers. In Puerto Rico, Loomis and Santiago (2013) found WTP of $54 for improvements to water clarity by CVM and $51 by DCE. In Honduras, St. Kitts & Nevis, and Barbados, Gill et al. (2015) estimated WTP of $84 for high fish abundance, $74 for moderate number of large fish, and $66 for high number of large fish.

We found no classes in the latent class analysis – preferences across respondents were relatively homogenous amongst socioeconomic groups (similar preferences across income group, similar preferences by residency, etc.). This implies that some interaction effects exist. Interaction testing confirmed a number of hypotheses about beach users' preferences, such as divers preferring high water clarity, but other findings were surprising, e.g., stand-up paddlers preferred not having a high coral cover (perhaps because of the injuries they may sustain). Snorkelers were more similar to the average recreationalist than divers, with no interaction effects to any attributes. The implication is that divers are much more concerned with water attributes then their more casual snorkeling counterparts. Hypotheses that certain activities (snorkelers and divers) would prefer high levels of ecological (fish, coral) properties did not bear out. Surprisingly, income did not interact with any of the attributes, in any income bracket. No trends in interactions were found between preferences and income, suggesting fairly uniform preferences across socioeconomic backgrounds. Particularly surprising is the similar WTP amongst residents and non-residents. The results suggest that price discrimination where locals are asked to pay less environmental fees than non-residents to visit protected beaches (entrance to Hanauma Bay on O'ahu for example) may be unnecessary if all recreationalists are willing to pay a similar amount.

We grouped beaches into regional groups and attempted to ascertain regional differences in WTP, and found that WTP is marginally higher on the North Shore than Waikiki, with Ala Moana being the lowest. Only a limited number of attributes and levels were comparable, as the smaller sample sizes resulted in many attributes becoming insignificant in the model. However, the pattern is generally consistent with the rationale that as the North Shore is the most distant beach group for most beach visitors, we expect WTP to be higher as these participants have already incurred a large cost (time, transportation) to get there. Waikiki having a higher WTP then Ala Moana is also consistent as the two groups are made up of largely local residents and tourists, respectively, who have both chosen not to incur large costs to travel to higher quality beaches elsewhere on Oahu, instead choosing beaches immediately available to them.

While water clarity or sediment-free water is often used as a proxy for pollutants, they are not the same and it is possible for clear water to be over the safe limit for bacteria. Attitudes results (Supplementary Fig. 1) suggest there was a great deal of conflation between water quality and water clarity, and that part of the utility for water quality may have been assigned to water clarity. This affects the marginal rate of substitution between the two attributes, but it is unclear to what degree. When considering the associated coefficient estimates (and WTP values) of water quality and clarity, one should be mindful of this caveat. The hypothesis that water quality would be the most important attribute to recreationalists did not bear out, but participants may be conflating water quality (bacteria) and water clarity (visibility). Over 60% of respondents agreed or strongly agreed with the statement “I judge how clean the water is by how clear it is”. We found negative interaction effects amongst those who answered disagree or neutral and their

preferences for water *quality*, while those who answered agree or strongly agree showed positive interactions with water *clarity*. The data suggest that respondents who do not judge water quality by water clarity are much less concerned with water clarity in general.

4.4. Limitations

This study does not control for avidity bias (Loomis, 2007) and hypothetical bias, but does follows others (Loomis and Santiago, 2013) that have taken great care to create a realistic scenario where bundled choices are believable and alternatives (with prices) are presented in a way to avoid protest bids. These nuances were evident in our survey pre-tests, where many participants expressed resistance to any sort of "fee" for improved attributes, but readily agreed to accepting "costs" if it was portrayed as an expense to physically travel to a beach with improved water attributes.

It is unclear how representative of recreationalists our sample population is. The study only targeted beaches with lifeguards, as there were no alternatives to ascertain beach attendance on Oahu. The Hawai'i Tourism Authority tracks inter-island travel, but there is no way to determine visitation patterns once an individual is on island. This survey took place from July to November, but certain beaches were only sampled towards the beginning or end of the sampling period and as a result the distribution is not uniform. When asked for "income", some participants may have interpreted the question as household income, while others as individual income. Similarly, there was some confusion in "education", where the number of participants with graduate degrees was unusually high, which we believe may be attributed to participants mistaking "graduate school" as having "graduated high school".

While we attempted to have clear and distinct photo depictions of all attributes, water clarity and coral cover were represented by photos that contained things other than the independent variable being manipulated. In water clarity photos, a turtle was visible to different degrees in the background depending on water clarity level. The 30 ft. visibility level had a sandy bottom, and the 60 ft. visibility level has a reef bottom. For coral cover photos, the 10% and 25% coral cover depictions were taken from a distance, while the 45% cover photo was a close-up. The 25% cover photo had a school of fish passing behind it, while the 45% cover photo had a single fish swimming in it. It should be noted we originally attempted to depict all coral cover levels with scientifically accurate photos from a USGS study of reef conditions offshore of Moloka'i, but returned non-significant results in our pilot surveys with repeated comments from respondents that they were not able to distinguish any differences between levels as depicted. Other respondents commented that the scientifically accurate depictions all looked unappealing in general. In being mindful of these limitations, results should be interpreted with caution.

4.5. Conclusion

Potential welfare gains by improving coastal water conditions are very large. Management actions and programs such as those governing point and non-point source pollution, Clean Water Act compliance, sediment and runoff control, fishing limits, and marine invasive species are directly linked to water quality, water clarity, coral cover, and fish diversity. These actions can effectively increase recreationalist welfare.

This study fills a gap in understanding of the non-market recreational value of Hawaii's coastline. In light of recent and repeated water quality warnings and beach closures (Davis, 2015; Solomon, 2015; Uyeno, 2015) that echo the serious and prolonged sewage spill in 2006 (Magin, 2006), it is all the more important that decision makers recognize the significant value of the coastline and the serious harm to the economy that takes place when natural resources are poorly managed and neglected. Non-market valuations in Hawai'i are scarce, and as a state heavily reliant on its natural capital for recreation and tourism, it would be prudent to conduct more studies of this type elsewhere in the Hawaiian Islands. This study estimated benefits of environmental improvements, further studies should attempt to ascertain the economic costs of our impact on the coastal zone, and together use these studies to set management priorities and allocate budgets.

By taking management actions targeting each of the areas relevant to recreationalists, government and other agencies can effectively increase the consumer surplus derived from improved coastal conditions, avoid beach closures from water quality events, and preserve future benefits. These findings are of particular relevance to economies dependent on tourism, where these recreational values are acutely important to visitors and locals alike. Reducing anthropogenic impact on our environment is not simply a government expense, but rather an investment that benefits society, and supports and sustains our quality of life.

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Appendix A. Supplementary data

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