University of Hawaiʻi Sea Grant College Program

Waikīkī Beach User Perceptions Survey

Economic Valuation of changes in Waikīkī Beach characteristics

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Waikīkī Beach User Perceptions Survey
Economic Valuation of changes in Waikīkī Beach characteristics

SUMMARY FINDINGS:

- 401 respondents intercepted for Waikīkī Beach perception survey conducted from Nov 2019 - Jan 2020.
- On average, the survey respondents are willing to theoretically pay $389 for the beach condition in Waikiki as-is; $4.24 per additional foot of beach width, and $14.66 per additional foot of underwater visibility.
- The survey respondents can be classified into two groups, with a majority of respondents (60%) supporting doing something about the beach conditions in Waikiki and not letting the beach erode away
- The total estimated willingness to pay by all Waikīkī beachgoers (including residents and visitors) is likely to exceed $1.8 billion annually for the beach as is; and $20 million annually for an increase in the beach width by 1 ft.

Executive Summary

Waikīkī Beach accounted for some $7.8 billion in visitor expenditures in 2019, representing 38% of total visitor expenditures statewide. Though the economic value of Waikīkī Beach is considered to be substantial, few studies have estimated the value in a comprehensive manner. Non-market valuation studies of natural resources are sorely lacking in Hawaiʻi, the last major beach valuation on Oʻahu dates back to 1975 (Moncur, 1975). Based on an in-person survey in Waikīkī Beach conducted in November 2019-January 2020 with 398 respondents, we estimate beach user's willingness to pay (WTP) for changes in beach width and water clarity as well as the preferences for the beach as-is (under its current condition). Survey respondents differ in their attitudes toward beach renourishment. Those who do not support further erosion of the beach are willing to pay $389 for the beach as-is, $4.24 per additional foot of beach width on average, and $14.66 per additional foot of underwater visibility. The WTP for additional beach width drops as the beach becomes wider, but stays positive over the range of Waikīkī's current beach width. The total WTP based on the estimated number of annual beachgoers in Waikīkī (including residents and visitors) is likely to exceed $1.8 billion for the beach as is; and $20 million for an increase in the beach width by 1 foot. These estimates clearly justify beach re-nourishment and runoff control measures to maintain the beach width and water visibility from an economic perspective.

A comprehensive assessment of the beach's value would account for other types of benefits provided by the beach and the nearshore marine environment including ecosystem services, recreational values, aesthetics such as ocean and beach views, and mitigated storm damage to coastal properties among others. Though this study does not quantify these benefits, further application of the survey data and additional valuation surveys could address them to supplement the WTP estimates.

This study fills a gap in knowledge of the non-market recreational value of Waikīkī Beach, and Hawaii's coastlines more broadly. In the context of continued beach erosion and high-tide events ("king tides") in recent years, it is important to understand and quantify the perceived value of the beach itself and how resource management strategies such as beach nourishment can maintain and enhance the value of the beach and marine resources. It is particularly useful for managers to be informed of the trade-offs they face in management decisions. Changes in beach and nearshore conditions can have significant implications for economic welfare, especially in a high-density setting such as Waikīkī involving tourism, recreation, and natural resources. This study aims to inform policy and practice by estimating the value of the beach as-is, in addition to the value of increased beach width and associated water clarity.

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Figure 1. Aerial view of Waikīkī Beach (DLNR, 2021)

1. Introduction

Beaches provide many benefits to the surrounding coastal communities and beyond. Visitors and residents alike enjoy coastal recreational activities including sunbathing, swimming, snorkeling, fishing, and surfing. In addition, people enjoy scenic views of beaches, shorelines, and the marine waters beyond. Beaches attracting visitors generate tourism benefits to the economy, as well as command a premium in real estate values for properties near the shoreline. Sea-level rise, coastal development, and land use, however, have accelerated beach erosion and deteriorated the nearshore environment in many parts of the world, including those in the main Hawaiian Islands. This effect is particularly pronounced along the south shore of Oʻahu, in Waikīkī Beach. While estimates of the costs of various beach management measures exist, few studies estimate the benefits of mitigating beach erosion in the area. This study fills the gap by estimating the willingness to pay of the residents and the visitors for changes in the beach width and the underwater visibility based on an on-site, in-person survey with beachgoers in Waikīkī.

1.1 COASTAL ENVIRONMENT AND ITS CHANGES IN WAIKĪKĪ

Waikīkī Beach is a highly engineered urban shoreline. The modern configuration is largely the result of past engineering efforts intended to widen the beach (e.g., groins, seawall, and sand fill, Miller and Fletcher, 2003). Due to ongoing chronic and episodic beach erosion, lack of coordinated management, and lack of capital investment, many sections of Waikīkī Beach are substantially narrowed or completely lost to erosion. Beach loss results in a variety of negative economic, social, cultural, and environmental impacts. These impacts highlight the need for sustained long-term capital investment and comprehensive beach management in Waikīkī Beach to maintain its unique economic, social, cultural, recreational, environmental, and historical qualities. Waikīkī Beach presents a wide range of management challenges that require consideration of a wide variety of innovative solutions and data to support these expenditures.

A variety of factors are contributing to narrowing the beach along the Waikīkī shoreline. In natural settings, beaches are highly ephemeral environments, continuously evolving with changing waves, tides, currents, sediment supply, and sea level. Waikīkī is a highly developed urban beach with a long history of coastal engineering projects including beach nourishment and shoreline structures such as groins and seawalls. Hardened shoreline structures dominate Waikīkī's beach dynamics by altering sediment transport dynamics, thereby influencing beach location and width. Historical sand mining from the beach and dredging of the coral reef in Waikīkī during the early 20th century also significantly altered coastal dynamics in the region and has led to chronic beach erosion in many parts of Waikiki. Therefore, in order to better protect and manage the beach resources in Waikīkī it is important to fully understand the cumulative effects of the shoreline structures, human activities, and coastal processes (natural and human-induced) that control the movement of sand in the littoral system and the economic value these resources offer.

Waikīkī Beach consists of primarily tan and white calcareous (coral) beach sand interspersed with larger-diameter coral cobble (Sea Engineering Inc., 2010). The origins of beach sand in Waikīkī vary widely and are not well documented but much of the beach sand in Waikīkī was imported from various sources

Figure 2. Waikīkī Beach located on the south shore of O'ahu, Hawai'i. (Credit: Hawai'i Sea Grant)

outside of Waikiki. The beaches of Waikīkī experience seasonal fluctuations in beach width and height due to variations in wave energy and direction. In the central portion of the Royal Hawaiian Beach a strong offshore rip current pulls sand out through the channel in the reefs including the ʻĀpuakehau paleo-stream channel in the Royal Hawaiian beach cell. If sand is transported far enough offshore and into deeper water it becomes unavailable to the beach system, as waves and currents will no longer be able to return the sand to the beach. From 1985 to 2009, the primary trend has been shoreline recession in the Royal Hawaiian Beach cell, with the shoreline retreating at rates up to 2.4 feet per year, and an average annual rate of 1.5 feet (Sea Engineering Inc., 2010).

1.2 IMPACT OF CHANGES IN BEACH CHARACTERISTICS

The direct and indirect contribution of tourism to Hawaiʻi's GDP was about 22% in 2010 (Tian et al., 2011). Waikīkī accounted for some $7.8 billion in visitor expenditures in 2019, representing 38% of total visitor expenditures statewide (State of Hawaii Department of Business Economic Development & Tourism, 2020). Tarui et al. (2018) updated a prior estimate, based on tourism expenditure data (Hospitality Advisors, 2008), demonstrating that nearly 2.0 billion (2016 U.S. dollars) in overall visitor expenditures and tax revenues could be lost annually from a complete erosion of Waikiki Beach. To remedy erosion in Waikīkī Beach, several beach restoration and improvement strategies have been proposed, differing in costs and consequences on the nearshore ecosystems (e.g., beach enhancement may impact water quality; shoreline structures may accelerate erosion of neighboring beaches).

