ABSTRACT

Title of Document: THE ROLE OF WATER QUALITY IN BEACH VISITATION DECISIONS IN CROATIA: IMPLICATIONS FOR DEVELOPMENT OF THE TOURISM INDUSTRY

Anthony Charles Dvarskas, PhD, 2007

Directed By: Associate Professor Douglas Lipton
Department of Agricultural and Resource Economics

Croatia is experiencing a surge in popularity as tourists are attracted to its pristine coastal waters. Although the growth of the tourism industry would bring increased revenues from visitation, the development of tourism could negatively impact the coastal resources. Worsening water quality could cause certain beaches, areas, or regions to become less desirable and consequently less likely to be visited. This study was designed to determine the role ofwater quality in tourists' decisions to visit beaches in Split-Dalmatia County and Krk Island using a conditional logit model. In addition to determining the role of water quality, this study used a multiple regression model to delineate the impact of changes in tourist numbers upon coastal water quality. As a final analysis, the findings from the economic conditional logit model were combined with an ecological multiple regression model in a 25-year dynamic model. Results of the conditional logit model indicated that water quality is positively and significantly related to the probability of a beach being selected by non-Croatian tourists in Split-Dalmatia County. Local perceptions of the safety of water for swimming also were significant predictors of the beach visitation decisions of non-Croatian tourists to Krk Island. The multiple regression

model indicated that the presence of more tourists is significantly related to worse coastal water quality. Finally, the dynamic model indicated that higher numbers of tourists over time would eventually lead to higher total coliform levels and that beaches without sewage treatment or removal of total coliforms would experience a declining probability of selection by non-Croatian tourists over the 25-yr period. The dynamic model also indicated that driving tourists to a beach by addition of a Blue Flag may have unintended consequences in the absence of sewage treatment as the increasing numbers of tourists decrease the water quality and the probability of that beach being selected over the long term. These findings have important implications for policymakers and planners in Croatia, as the decision to pursue tourism growth without concomitant investments in sewage infrastructure may not be sustainable for the long term.

THE ROLE OF WATER QUALITY IN BEACH VISITATION DECISIONS IN CROATIA: IMPLICATIONS FOR DEVELOPMENT OF THE TOURISM INDUSTRY

by

Anthony Charles Dvarskas

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Advisory Committee:

Professor Douglas Lipton, Chair
Dr. Thomas Jordan
Professor Erik Lichtenberg
Professor Michael Paolisso
Visiting Professor Kevin Sellner

Dedication

Dedicated to my family—all 14 of them.

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I would like to thank a number of individuals and groups who have been essential in the process of conducting and completing my dissertation research. My advisor, Doug Lipton, guided me in bridging the gap between my marine science background and natural resource economics and developing the strategy for conducting the research in Croatia. My committee members, Kevin Sellner, Thomas Jordan, Erik Lichtenberg, and Michael Paolisso provided important input throughout the process. The project also benefited from the support of the Fulbright Program of the United States Department of State and by my mentors while in Croatia—Maja Fredotovic and Lidija Petric at the University of Split. Miroslav Musnijak at Hrvatske Vode, the Institutes for Public Health in Rijeka and Split, and the Croatian Office of Statistics also provided important information and assistance in the conduct of this research. I would like to thank my family for supporting me throughout this process; in particular, my mother Donna, father Richard, and brother Allen encouraged me throughout and helped keep me on track toward completion. Importantly, I would like to thank Travis for unconditionally providing emotional, spiritual, and logistical support in this undertaking; without his constant willingness to listen and motivate throughout this process, the path would have been far more difficult.

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Chapter 1: Introduction

The concept of ecosystem services has been developed to provide a framework for evaluating the contribution of the environment to human well-being. The Millennium Ecosystem Assessment defined ecosystem services as “the benefits that people obtain from ecosystems” (2006). In growth and development decisions, there is a tradeoff between the direct benefits accruing from the development activity and ecosystem benefits that may be lost due to negative environmental impacts. Society must weigh the costs and benefits of the development to determine whether or not to implement the proposed project, or if it is implemented, how to do so in a way that maximizes the sum of development and ecosystem benefits.

Development of the tourism industry is not immune from the potential negative environmental consequences traditionally associated with the “dirty” industrial sectors. For example, construction of hotels or apartment houses can result in sediment runoff into nearby rivers and coastal waters and development of these tourist facilities without adequate sewage infrastructure can lead to increased bacterial counts in nearby waters (Brachya et al. 1994). As is the case with development decisions involving commercial and industrial development, easily quantifiable market-based benefits and costs are often included in cost-benefit analyses; planners can present benefits in terms of the revenue and employment generated by the industry and costs in terms of factors such as development of the property, operational costs, and production costs. In terms of the environmental costs of the proposed development, however, readily available dollar values are often not available for the services provided by clean air, clean water, and other environmental attributes.

As industry and manufacturing sectors of the economy have become less competitive for certain countries, many have focused on developing the tourism sector as a method to contribute to the country's Gross Domestic Product (GDP). Tourism has the opportunity to not only provide countries with a source of revenue, but also to leverage the environmental advantages that may make it a unique tourist destination. As suggested above, however, development of the tourism industry without consideration of the potential loss in ecosystem services can lead to an underestimation of the true costs of development and a bias favoring development rather than conservation. In the case of tourism, neglect of environmental considerations could be especially detrimental since those environmental attributes may in fact be the characteristics that are driving tourists to visit a given location. One category of environmental services provided by coastal ecosystems, according to the Millennium Ecosystem Assessment, is recreational ecosystem services provided to people who use the coastal area to bathe, swim, and for other water-based leisure activities.

