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

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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 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

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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 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.