In order to assess the economic benefits of beach improvement strategies, it is not sufficient to only know the market costs of such strategies. Rather, it is necessary to have reliable estimates of the actual and perceived value of the beach and nearshore ecosystem along with estimates of changes in these values under alternative beach management scenarios. A comprehensive assessment of the beach's value would account for other types of benefits provided by the beach and the nearshore marine environment including recreational values, ecosystem services, aesthetics such as ocean and beach views, mitigated storm damage to coastal properties, among others. Though the value of Waikīkī Beach is considered to be substantial, few studies have addressed the value of the beach itself. Non-market valuation studies of natural resources are sorely lacking in Hawaiʻi. Some recent studies estimate the value of some natural attributes associated with the beaches and beach management options (Peng & Oleson, 2017; Penn et al., 2014, 2015). However, except for Moncur (1975), no studies address the value of the beach width and usable beach area, i.e., the critical attribute related to coastal erosion 1975 (Moncur, 1975).

Changes in beach and nearshore conditions can have real and serious implications for economic welfare, especially in a high-density setting like Waikīkī involving tourism, recreation, and natural resources. Lack of reliable estimates about the benefits may lead to poorly-informed beach management decisions. Our study aims to inform policy by estimating the value of the beach as-is, in addition to the value of changed beach width and associated water clarity.

2. Methods

For goods and services subject to marketed transactions, the market prices represent a signal of their value. Similar to many other environmental resources, benefits provided by beaches and shoreline ecosystems are not traded in conventional markets. A conventional economic analysis applies prices of related products (such as expenditures by tourists visiting the beach, e.g., Hospitality Advisors, 2008; Tarui et al., 2018). Such approaches, by focusing on direct-spending economic activity such as commercial activities, jobs and tax revenue, may miss a significant part of the benefits that are not reflected in market prices. Expenditures by a recreationist who visits the beach (such as those associated with transportation, time, and accommodations) indicate a lower bound estimate of the value of the beach: the value of the beach would be at least as much as what the recreationist would pay through these marketed interactions. For a more comprehensive assessment of what the beach is worth to consumers, researchers apply non-market valuation methods to capture the consumer surplus (i.e., what the consumer benefits beyond the payment) associated with the beach use.

The most commonly used non-market valuation methods for assessing beaches are stated preference methods such as contingent valuation (Binkley & Hanemann, 1978; Bishop et al., 2011; Tsuge & Washida, 2003) and discrete choice experiments (Adamowicz et al., 1998; Beharry-Borg & Scarpa, 2010; Loomis & Santiago, 2013), as well as revealed preference methods such as travel cost (Hanemann et al., 2004; Lew & Larson, 2005; Parsons et al., 2009). This study applies discrete choice experiments to estimate the beachgoers' willingness to pay to visit and use Waikīkī Beach. Non-market valuation studies are rare in the Hawaiian Islands, and most conspicuously absent are those that value the shoreline, beaches and coastal ecosystems. We improve on previous valuation work on O'ahu beaches by assessing comprehensive willingness to pay for the beach itself and its multiple attributes. To produce standardized, defensible economic values for recreation from both resident and visitor populations, we conducted an in-person survey with respondents in Waikīkī Beach.

2.1 SURVEY

The survey was designed as an on-site, respondent intercept survey, where surveyors walk up to potential respondents on the beach and solicit participation. Every effort has been made to capture as random a sample population as possible. A group of surveyors executed the survey in the field in November 2019 - January 2020. The surveyors spread out across Waikīkī Beach, starting at the central point of the Duke Kahanamoku statue in Kuhio Beach walking in either direction covering the length of Waikīkī Beach (from Hilton Hawaiian Village to Kaimana Beach).Surveyors randomly approached individuals they encountered on the beach, soliciting one individual of any group or household to participate on a provided iPad. Both residents and visitors were targeted, with surveyors taking reasonable care to not interrupt individuals who are clearly in the middle of some activity. In addition to in-person surveys, additional responses were collected from self-selected respondents via a flier with a QR code distributed by surveyors. Scanning the QR code with a cell phone or tablet's camera will open a link to the online version of the survey. The field survey instrument consists of four parts: general perceptions, choice scenarios, travel cost, and demographics as detailed below.

2.2 DISCRETE CHOICE EXPERIMENT DESIGN

This study consisted of a three-attribute survey, focusing on the nearshore geomorphologic features of the study site. The attributes are selected for their relevance to recreationists: beach width, underwater visibility (clarity), and price (or the cost of access to the beach). For both beach width and underwater visibility, four reference levels were determined by geomorphological reference data in consultation with the Waikīkī beach resource managers. A "base condition" was designated that closely matched the existing beach conditions on average. Alternative conditions such as wider or narrower beaches and clear or turbid water visibility were designed such that differences could be perceived by a beach user and were of management interest. Prices were set at nine levels, which were determined based on a preliminary test soliciting respondents for probable prices at the study site.

Table 1. Attributes and levels for discrete choice experiment

Attribute	Current condition	Levels			
Beach width	77ft average	50% width	100% (base)	150% width	200% width
Underwater visibility	10ft average	5ft	10ft (base)	15ft	30ft
Price	$0	Variable ($-10, $-5, $0 (base), +$5, +$50, and +$150)			

We represented all variable feature attributes with a single photo except price, which was represented numerically. These images were created in Adobe Photoshop based on an aerial overview of the study site. Each photo is a composite of two attributes: a variable level of beach width and variable level of underwater visibility. Respondents were presented with eighteen different versions of the survey instrument, each of which had three choice scenarios (Figures 3 – 5). Participants were asked to choose their preference between a base condition approximating the beach as-is and two hypothetical conditions where levels varied for each attribute (including associated price).