With over 5,800 kilometers of shoreline, the Croatian coastal ecosystem historically has provided and continues to provide recreational ecosystem services to both residents and domestic and foreign visitors. The Croatian government has plans to increase the size of its tourism sector and is focusing its efforts on sustaining the growth that has been demonstrated. According to the United Nations World Tourism Organization, international tourist arrivals have increased at an average of 7.4 percent per year between 2000 and 2004; this is above the world average of 2.7 percent for the same period and the average for Europe of 1.8 percent average annual growth (WTO 2005). Growth of the tourism industry cannot be accomplished without appropriate investment since, as indicated by the 2005 report of the European Bank for Reconstruction and Development, "Croatia is oriented towards a dynamic tourism industry that depends on a clean coastal environment, implying considerable investment in wastewater treatment (EBRD 2005a)." Economic evaluation of the contribution of water quality to tourism visitation could provide a strong rationale for continued investment and infrastructure improvements that maintain water quality along the Croatian coast.

Without continued investment in wastewater treatment infrastructure, it is possible that increasing tourism development could lead to degradation of water quality and negative impacts upon the tourism industry and the Croatian economy. A recent report by the Centre for Future Studies suggested that the Dalmatian coastline of Croatia was threatened by a potential "explosion" of tourists (CFS 2006). Rather than believing that tourism growth can continue indefinitely, it may be necessary to consider caps on tourism in order to avoid overwhelming the Dalmatian coastal ecosystem or to consider methods that reduce the human impact per capita upon the Dalmatian coastal resources.

The rationale for this study is to provide an estimate of the impact of water quality on the beach visitation decision of foreign and domestic tourists in Croatia and a value for clean water for recreational use. By comparing visitation patterns at sites with varying water quality, the role of water quality can be elucidated. Combining this information with knowledge about the relationship between tourism density and water quality parameters, an economic-ecologic model will be developed to assess the impact of Croatian tourism industry growth. The model can be of assistance in providing guidance for policies that may need to be developed to avoid water quality degradation.

To address the relationship between tourism development, water quality, and the economic value of a region's beaches, this dissertation will answer multiple research questions using data collected at two study locations along the Croatian Adriatic coast. Study Location 1 was the island of Krk in Primorsko-Goranska County and Study Location 2 was Split-Dalmatia County along the Dalmatian coastline of Croatia.

The outline of this dissertation and the research questions are indicated below:
Chapter 2 of this dissertation will provide a general overview of study sites and locations. This chapter will also provide an overview of demographic characteristics of the two counties that were studied.

Chapter 3 describes the selection process for study sites and presents the water quality valuation component of this research and will use a logistic regression to determine the role of water quality in the beach visitation decision and correlation analysis to determine relationships between local residency and choice of beach site. The goal of this chapter is to determine the parameters of the indirect utility function for domestic and foreign tourists visiting the two study locations. The following research questions will address the links between beach visitation choices and water quality using either subjective perceptions of water quality or objective measures of water quality.

Role of Objective Measures of Water Quality in Predicting Beach Visitation

RQ1: Does water quality as measured by total coliform in 2005 and average water quality as reported in a governmental publication and on a governmental Web site in 2005 impact the beach visitation decision of foreign and domestic tourists?

RQ2: Does the presence of a blue flag impact the beach visitation decision of foreign and domestic tourists?

Role of Subjective Measures of Water Quality in Predicting Beach Visitation

RQ3: Does local knowledge about water clarity, health of bathing waters, or beach experience have a significant influence on the beach visitation decision of foreign and domestic tourists?

RQ4: Does local residency status impact the choice between a high versus low bathing water quality site?

RQ5: Do self-perceptions of the water health, water clarity, and beach cleanliness impact the decision of beachgoers to return to that beach?

Historical water quality challenges along the Croatian Adriatic coast and existing Croatian and European Union policies concerning bathing water quality will also be discussed. The random utility models to be analyzed will be described and the results and implications of the results will be discussed relative to the decisions of beachgoers visiting Croatia for recreational purposes.

Chapter 4 addresses the relationship between changes in wastewater discharge during the summer months, reported water quality measures, and precipitation using multiple regression analysis. In addition, the chapter will provide an overview of tourism statistics in each of the study counties and Croatia as a whole. Tourism and residential numbers will be included in a multiple regression analysis to determine their relative impacts upon total coliform levels in the towns where these data are available. The following research question will address the relationship between monthly wastewater figures, residential population numbers, tourism numbers and total coliform measures:

RQ6: Are monthly wastewater discharge measures, residential population numbers, or tourist population numbers significant predictors of proximate total coliform measures?

The statistical analysis will use a basic multiple regression model using monthly data from 2005 that is available for three wastewater treatment plants in Primorsko-Goranska County. The regression will include the following predictors of offshore water quality: connected wastewater discharge, total estimated wastewater discharge, estimated unconnected wastewater discharge, and average monthly precipitation and precipitation intensity. Offshore water quality will be measured by total coliform levels.

Chapter 5 will formulate a basic dynamic ecologic-economic model using STELLA software. The following research question will address the potential economic and ecologic impacts of continued tourism industry growth along the Croatian coast:

RQ7: What is the impact of continuing tourism industry growth over the next 25 years (at the average 2000-2004 Croatian tourism industry growth rate) upon water quality and the utility to visitors to two hypothetical beaches in Croatia that differ in (1) total coliform levels, (2) sewage treatment levels, or (3) presence of blue flag?

The approach will be set up to model visits to two hypothetical Croatian beaches that are initially alike in all characteristics. The model will drive increasing numbers of visitors to one of the beaches and determine if the increasing bacterial levels at that beach resulting from increasing wastewater discharge lead to changes in the trends of beachgoer visitation.

Chapter 6 will discuss conclusions and implications that can be drawn from the analyses, limitations of the research, and potential areas for future research into this topic.

Chapter 2: Study Site Description

The objective of this chapter is to provide an overview of Croatia and the two counties where the study was conducted. Chapter 3 will detail the method for selection of sites within the two counties.

2.1. Croatia

After declaring its independence from Yugoslavia in 1991, Croatia fought a 4-year long war with the Yugoslav Army, resulting in occupation of its territory and substantial damage to its municipal and tourist infrastructure. Croatia is presently bordered to the north and east by the countries of Slovenia, Hungary, Bosnia and Herzegovina, and Montenegro; its western border is the Adriatic Sea. There were 4.4 million Croatian citizens (2001 census) living on a territory of 56,594 km^2, leading to a population density of 78.4 people per square kilometer (DZS 2006c). Croatia applied for European Union (EU) accession in 2003 and is currently in the process of reforming its institutions and adapting to the legislative requirements for eventual membership (EC 2004). Depending on progress that is made in adopting necessary EU legislation and standards, Croatia may enter as a full member as early as 2009.

Along with Slovenia, Croatia has always been more closely associated with the Western nations rather than Eastern nations and wealthier than the other Yugoslav republics. As of 2005, the GDP per capita in Croatia was US$12,336 and the GDP growth rate in 2005 was 3.5 percent. Out of a possible maximum score of 4.33, Croatia received a score of 3.41 from the European Bank for Reconstruction and Development on its Transition

Index, which measures the progress made in transitioning toward an industrialized market economy (EBRD 2005b). Although some structural challenges remain, these data suggest that Croatia is on track to transitioning toward a more open market-based economy. Unemployment remains high at 16.8 percent (October 2006), and the average monthly net earnings per person in legal employment in the period of January to September 2006 was 4,542 kuna or approximately US$781 (DZS 2006b; DZS 2006a).

Administratively, Croatia is divided into 21 counties that are each responsible for administering and representing the interests of the different regions of Croatia. Within these counties, the territory is divided into 124 towns, 426 municipalities, and 6,751 settlements. County governments are responsible for addressing a range of issues that are of specific interest to the local and regional populations. For example, the Institute of Public Health for each county is responsible for collecting data on bathing water quality in Croatian waters that is subsequently reported to and published by the Croatian Ministry of Environmental Protection, Physical Planning, and Construction. A summary report of the collected data is made available to the public on the Ministry of Environmental Protection website.

The Adriatic Sea stretches northwestward from the Mediterranean Sea and covers an area of 138, 600 km^2 with an average depth of 160 meters (Franic 2005). The major river inputs into the Adriatic Sea are from the Italian coast, with the Po River contributing 28 percent of the total runoff. The largest input from the eastern side of the Adriatic comes from the Neretva Delta (approximately 900 m^3s^{-1}); the karst geology of the Croatian coast has prevented the development of significant rivers as precipitation is rapidly transported through the rock and may emerge as short streams or submarine seeps in the Adriatic. The yearly temperature in the Southern Adriatic (roughly between 40ºN and 42ºN) can span a range of as much as 18°C, while in the Northern Adriatic (roughly between 42ºN and 45ºN) it can be as much as 25° C. Salinity peaks at 38.9 parts per thousand (ppt) in the open, southern portions of the Adriatic and appears to be increasing over time (Cushman-Roisin et al. 2001). Recent radioactive tracer analysis estimated a turnover time of water in the Adriatic Sea of 3.4 years, which falls within the existing reported range of 0.7 and 5 years (Franic 2005).

The general circulation pattern in the Adriatic Sea is from southeast to northwest, with the current moving northward along the Croatian coast and then returning southward toward the Mediterranean along the Italian coast. The highly indented nature of the Croatian coastline modifies the longshore current flow, resulting in more variable local circulation patterns. Winds have an influence on the ocean currents, with the jugo and bura the most significant seasonal winds. The bura is a northeasterly wind that is strongest and most common during the winter and the jugo is a southerly humid wind that does not demonstrate any particular seasonal pattern. The westerly maestral that blows during the summer afternoons influences local circulation patterns (Cushman-Roisin et al. 2001).

2.2 Water Quality and Site Selection

The summary water quality rankings from the Ministry of Environmental Protection for each of the counties monitored in Croatia are shown in Table 2.1.