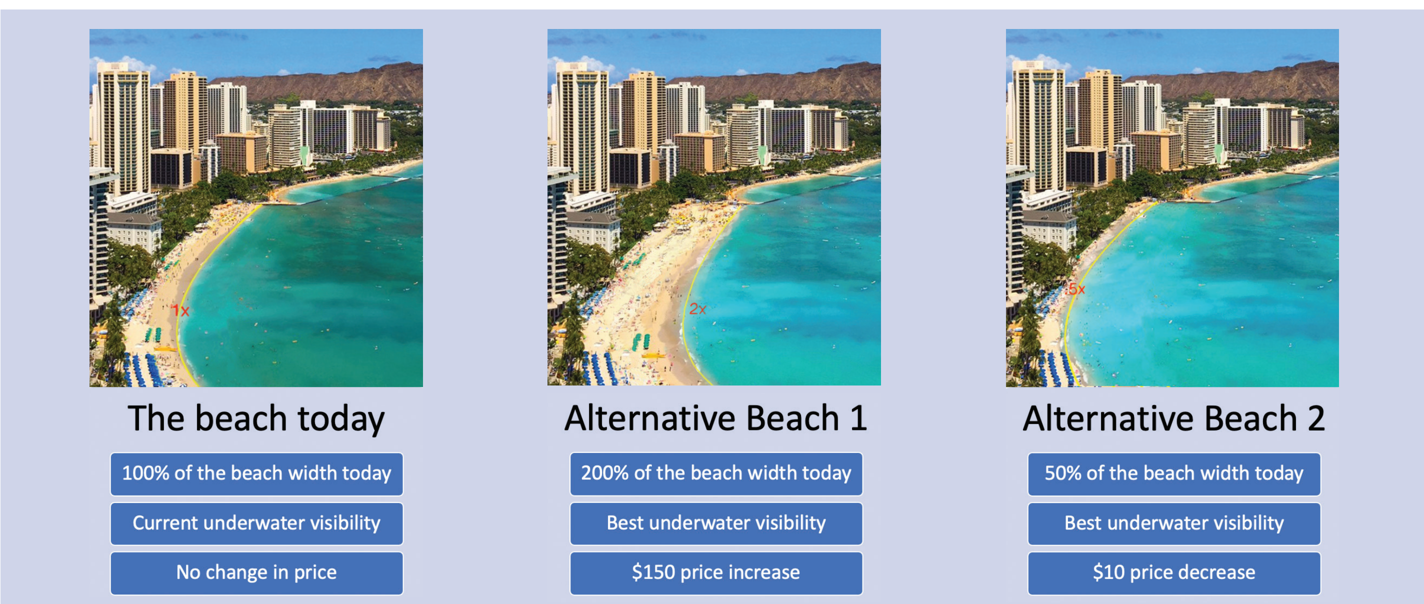


Figure 3. Choice scenarios presented to the respondent, with a "base" condition approximating the beach today (left) and hypothetical alternatives where the attribute levels vary (middle and right).

The two alternative and hypothetical conditions involve combinations of the beach attributes (beach width, underwater visibility, and price). Prices were then assigned to each choice scenario with an efficient design (minimizing number of questions) using the software program *Ngene* version 1.2.1. The estimated values for each parameter in a pilot survey were used as prior values for each parameter in the design. Each respondent received three such questions. By statistically investigating the association between the subject's choices and the associated attributes, this experimental approach provides estimates of the beachgoer's willingness to pay to have a wider beach and water with more underwater visibility. It also indicates how much value the subjects place on the beach under the current condition.

Beach width

Beach width is defined as the usable beach area, typically the distance from the seawall to the ocean. The characteristic of beach width is of particular importance, as it provides physical space for recreationists on the beach, habitat for native species such as turtles and Hawaiian monk seals, among other uses. As beaches in Waikīkī have eroded over time, beach renourishment has been adopted as a strategy to maintain the beach at a minimum size. Nourishment efforts in Waikīkī have historically been relatively small-scale compared to elsewhere in the United States, maintaining a historical beach width as opposed to dramatically expanding it. Based on subject matter expert feedback, it was determined that realistic hypothetical levels at 50%, 100%, 150% and 200% of the current beach width as beach maintenance nourishment targets. These are visualized in Figure 4.

Figure 4. Beach widths used to indicate the possible beach sizes relative to the beach today.

Water Clarity

We define water clarity as the distance a beach user is able to see underwater. It is of particular importance to activities such as snorkeling and diving, which involves watching the ocean floor and associated marine life such as fish and coral reefs. Further, clear water provides aesthetic benefits in general. A variety of factors can affect underwater visibility, some of which include land-based point source and non-point source pollution. We determined realistic hypothetical underwater visibility levels at 5ft, 10ft, 15ft and 30ft as levels perceivable by the respondent. That is, we assume after 30ft any additional underwater visibility cannot be perceived and benefits to additional underwater visibility diminish to zero.

Figure 5. Levels of underwater visibility and associated distances.

Payment vehicle

Each beach choice scenario has an associated price. The price is presented as a hypothetical additional cost increase (or decrease) to go to the alternative beach presented, while the "base condition" that approximates Waikīkī Beach on average is constrained to have a $0 cost. The cost of travel to Waikīkī Beach is not considered, but rather the additional cost of substitution from Waikīkī is of interest. That is, respondents are asked to make trade-offs between additional costs for better environmental conditions and the as-is condition of Waikīkī Beach at zero additional cost which also functions as an opt-out. The resulting WTP estimates for beach width and underwater visibility are the value of making marginal improvements for Waikiki Beach visitors.

To avoid generating respondent biases associated with particular payment modes (such as taxes, fees, and donations), we use the neutral expressions "price" and "cost" represented as the cost of visiting a substitute beach nearby (assuming the current beach where the respondent is intercepted in Waikīkī is zero-cost as they are already there) (Figure 3). By having a realistic scenario described as a cost that is not a government intervention as the payment vehicle, we minimize protest bids associated with common payment vehicles such as taxes and fees (Campos et al., 2007; Shah et al., 2017), arrive at a conservative estimate (Talpur et al., 2018), and still maintain the payment to be binding and salient (Johnston et al., 2017).

Using a range of probable prices, we solicited a range of prices as an additional cost increase (or decrease) to go to an alternative beach during a pre-test. Bids were $-10, $-5, $0, $5, $50, and $150, where negative prices do not denote the respondent receiving money, but rather being an alternative beach that would cost the respondent less than what they have incurred for a beach day compared to where they were intercepted. The beach became narrower and accommodations become slightly less costly because the destination has become less attractive. All bids are indicative of incremental changes to costs faced by the respondent for the given beach, where the existing status quo is assumed to have an incremental cost of zero.

2.3 ECONOMETRIC STRATEGY

Random Utility Theory, conditional logit (McFadden, 1974), mixed logit (Train, 2009), and latent class model form the basis for this survey analysis. Specifically, a Discrete Choice Experiment (DCE) was applied with a carefully designed with consideration for contemporary issues in stated preference (McFadden, 2017) and justifying all parts of the instrument by setting the choice parameter values in consultation with beach managers and by checking their validity via pre-test. We include an Alternative Specific Constant (ASC) to indicate the "base" condition of the beach as-is to show the relative difference in utility to respondents between alternatives. The latent class logit model allows us to examine multiple "classes" of respondents, where the membership of the classes of respondents are not arbitrarily determined (or known) by the analyst but revealed in the process to avoid bias. See Appendix B for a mathematical description of relevant models.

3. Results

SUMMARY FINDINGS:

- Results of Waikīkī Beach perception survey in Nov 2019 - Jan 2020 (N=398)
- On average, the survey subjects are willing to pay $389 for the beach condition as is; $4.24 per additional foot of beach width, and $14.66 per additional foot of underwater visibility.
- Survey respondents can be classified into two groups, including one with a strong preference for the beach as-is, with different attitudes toward beach management.
- A majority of respondents (60%) are less likely to support doing nothing and letting the beach erode away; but at the same time less likely to support large-scale nourishment; more likely to be visitors, and have moderate willingness to pay.
- The total willingness to pay by all Waikīkī beachgoers (including local residents and visitors) is likely to exceed $1.8 billion annually for the beach as is; and $20 million annually for an increase in the beach width by 1 ft.

3.1 SUMMARY STATISTICS

A total of 401 respondents were interviewed from November 6, 2019 to February 2, 2020 across six sections of Waikīkī Beach, where each classified as a littoral cell. A majority of respondents were aged 18-34, more than 40% hold a college degree, a quarter had an income below $40,000, and female respondents answered the survey more often on behalf of their group. Over 75% of respondents were visitors, with over half from the rest of the United States, 16% from Japan, and 10% from Canada (Figure 6).