Table 2.1. Summary Water Quality Rankings by Croatian County (MZOPU 2006)

	Average Water Quality Ranking				
County	**Sampling Points**	**High**	**Good**	**Moderate**	**Not suitable for swimming**
Istria	203	5	196	2	0
Primorsko-Goranska*	231	94	121	15	1
Lika-Senj	45	29	16	0	0
Zadar	79	34	42	3	0
Sibenik-Knin	73	10	63	0	0
Split-Dalmatia*	134	2	130	2	0
Dubrovnik-Neretva	86	12	57	7	0

*Selected study counties

Of the seven coastal counties, two counties, Primorsko-Goranska and Split-Dalmatia, were selected as foci for the study because of the range in water quality at the beaches/sampling points that are monitored by the Institutes of Pubic Health in each of the counties, because they are popular tourist destinations, and because they are also home to the second- and third-largest cities in Croatia. Figure 2.1 shows a map of Croatia with the two study county locations.

Figure 2.1. Map of Croatia with Study Locations: 1 = Primorsko-Goranska County/Krk Island, 2 = Split-Dalmatia County

It is important to note that the results in Table 2.1 are averaged over the entire summer so it should not necessarily be interpreted that no beaches in a county ever had a water quality rating of “not suitable for swimming” in counties where a “0” is indicated. Further details of the water quality monitoring program and site selection within the counties will be described in Chapter 3.

While there are multiple informal bathing locations that are used and certainly have value to locals and tourists, the choice to focus only on monitored beach locations in both counties was made because of the availability of the above mentioned water quality data. These “formal” beach locations also would be expected to have sufficient beachgoer traffic and use to allow for efficient administration of surveys and interviews. Other locations also tend to be more remote and located further from tourist infrastructure and the possible water quality impacts of hotels, camps, and holiday apartment housing.

2.3. Primorsko-Goranska County

2.3.1. County Demographics and Characteristics

By 2001, Primorsko-Goranska county had 305, 505 residents with 144,043 living in Rijeka, the third largest city in Croatia (DZS 2001). Shipbuilding continues to be an important industry in the county with two of the three major shipbuilding centers in Croatia located in this city. Ferry lines travel to Rijeka from the nearby islands and Italy, and there is a rail line running to the Croatian capital, Zagreb, and Ljubljana, the Slovenian capital. The coastal region of the county borders the Kvarner Gulf, a deep semi-enclosed body of water that can accommodate large ship and tanker traffic and is also home to the principal tourist islands of Krk, Losinj, Cres, Rab, and Pag (Figure 2.2).

Figure 2.2. Map of Kvarner Gulf Region (Source: GoogleEarth)

2.4. Split-Dalmatia County

2.4.1. County Demographics and Characteristics

The county of Split-Dalmatia is located in the region known as Central Dalmatia and contains the historic city of Split, the second largest city on Croatia. The population of Split grew dramatically during and in the years following the 1991 to 1995 war as refugees and ethnic Croatians from Bosnia-Herzegovina moved to the city (Klempic 2004) and by 2001, the population was estimated at 188,694. The population of the county by 2001 was 463,676 (DZS 2001). Split has the popular tourist attraction of Diocletian's Palace, built by the emperor Diocletian as his retirement home and completed in 305 A.D., and is the hub for most ferry departures to the Dalmatian islands and Italy. A rail line runs from Split to Zagreb, and the recently constructed modern coastal highway currently terminates outside of the city.

Chapter 3: Water Quality and Beachgoer Visitation Decisions

3.1 Introduction

Croatia's tourism strategy is to position the country as "The Mediterranean as it Once Was." This campaign seems in part to be directed toward offering an alternative to the crowded and expensive resorts of the Spanish, French, and Italian coasts. The Croatian coast is relatively less developed and costs are certainly less than those in Spain, France, or Italy. One may also argue that the slogan is enticing people to visit a location with a pristine environment and nature that are worthy of exploring. As such, the maintenance of the pristine state of environmental resources, including coastal resources, would appear to be a priority for Croatia.

The research reported in this chapter will more specifically address how people who have decided to visit Croatia are impacted by the water quality at different beach locations. Specifically, I address the following research questions:

RQ1: Does water quality as measured by total coliform in 2005 and average water quality reported in governmental publications and on governmental websites in 2005 impact the beach visitation decision of foreign and domestic tourists in 2006?

RQ2: Does the presence of a blue flag impact the beach visitation decision of foreign and domestic tourists?

RQ3: Does local knowledge about water clarity, health of bathing waters, or beach experience have a significant influence on the beach visitation decision of foreign and domestic tourists?

RQ4: Does local residency status impact the choice between a high versus low bathing water quality site?

RQ5: Does an individual's perceptions of the water health, water clarity, and beach cleanliness impact the decision of the beachgoer to return to that beach?

3.1.1. Water Quality Legislation in the European Union and Croatia

To become a member of the European Union (EU), Croatia must successfully conclude negotiations on 35 chapters of EU legislation or acquis, the European Union community regulations that need to be incorporated into the laws of EU member countries. These include a chapter on environmental regulation. An initial directive on bathing water was passed by the EU in 1976, and a revision recently adopted in 2006. Goals of the revision include the desire to move from sampling and monitoring to more integrated management of bathing water and the desire to provide better and earlier information to the public (EC 2002). The microbiological parameters specified in the revised directive separate the beach categories into excellent, good, sufficient, and poor quality based on the number of coliform colony forming units (CFUs) per 100 mL of water as shown in Table 3.1.

Table 3.1 Limits for EU Bathing Water per the Revised 2006 Directive (2006)

Bacteriological Parameter	Excellent Limit (CFU/mL)	Good Limit (CFU/mL)	Sufficient Limit (CFU/mL)	Poor (CFU/mL)
Intestinal enterococci	100	200*	185**	Worse than sufficient
Escherichia coli	250	500*	500**	Worse than sufficient

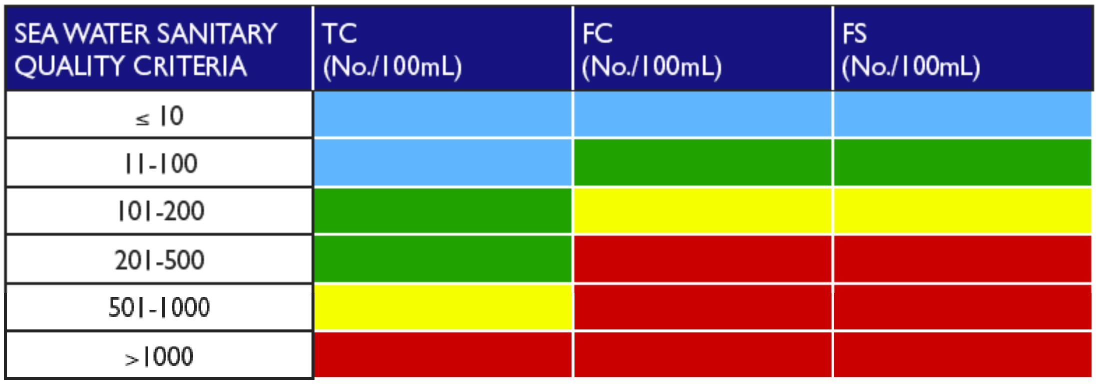
*Evaluated at 95th percentile

**Evaluated at 90th percentile

The revised directive will take effect in 2014, repealing the prior bathing water quality directive, and states that the water quality assessment should be carried out at the end of the bathing season and is based on the average of the samples obtained during the bathing season. Importantly, the directive also states that EU Member States should ensure that all bathing waters are at least of "sufficient" quality by 2015. Exceptions may be made under certain circumstances.

Croatia's standards for water quality are different from those of the recently revised directive and are based on the previous EU bathing water quality directive that grouped bacteria as total coliforms, fecal coliforms, and fecal streptococci per 100 mL water (1976). In terms of the sampling process in Croatia, the Institute of Public Health collects a single sample every two weeks during the official bathing season (May to September). Depending on the bacterial count observed in the plated samples, a color level and associated ranking are assigned to the beach. Red corresponds to water not suitable for swimming, yellow corresponds to moderate quality sea, green corresponds to good quality sea, and blue corresponds to high quality sea. The matrix used to determine the score or color for a beach for each 2-week reporting period is shown in Figure 3.1.

Figure 3.1. Matrix for Assignment of Color/Water Quality Ranking (MZOPU 2006)



These water quality ratings were used in the initial classification of beaches in terms of water quality for 2004 to 2005 in Split-Dalmatia county as described in the site selection section below; for the purposes of this study a score of 3 (yellow) or 4 (red) in 2004 or 2005 was deemed poor water quality and a score of 1 (blue) or 2 (green) throughout 2004 and 2005 was deemed an absence of adequate records of poor water quality. These data were also used as described in section 3.2.4 for the 2005 reported percent of poor water quality samples variable in the logistic regression.

3.1.2. Water Quality Concerns Along the Croatian Coast

Although the Croatian coast consists of primarily pristine waters, several “hot spots” were identified by the Agency for Environmental Protection indicators report in 2004. Three of these hot spots are located in the study counties, Bakar Bay and Rijeka Bay in Primorsko-Goranska County and Kastela Bay in Split-Dalmatia County. Water quality challenges in these three areas are related to the history of industrial pollution (shipbuilding in Rijeka and Bakar Bays, cement, steel, and PVC production in Kastela Bay) as well as on-going challenges relating to wastewater infrastructure (AZO 2004). Shipbuilding remains an important economic activity in both Rijeka Bay and Bakar Bay, while cement factories and a steel mill remain in the western portion of Kastela Bay. The lingering effects of mercury pollution from the previous PVC production in Kastela Bay continue to be investigated (Kwokal et al. 2002; Mikac et al. 2006).

A range of algal blooms has occurred in the Adriatic Sea during the past several decades. The majority of the research has focused on the northwestern Adriatic, along the Italian coast surrounding Venice, which is influenced by nutrient inflow from the Po and Adige Rivers. An examination of *Dinophysis* blooms in this area suggested that the blooms of all *Dinophysis* species were only very weakly related to nutrient concentrations (Aubry et al. 2000). Depending on the species, wind direction (whether bura (northeasterly) or jugo (southerly)) and temperature were most important in determining the distribution of this genus. Over a 7-year sampling period, no species were found in winter water samples, with species abundant in either spring and summer or summer and autumn, likely as a result of wind transport of these offshore organisms in to coastal regions and bays. Blooms of the macroalgae *Ulva rigida* have also been documented as a result of high nutrient load from the Po River, causing damage to aquaculture of clam species in the coastal area surrounding Venice (Cellina et al. 2002).