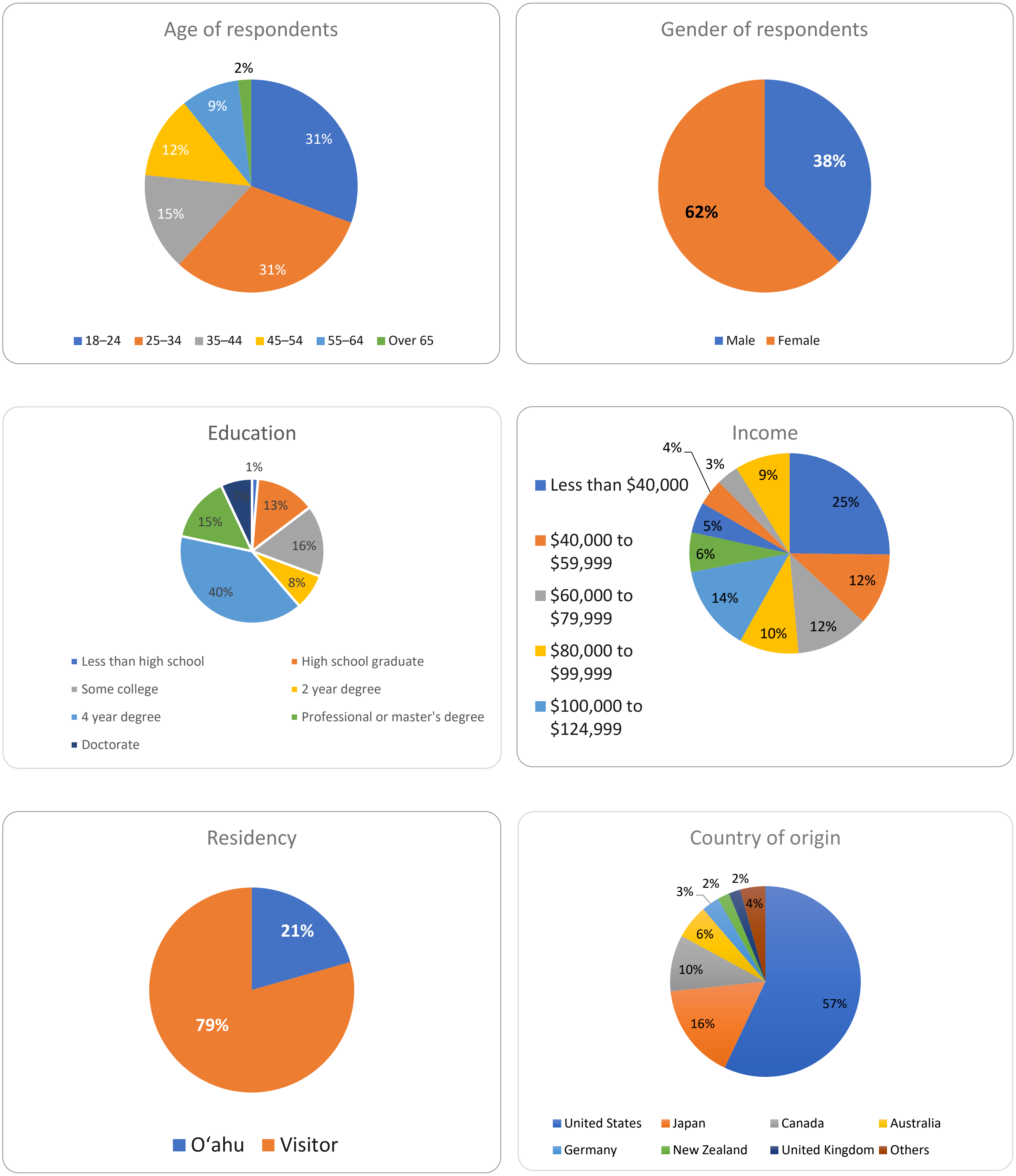
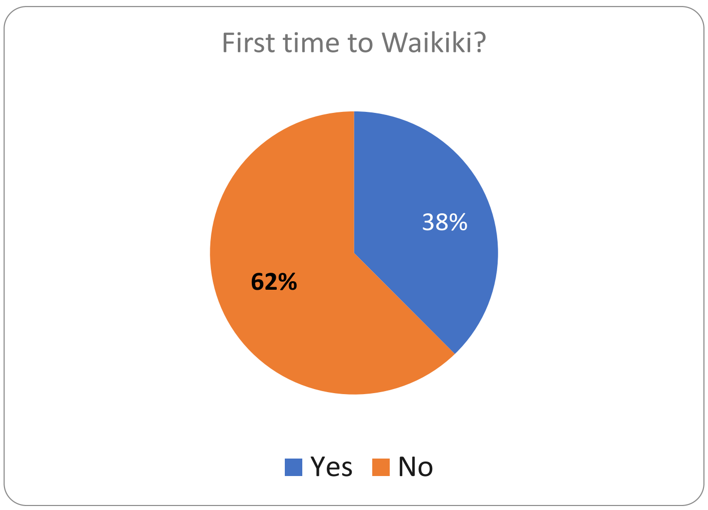
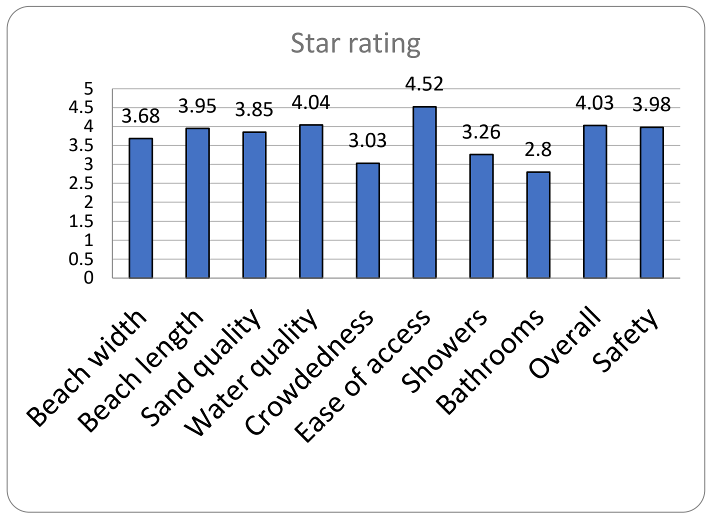
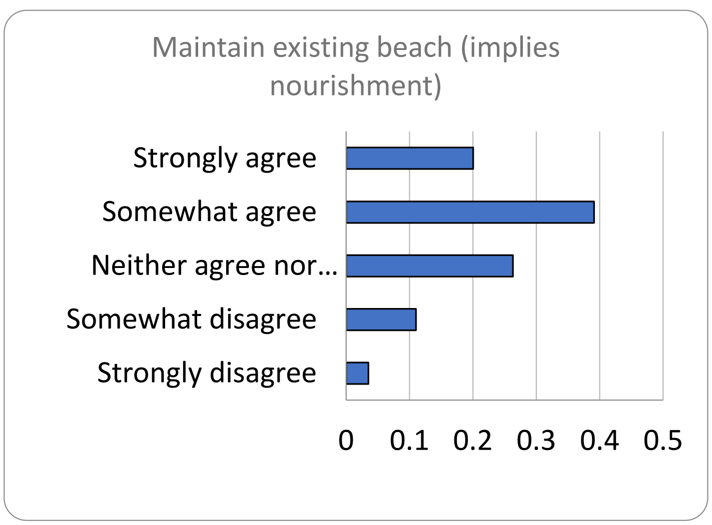


Figure 6. Demographics of survey respondents

Respondents were asked to rate beach characteristics such as beach width, ease of access, public facilities, etc. (Table 3) out of 5 stars in a similar fashion to popular travel websites. On the 5-point scale (1 the lowest, 5 the highest), respondents rated Waikīkī Beach features with a mean score of 4 most often, ranging from a mean of 2.8 for bathrooms and a mean of 4.5 for ease of access. The lowest rated amenities including public bathrooms, crowdedness, and showers may require management attention. More generally, results suggest management strategies that target improvements to public infrastructure and crowding are important to visitors. Further, respondents were asked about their attitudes towards beach maintenance and nourishment. Respondents were generally supportive of beach nourishment (60% agree or strongly agree with maintaining existing beach) and opposed to doing nothing and letting the beach erode away (Figure 7).