Mucilaginous material blooms occurred in the northern Adriatic Sea during the late 1980s and early 1990s in an area between Venice and the Istrian peninsula in Croatia. These blooms appear to be composed of marine snow flocs with polymer bridges between bacteria, phytoplankton, and macroalgae (Leppard 1999). A hypothesis for the formation of these blooms involves a spring bloom of phytoplankton followed by subsequent stress-causing nutrient limitation that results in the production of large amounts of extracellular carbohydrates that comprise the mucilaginous blooms (DeGobbis et al. 1999). One study of *Skeletonema,* associated with mucous macroaggregates in the Northern Adriatic, suggested that the blooms form primarily because of nitrogen limitation conditions in the northern Adriatic caused by decreased Po River flow, combined with the mixing of low calcium level Po River delta waters with the high calcium level Adriatic waters (Thornton et al. 1999). Nitrogen limitation resulted in a greater production of extracellular carbohydrate than phosphorus or light limitation and addition of calcium increased the amount of extracellular carbohydrates. Another possibility is a role for phosphorus limitation that results in polysaccharide accumulation by bacteria in the mucilaginous material (Azam et al. 1999). The cause of the blooms, however, still remains unclear and it may involve a complex interaction between environmental factors and the type of species composing the mucilage bloom. The initial step resulting in a spring bloom and high phytoplankton concentrations would be aided in either case through the addition of nutrients from sewage outflow. These blooms prevented tourists from using the waters for recreational purposes and had serious economic consequences (Baldi et al. 1997; DeGobbis et al. 1999; Thornton et al. 1999).

Red tide blooms have occurred in the Adriatic Sea for decades; however, harmful algal blooms appear to be a more recent phenomenon. A study of red tide records and mucilage events from 1968 to 2002 suggested a potential transition from coastal red tide dinoflagellates to open water mucilaginous blooms in the western and northern Adriatic (Sellner and Fonda-Umani 1999). Pavela-Vrancic et al. (2004) describe surveillance from 1995 to 1997 of paralytic shellfish poisoning (PSP) in Kastela Bay, mentioned previously as suffering from household and industrial waste pressures. They analyzed the phytoplankton community through seawater sampling and concluded that there was an association between the incidence of PSP toxicity and *Alexandrium minutum*. *A. minutum*, however, is not always associated with PSP and the authors suggest that the roles of nutrient concentrations may impact the strains of *A. minutum* and, consequently, the occurrence of PSP. They also suggest that an unusual species of *Gyrodinium* present in the seawater samples may be responsible for the occurrence of PSP (Pavela-Vrancic and Marasovic 2004). These blooms can clearly have impacts upon the shellfish and tourism industries in a given locale, as the accumulation of the PSP toxins can contaminate shellfish and lead to poisoning of the human population.

The Environmental Protection Agency of Croatia reported a series of algal blooms in their report of environmental indicators (AZO 2004). In 1998 and 2001, *Mesodinium rubrum* blooms were reported in Kastela Bay and in 2003 *Prorocentrum minimum* blooms were reported in Kastela Bay. *P. minimum* blooms were also reported in Sibenik Bay in 1998, 2000, 2002, and 2003. All of these blooms occurred during the summer months. According to anecdotal evidence, the frequency of algal blooms has decreased in Kastela Bay over the past several years, potentially because of adjustments to the wastewater treatment system.

There was at least one localized fish kill in the summer of 2006, but the cause remains unknown (Marasovic 2006).

The final area of water quality concern relates to water quality impacts resulting from wastewater discharge and is the subject of this study. As opposed to algal blooms that occur on an intermittent and short-term basis, bacterial contamination may occur in one location year after year, leading to the development of a negative reputation and potentially impacting the type of visitor that the beach is able to attract. Kastela Bay in Croatia is a good example as its beaches, one of which is investigated later in this chapter, are subject to bacterial contamination resulting from an incomplete sewerage network (Ostojic-Skomrlj and Margeta 1996). Most houses are not connected to the sewage system despite the fact that new pipes have been built designed to carry the wastewater into the Adriatic and away from the enclosed bay. Residents are unwilling to pay the cost for connection into the system. Instead, residents construct improvised septic tanks that may or may not be technically appropriate or have individual discharge pipes into Kastela Bay. According to the bathing water quality report of the Ministry of Environmental Protection, Physical Planning, and Construction, the most significant challenges in terms of fecal contamination are in the tourist-populated coastal areas, although, as it points out, some progress has been made with the ongoing construction of wastewater infrastructure (MZOPU 2006). Importantly, a recent EU decision on Croatia's progress reinforced the need for significant investments in wastewater infrastructure. Despite the positive alignment with EU standards given Croatia's existing water quality legislation, only a small percentage of wastewater is treated overall and less than half the population is connected to a wastewater system (only 30 percent of Kastela Bay residents, for example, are estimated to be connected to the sewage system; (EC 2004).