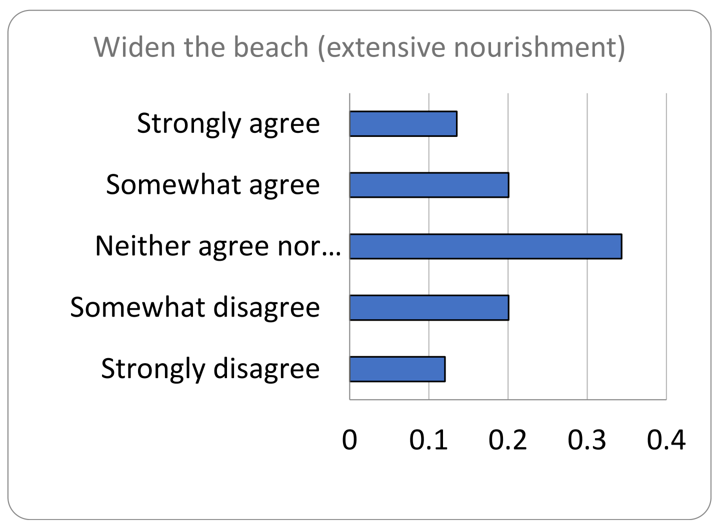


Figure 7. Respondent attitudes *(continued on next page)*

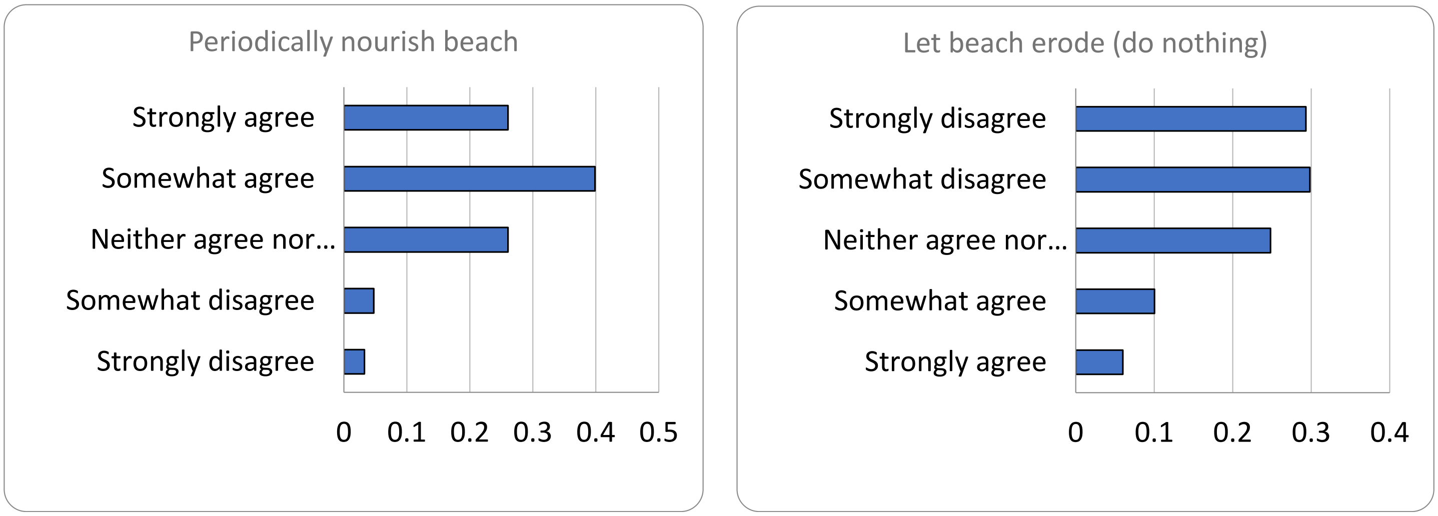


Figure 7 *(continued)*. Respondent attitudes

We noted the circumstances in which respondents were interviewed, considering weather, day of the week, beach segment, beach width, and accommodation choice in addition to typical choice-invariant variables captured by socioeconomic background. Respondents were interviewed most often in partly cloudy weather, with only 9% encountering showers. Over 30% of respondents were interviewed in the Royal Hawaiian cell and in Queens Beach. The average beach width respondents encountered was 77ft. The highest number of respondents were interviewed on Saturday, with Friday and Sunday being close seconds. Over 65% of visitors stayed in hotels, while 18% stayed in secondary market accommodation (defined as timeshares, vacation rentals, and Airbnbs). Just under 40% of respondents are visiting Waikīkī for the first time (Figure 8).

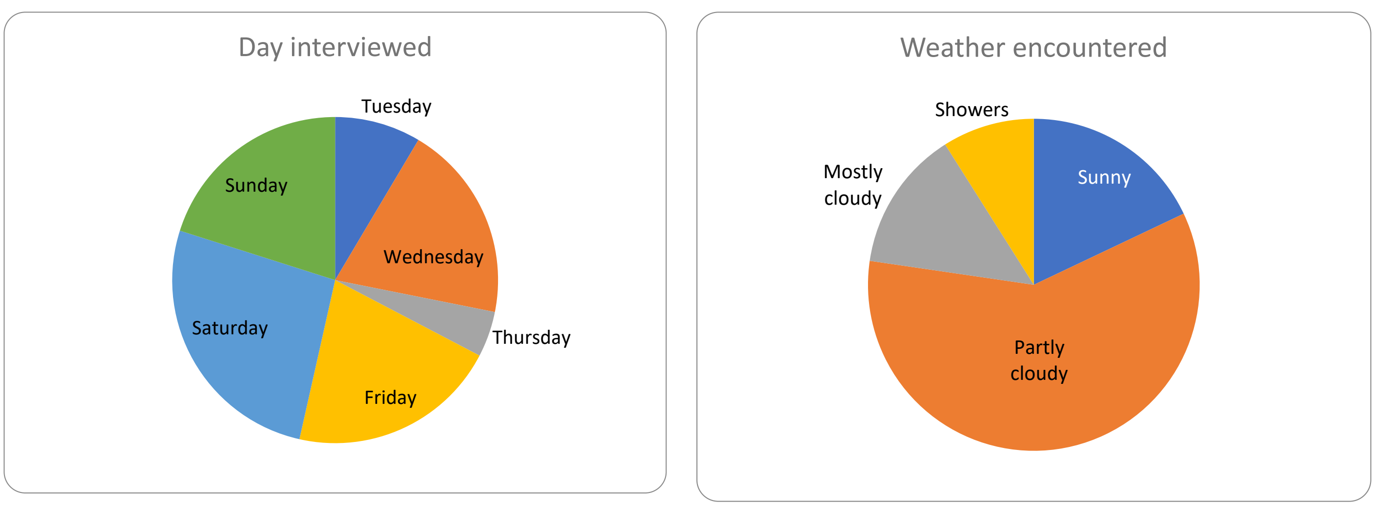
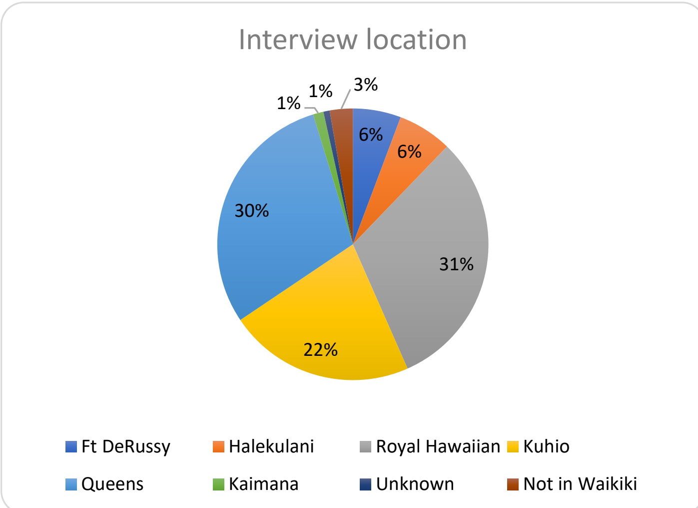
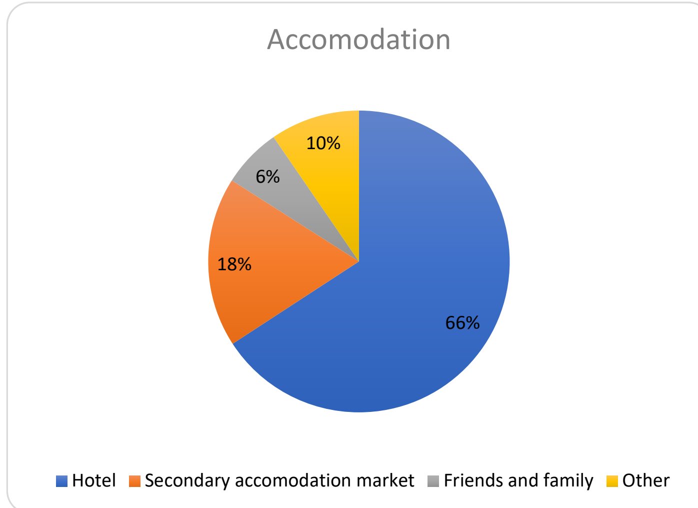


Figure 8. Interview conditions *(continued on next page)*





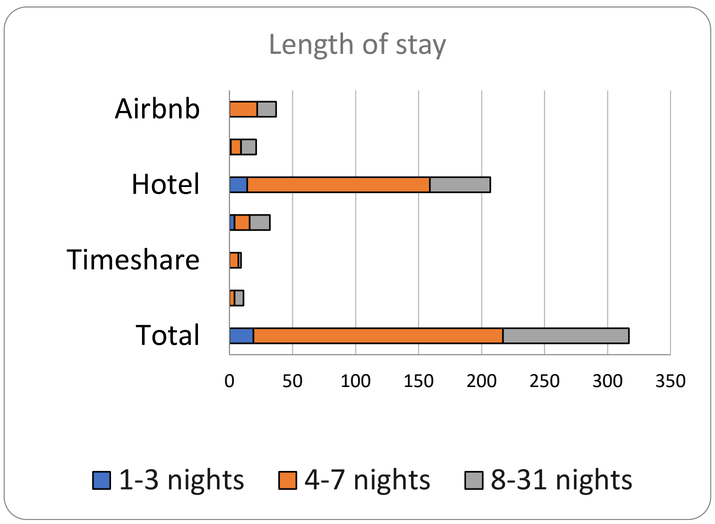


Figure 8. *(continued)* Interview conditions

For each shoreline segment, we determined beach widths individually and treated parts of each segment independently (i.e., the smallest unit of measure for beach segments is not the beach itself such as Royal Hawaiian, but rather broken down into its component sections assigned different beach widths). Results were then combined with GPS coordinates of respondents and approximated to the nearest shoreline to determine the beach width to be used.

3.2 MODEL SELECTION

We considered several multinomial logistical regression models, with selection based on significance of coefficients and conventional estimators such as Akaike information criterion (AIC) and Bayesian information criterion (BIC). We make use of the random parameters logit for estimation and results.

Table 2. Willingness to pay results

	Beach as-is	Beach width	Underwater visibility
Mixed logit	$388.76	$4.24	$14.66
Latent class	$389.42	$2.02	$10.89
Latent class with membership	$475.94	$1.96	$13.16

Note: Beach width refers to WTP for 1ft wider beach, evaluated at the average beach width in the sample. Underwater visibility refers to WTP for increased underwater visibility by 1ft. WTP under the latent class model and the latent class model with membership is for class 1 only.

Latent class model

It should be noted that the choice experiment data can also be analyzed using a latent class model. Our estimated model assumed two classes (Table 4), and produced a class 1 where all attributes are significant for 60% of respondents, and a class 2 where all attributes are significant except bid for 40% of respondents. The membership function includes preferences for beach nourishment, doing nothing and letting the beach erode away, and being a visitor instead of being a resident. That is, 1) respondents that do not support re-nourishment are likely to belong to class 1, 2) respondents that do not support doing nothing and letting the beach erode away are likely to belong to class 1, 3) visitors are likely to belong to class 1. All coefficients in class 1 have expected signs, positive coefficients for attributes (upward sloping) and negative coefficient for bid. The result is a lexicographic preference.

Willingness to pay (WTP)

The generic formula for WTP is coefficient of attribute/-(coefficient of price) The generic formula for WTP is coefficient of attribute/-(coefficient of price)

$$WTP_{attribute} = -\frac{d(bid)}{d(attribute)} = -\frac{\partial V/\partial attribute}{\partial V/\partial bid} = -\frac{\beta_{attribute}}{\beta_{bid}}$$

Respondents are willing to pay $389 for the base condition as-is (independent of the consideration about the beach width or the water clarity), $6.56 per additional foot of beach width when the beach width is at zero, $4.24 per additional foot of beach width when the beach width is at the average interviewed condition of 77ft, and $14.66 per additional foot of underwater visibility at all underwater conditions (Table 2). Our model assumes a quadratic relationship for beach width and linear relationship for underwater visibility, with a peak WTP for beach width at 218 ft (Figure 9). Based on feedback from the subject matter expert, we also assumed recreationists perceive no difference in underwater visibility in Waikīkī past 30 ft.

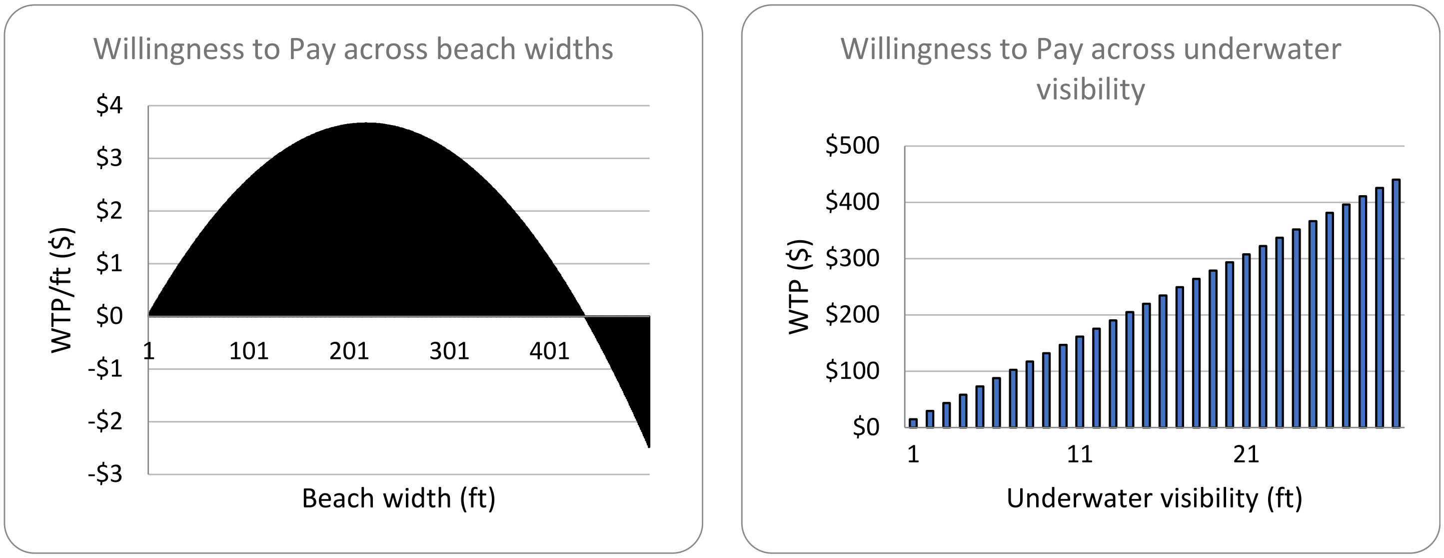


Figure 9. WTP curves for beach width and underwater visibility. We found only a quadratic relationship for the former and a linear relationship for the latter could be estimated.