3.1.3. Economic Valuation of Water Quality

Unlike the value of goods that can be purchased in a store, the value of environmental goods is not readily available as a price determined by market forces. As a result, non-market valuation techniques have been developed in order to assign a value to environmental goods. Two main categories of valuation methods are stated preference methods, which directly ask respondents about their willingness-to-pay (WTP) for an environmental resource, and revealed preference methods, which use a proxy good whose price can be determined to indicate the value that people place on an environmental good or service; the use of revealed preference enables economists to construct utility functions for consumers through observation of their purchasing behaviors and choice of one bundle of goods or services over another (Markandya et al. 2002). In the case of recreational sites, this would occur by observing the choice that a user makes in determining which recreational site to visit. Water quality has been demonstrated to play a significant role in people's recreation decisions by a number of studies(Caulkins et al. 1986; Bockstael et al. 1987; Bockstael et al. 1989; Bell and Leeworthy 1990; Leeworthy 1991; Layman et al. 1996; Sandstrom 1996; Murray and Sohngen 2001; King 2002; Hanley et al. 2003; Phaneuf and Siderelis 2003) that have used both revealed preference (e.g., travel cost, random utility models) and stated preference methodologies (e.g., contingent valuation).

Stated preference models

The idea of stated preference models may be traced to 1947 when it was proposed to directly ask consumers about the value that they place on obtaining additional quantities of a good that is not traded in the market (Hanemann 1994). An advantage of using the stated preference technique as opposed to revealed preference techniques is that it can be applied to both users and non-users of the resource, providing estimates of the total economic value (TEV) of a resource. The total economic value of a resource consists of both use (e.g., recreational) and non-use values (value of knowing a resource exists in a given state (existence values), value of leaving the resource in a given state for future potential users (bequest values)). The technique has developed extensively since its initial proposal, most famously in estimating damages to the natural resource base from the Exxon Valdez spill (Carson et al. 1995), and has generated controversy in terms of the reliability of its estimates of consumer values for resources (Hanemann 1994).

Despite the attractiveness of directly obtaining estimates of the value that people place on environmental goods and services, stated preference methods have several limitations (Mitchell and Carson 1989). These limitations arise from the fact that the stated preference methods rely on using a survey to elicit responses from individuals about the value they place on environmental goods and surveys. Poorly designed surveys can lead to inaccurate estimates of the value of the environmental resource in question. Open-ended questions may lead people to provide maximum WTP values that are well beyond their budget constraint or, alternatively, lead to protest and zero responses (Mitchell and Carson 1989). The framing of the question and the method for payment is also important as it can influence the response of the person being surveyed. Insensitivity to the scope of the proposed environmental change as well as embedding issues are also a concern as they may lead respondents to give a WTP value that does not correspond precisely with the scenario being proposed; for example, a respondent may feel they are valuing a more inclusive good than the scenario is actually presenting (Carson and Mitchell 1993). An additional important criticism is that the hypothetical nature of the stated preference survey does not require any actual commitment and thus would not be representative of actual behavior (Hanemann 1994).

In response to the concerns about the artificiality of stated preference survey methods, the NOAA Blue Ribbon Panel developed a series of methodological recommendations for conducting a stated preference study (Arrow et al. 2002). These recommendations include the use of in-person interviews with at least a 70-percent response rate, inclusion of a realistic valuation scenario, and use of a referendum method. In addition, the panel recommended conducting a debriefing following the interview. Although the panel recommended a referendum method, more recent studies have revealed that use of this procedure can result in values substantially larger than those obtained using open-ended questions (Bateman and et al. 2002).

To answer criticisms regarding the hypothetical nature of the valuation scenario in stated preference models, multiple studies have compared predicted behavior from contingent valuation surveys with actual behavior (Dickie et al. 1987; Bishop et al. 1990; Duffield and Patterson 1991; Seip and Strand 1992; Cummings and Harrison 1995; Bohm and Shogren

2003). While limited in number, several studies revealed no statistically significant differences between behavior implied by contingent valuation exercises and actual purchasing or referendum voting behaviors (Dickie et al. 1987; Bishop et al. 1990; Cummings and Harrison 1995; Bohm and Shogren 2003). Other studies have revealed differences between predicted and actual behavior although the studies may have used elicitation formats that are not consistent with recommended procedures (Duffield and Patterson 1991; Seip and Strand 1992). Given the fact that some people responding to a contingent valuation survey may provide very high or low estimates of WTP, Hanemann (1984) has suggested the possibility of using the median rather than the mean WTP as the former is less sensitive to outliers than the latter.

Stated preference methods can be divided into both contingent valuation surveys and choice experiment approaches. Both of these stated preference methods have been used to determine WTP values for water quality improvements. Contingent valuation surveys elicit WTP by asking, in some format, how much a respondent would be willing to pay for a given environmental change while choice experiment approaches provide a range of different combinations of attributes that respondents can select and value as part of a proposed environmental plan. Mourato et al. (2003) used a choice experiment method to determine the impact of bathing water directive revisions in England and Wales. After presenting beachgoers with a variety of scenarios, the study authors found that respondents had a WTP amount between 1.1 and 2.0 British pounds (BP) to decrease the chance of getting stomach upset by 1 in 100, between 0.9 and 1.1 BP to reduce unsafe to swim bathing days by 1, and between 5.6 and 12.1 BP to have an advisory note system that advised on poor water quality days. This suggests that people do place a value on having information about water quality and also place an economic value on bathing water quality.

Using a contingent valuation methodology, le Goffe (1995) evaluated the non-market value for improved water quality in Brest for swimming in addition to improvement of the ecosystem (avoiding eutrophication). Using Tobit models, le Goffe determined that households were willing to pay an average of between 214 and 215 FF per year to improve water quality for swimming and between 150 and 162 FF per year to protect against eutrophication.