Interaction effects

We tested interactions between variables using different random parameter logit models. Positive interactions indicate the two variables together led to the respondent agreeing to pay more for an improvement in beach attributes. A negative interaction term means that the two variables together led to the respondent to pay less for an improvement in water attributes. For interaction testing, groups of choice invariant variables were grouped together and interacted with attributes for significant results. The largest, followed by the second largest, choice invariant dummy variable was dropped in subsequent runs such that one group of dummy variables was dropped in each interaction test run. That is, interaction results are for three independent runs of English language (Japanese dropped), Japanese language (English dropped), and visitor origin (Oahu dropped). Both survey language (English or Japanese) and country of origin dummy variables suggest that the non-Japanese visitor would pay more for the existing beach as-is (ASC). The amount is not trivial, with the disutility of the beach as-is effectively canceling out the WTP of Japanese visitors for the unimproved beach by itself. However, results also show Japanese visitors have a positive WTP, along with other visitor groups, for beach and water quality improvements (Table 3).

4. Discussion

4.1 CONTEXT

Compared to other studies, our results are notable for the high value of the beach as-is. Beharry-Borg and Scarpa (2010) found a 2-class result with respondents willing to pay up to $40 for 10 meters of underwater visibility in Trinidad and Tobago. Bishop et al. (2011) found each household was willing to pay up to $287.62 for the protection and restoration of degraded Hawaiian ecosystems (including the rehabilitation of coral reefs from ship strikes). Parsons et al. (2013) found recreationists were willing to pay up to $32.89 per trip for daytrip access and $80.66 for overnight trips in Delaware. Whitehead et al. (2008) found respondents willing to pay between $782 — $1090 per year for the beach in North Carolina, a further $268 — $392 per year for improved beach access, and an additional $61 — $85 per year for beach width increase. Landry et al. (2020) found a baseline WTP of $477 per household/year for North Carolina beaches. While our WTP estimates are on the high end of the range (Table 4), it is in fact quite intuitive as we can expect higher WTP for expensive trips such as those to Hawaii that are not taken as often as those to other destinations.

Table 3. How our estimates compare to those for other beaches? Willingness to pay for beach attributes tends to be higher for higher-quality beaches; and those in destinations that require long travel (all values in 2020 USD)

	Waikīkī Estimate	Previous Studies
Underwater visibility	$14 per foot	$2.8 per foot (in Tobago, Beharry-Borg and Scarpa 2010)
WTP to visit beach	$389 for Waikiki	$477 per year in North Carolina (Landry et al. 2020)
WTP for wider beach	$4.24 per ft $273 for extra 100ft	$0.83-$1.23 per ft; $83-$123 for extra 100ft in North Carolina (Whitehead et al. 2008)

4.2 IMPLICATIONS

When we generalize the WTP values to both the tourist and resident populations, we can use beach attendance data to determine the population to which these values would apply to. The average beach attendance for the past seven years 2013— 2019 in Waikīkī is 10,031,030 (City and County of Honolulu Department of Ocean Safety, 2020), although this figure may be discounted by 25%—50% because of possible overestimates due to the counting methodology employed by lifeguards to maintain a conservative estimate. We do not have data on the demographics of Waikīkī beachgoers. With the mixed logit estimate, we have the average WTP estimates for the whole sample. With the latent class models, we have statistically precise WTP estimates for only class 1 respondents, which make up 60% of the survey sample. We take the aggregate WTP based on the mixed logit model as the central estimates. The aggregate WTP based on the latent model estimates, for Group 1, extrapolated to all potential beachgoers, would give us a lower bound. Even with such a reduction for a conservative estimate, the value is substantial. Using Waikīkī hotel capacity, Waikīkī beach attendance (City and County of Honolulu Department of Ocean Safety, 2020) at 50%, 75%, and 100%, we estimate an aggregate value ranging from $1.8 billion to of $4.0 billion for the beach as-is (Table 5). Further, we can estimate additional benefits from beach nourishment by applying marginal WTP/ft for beach width. Using Waikīkī hotel capacity, Waikīkī beach attendance (City and County of Honolulu Department of Ocean Safety, 2020) at 50%, 75%, and 100%, a 1-ft increase in beach width is worth $19.7 million, and a 3-ft increase is worth $58.9 million

Table 4. Aggregate willingness to pay estimates

	From hotel capacity	Lifeguard data (LGD)	LGD * 75%	LGD * 50%
Waikiki beach visit estimate (annual, in thousands of persons)	4,646	10,324	7,743	5,162
Total WTP for the beach as is (annual, in million USD)	$1,806	$4,014	$3,010	$2,007
Total WTP for a 3-ft wider beach (annual, in million USD)	$58.93	$130.9	$98.21	$65.47

Note: "From hotel capacity" is based on the total visitors on O'ahu, multiplied by the share of hotel rooms in Waikīkī, which equals 4,646,487 in 2018. Lifeguard data indicates 10,323,929 people visited Waikīkī Beach in 2019. The lifeguard data is from the Ocean Safety and Lifeguard Services Division, City & County of Honolulu.

4.3 LIMITATIONS

Compared to results of the attribute values (Table 4), the value of the as-is base condition (ASC) stands out. At $388.76 per trip, it is larger than either the peak willingness to pay for beach width or underwater visibility. There may be several reasons for this, including attribute non-attendance, loss aversion (WTP vs WTA), and the behavior of recreationists when traveling.

We tested for effects from days of the week (weekday or weekend), weather conditions, time to completion for survey, among other choice invariant variables, and did not find anything significant. We also tested for attribute non-attendance (where the respondent only pays no attention to one or more attributes) with inconclusive results.

Loss aversion is a well-known phenomenon where respondents must be compensated a great deal more to accept a loss compared to some amount that they are willing to pay for a benefit. WTA vs WTP has been examined in great detail (Horowitz & McConnell, 2002). We make use of a "base" condition in our survey design where the status quo choice is constrained to an approximation of what existing conditions are like today. While having a base is not unusual, we set an attribute level below the base (in addition to levels above it, as other studies do). Respondents may react strongly to any perceived "loss" (moving down a level in any given attribute), and be strongly against any such change.

It is important to consider the behavior of recreationists on trips, particularly those where the cost is high and frequency low. Typically, in non-market valuation for the purposes of conservative estimates, a very low value of time is assumed (typically one-third of wages). This assumption is not only overly simplistic and inconsistent with recent evidence (Fezzi et al., 2014), but also does not account for behavior changes when trips are costly, infrequent, or both as is the case with a vacation in Hawaii.

Respondents may perceive it is implied that renourishment means widening the beach. If no renourishment is done, the status quo is actually a smaller beach width. That is, renourishment does not necessarily widen the beach, and rather maintains the as-is condition by default. While respondents from class 1 of the latent class model favor neither making the beach wider nor letting it erode away, a more accurate interpretation would be respondents are in fact in favor of some beach nourishment (to the extent the beach width is at least maintained) while also against doing nothing (no nourishment) which would mean the beach erodes away.

Ocean conditions vary greatly, and underwater visibility is highly variable in general. It should be noted that respondents are asked to choose among given hypothetical underwater visibility conditions in each choice occasion (the beach widths are exact based on where the respondent is interviewed), not make judgements based on what they see in front of them at the beach itself as they do for the beach width questions.

We use underwater visibility (clarity) as the sole proxy for water quality. In Hawaii, there are a host of issues associated with water quality data as defined by the BEACH and Clean Water Act, particularly with poor data collection and availability. Water quality (bacterial standards) are also often conflated with underwater visibility (turbidity) as respondents are only able to perceive the latter (Peng & Oleson, 2017).

4.4 CONCLUSION

Changes in beach and nearshore conditions can have significant implications for economic welfare, especially in a high-density setting such as Waikīkī involving tourism, recreation, and natural resources. This study aims to inform policy by estimating the value of the beach as-is, in addition to the value of beach width and associated water quality.

The as-is value of Waikīkī Beach is very large, as are the associated welfare gains from beach nourishment and water quality improvements. Even without a recent, robust, or defensible valuation of the beach, Waikīkī Beach has been repeatedly re-nourished by public-private cost-shared improvements over the past decades. It is clearly understood that Waikīkī Beach is very valuable, and management action should consider that value.

This study fills a gap in knowledge of the non-market recreational value of Waikīkī Beach, and Hawaii's coastlines more broadly. In the context of continued beach erosion and high-tide events ("king tides") in recent years, it is important to understand and quantify the perceived value of the beach itself and how management strategies such as beach nourishment can maintain and enhance the value of the beach.

A comprehensive assessment of the beach's value would account for all types of benefits provided by the beach and the nearshore marine environment in addition to recreational value. The value of aesthetics such as ocean views, mitigated storm damage to coastal properties, among others, were not included in this study. Further application of the survey data and additional surveys can supplement our WTP estimates in the future.

It is particularly useful for managers to be informed of the trade-offs they face in management decisions. Further, with recent, robust, and defensible environmental values, beach managers are able to better model and optimize their management actions to preserve and enhance the underlying natural resource that draws visitors to Waikīkī Beach from all over the world, and from which local residents continue to draw large socio-economic benefits from.

Appendix A: Model description

The conditional logit model can be generally described as a random utility model

$$U(choice\ j\ for\ individual\ n) = U_{nj} = V_{nj} + \varepsilon_{nj} \forall j,$$

(1)

Where the V_{nj} is known by the researcher and the error term ε_{nj} is unknown, assumed to be independent and identically distributed with a type 1 extreme value distribution (McFadden, 1974).

For independent type 1 extreme value distributions, the probability that individual n chooses alternative j is

$$P_{ni} = \frac{exp\ exp\ (V_{ni})}{\sum_j \quad exp\ exp\ (V_{ni})},$$

(2)

(McFadden, 1974).

The random parameters logit model (or mixed logit) is given by

$$U_{nj} = \beta'_n x_{nj} + \varepsilon_{nj},$$

(3)

where x_{nj} are observed variables relating to the alternative, β_n is a vector of coefficients of variables for individual n (representing taste), and ε_{nj} is independent and identically distributed with a type 1 extreme value distribution (Train, 2009).

The mixed logit probability is

$$P_{ni} = \int \quad \left(\frac{exp(\beta' x_{ni})}{\sum_j \quad exp(\beta' x_{nj})} \right) f(\beta) d\beta,$$

(4)

(Train, 2009)

From (4), if we assume $f(\beta)$ is discrete, with β takes M possible values b_1,..., b_M (M segments in population each of which has distinct preferences), with probability s_m (share of population in segment m) that $\beta = b_m$, the choice probability becomes

$$P_{ni} = \sum_{m=1}^{M} \quad s_m \frac{exp(b'_m x_{ni})}{\sum_j \quad exp(b'_m x_{nj})}$$

(5)

(Train, 2009)

Appendix B. Summary statistics of the survey respondents

Table 5. Demographics, n = 398

Gender	n	Share of respondents
Male	116	37.7%
Female	192	62.3%

Age	n	Share of respondents
18-24	93	30.2%
25-34	95	30.8%
35-44	45	14.6%
45-54	38	12.3%
55-64	27	8.8%
Over 65	6	1.9%

Education	n	Share of respondents
Less than high school	4	1.3%
High school graduate	40	13.3%
Some college	48	16%
2 year degree	24	8%
4 year degree	119	39.7%
Professional or master's degree	44	14.7%
Doctorate	21	7%

Household income		Share of respondents
Less than $40,000	71	25.2%
$40,000 to $59,999	33	11.7%
$60,000 to $79,999	33	11.7%
$80,000 to $99,999	27	9.6%
$100,000 to $124,999	39	13.8%
$125,000 to $149,999	18	6.4%
$150,000 to $174,999	14	5.0%
$175,000 to $199,999	12	4.3%
$200,000 to $249,999	10	3.6%
More than $250,000	25	8.9%

Residency	n	Share of respondents
Oʻahu	82	20.6%
Visitor	316	79.4%

Country of origin	n	Share of respondents
United States	227	57.0%
Japan	65	16.3%
Canada	38	9.6%
Australia	23	5.8%
Germany	12	3.0%
New Zealand	8	2.0%
United Kingdom	8	2.0%
Other	17	4.3%

Table 6. Respondent attitudes

First time in Waikīkī?	n	Share of respondents
Yes	151	37.7%
No	250	62.3%

Star rating	Mean	Standard deviation
Beach width	3.68	1.12
Beach length	3.95	1
Sand quality	3.85	1
Water quality	4.04	1.04
Crowdedness	3.03	1.17
Ease of access	4.52	0.75
Showers	3.26	1.16
Bathrooms	2.8	1.16
Overall	4.03	0.85
Safety	3.98	1.05

Maintain	n	Share of respondents
Strongly agree	80	20.1%
Somewhat agree	156	39.1%
Neither agree nor disagree	105	26.3%
Somewhat disagree	44	11.0%
Strongly disagree	14	3.5%

Widen	n	Share of respondents
Strongly agree	54	13.5%
Somewhat agree	80	20.1%
Neither agree nor disagree	137	34.3%
Somewhat disagree	80	20.1%
Strongly disagree	48	12.0%

Periodic	n	Share of respondents
Strongly agree	104	26.1%
Somewhat agree	159	39.8%
Neither agree nor disagree	104	26.1%
Somewhat disagree	19	4.8%
Strongly disagree	13	3.3%

Erode	n	Share of respondents
Strongly disagree	117	29.3%
Somewhat disagree	119	29.8%
Neither agree nor disagree	99	24.8%
Somewhat agree	40	10.0%
Strongly agree	24	6.0%

Table 7. Interview conditions

Day of the week (interviewed)	n	Share of respondents
Tuesday	34	8.5%
Wednesday	78	19.6%
Thursday	18	4.5%
Friday	83	20.9%
Saturday	105	26.4%
Sunday	80	20.1%

Weather conditions encountered	n	Share of respondents
Sunny	72	18.0%
Partly cloudy	238	59.4%
Mostly cloudy	55	13.7%
Showers	36	9.0%

Littoral cell	n	Share of respondents
Ft DeRussy	23	5.9%
Halekulani	26	6.7%
Royal Hawaiian	125	32.3%
Kuhio	89	23.0%
Queens	119	30.7%
Kaimana	5	1.3%

Accommodation	n	Share of respondents
Hotel	206	65.8%
Secondary accommodation market	57	18.2%
Friends and family	20	6.4%
Other	30	9.6%

Length of stay	1 – 3 nights	4 – 7 nights	8 – 31 nights
Airbnb	0	22	15
Friends and family	1	8	12
Hotel	14	145	48
Other	4	12	16
Timeshare	0	7	2
Vacation rental	0	4	7
Total	19	198	100

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