Revealed Preference Models

While stated preference methods such as contingent valuation can be useful in obtaining the value of environmental goods from both non-users and users of the environmental good or service in question, revealed preference methods are limited to providing the “use value” of an environmental good or service; that is, the value of the resource as determined by observing those who are making use of the resource. An advantage of using revealed preference methods rather than stated preference methods is that they do not require construction of a hypothetical scenario and thus avoid some of the potential biases indicated above. Travel cost models were first developed following a suggestion by Hotelling in 1949 and have attempted to model the demand for a recreational site using the price that people are willing to pay to access the site in terms of travel costs (gasoline, tolls, etc.) and opportunity cost of travel time (Hotelling 1949; Clawson 1959). Opportunity cost is the cost of the opportunity foregone by choosing to participate in a given activity, in this case the time spent traveling to a site that could otherwise have been spent in wage-earning labor. As long as the sampled population includes people traveling a range of distances, a demand curve can be constructed and the value of the recreational site calculated. The model can be calculated using the individual travel cost or, if individual level data are unavailable, using a zonal travel cost model. Zonal travel cost models (Cesario and Knetsch 1976; Cicchetti et al. 1976; Hellerstein 1995) use data about the number of visitors coming from a defined geographic area to the recreational site of interest, calculating the travel costs based on the distance from the centroid of the specified geographic zone.

Several studies using the basic version of the travel cost model have been applied in studies of the values of beach and water resources. In a study for Carpinteria, California beaches using the travel cost method, King found that the value of a beach day during the high season was $23.38 and the value of a beach day during the low season was $3.00 (King 2002). This points out some of the limitations of using a travel cost approach, in that, since only use values are considered and non-use values such as existence and cultural values are not taken into account, the true TEV of the beach resource may be underestimated. King also points out the important distinction between the economic value to the person of being able to use those particular beaches versus the economic activity (e.g., expenditures for hotels and restaurants) that is generated by people visiting the city.

A study by Bell et al. that evaluated recreational demand for saltwater beach days calculated a consumer surplus for the typical Florida tourist of $38.46, a compensating variation of

$38.33, and an equivalent variation of $39.00 (Bell and Leeworthy 1990) and in an evaluation of recreational use of John Pennekamp Coral Reef State Park in Florida, Leeworthy estimated a consumer surplus ranging from $130.62 to $304.44 per person per day (1991).[1] Both of these studies employed travel cost models that are based on the total number of trips that are taken to sites during the period of interest. The basic travel cost model is limited by the fact that substitute sites available to the user are not explicitly included in the evaluation of the value of the sites.

Since their initial development, travel cost models have increased in complexity as researchers have attempted to incorporate the value of site quality attributes and account for the fact that substitute sites are available to the recreational user. To address the challenge of potential substitution between sites, travel costs models were developed that attempted to allocate visits from certain zones to recreational sites based on the characteristics of the sites (Cesario 1973; Cesario 1974; Cesario and Knetsch 1976; Sutherland 1982). These trip allocation models, however, are not grounded firmly in the economic theory of utility maximization (Bockstael et al. 1987). Investigators continued the development of travel cost models with the use of a system of demand functions that attempted to capture the fact that multiple sites were available to the interviewed households (Burt and Brewer 1971; Cicchetti et al. 1976). Other research has modified these multiple site travel cost models using a

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[1] Consumer surplus, compensating variation, and equivalent variation are differing measures of economic value from changes in price or site quality. Consumer surplus measures the monetary benefit to consumers of a price decrease (or environmental improvement) assuming income remains constant, compensating variation measures the WTP for a price decrease or environmental improvement, and equivalent variation measures the willingness-to-accept (WTA) or how much an individual would need to be paid to forego a price decrease or environmental improvement.

household production function and varying parameters approach in order to quantify the impact of variations in water quality among sites and the economic impact of an improvement in water quality (Vaughan and Russell 1982; Smith et al. 1983; Smith and Desvousges 1985). Using these methods, Smith and Desvousges (1985) estimated that improvements in water quality from boatable to fishable range were valued from $0.39 to $33.62, depending on the site being considered. Despite the advances of these models in their consideration of multiple sites, their specifications do not allow site quality to vary for the individual recreational user (Bockstael et al. 1987).

Developed in the area of product marketing and consumer choice, the random utility method has been applied to valuation of environmental attributes to formally incorporate the site choice decision of the individual consumer (McFadden 1974). This model allows for incorporation of both site and individual attributes. A limitation of this model is that, while the model can assist in demonstrating the parameters that are significant in the decision to visit a recreational site, it does not predict the number of trips that will be taken to the site by a given population (Bockstael et al. 1987). To address this concern, research has attempted to link a trip prediction model with the random utility model (Bockstael et al. 1987; Hausman et al. 1995). An important on-going limitation of the travel cost models and random utility models are difficulties in dealing with trips for which the whole value cannot be ascribed to a single recreational site; i.e., multi-purpose trips. Research into multi-purpose trips has attempted to assign a fraction of the overall trip cost to each site and estimate demand using those figures, use the marginal cost of visiting the second site after having traveled to the first site, and treating combinations of sites as an additional site (Haspel and Johnson 1982;

Mendelsohn and et al. 1992). Aside from visiting multiple sites, there is also the challenge of separating the cultural value from visiting a new location from the recreational value of visiting that location.

The random utility model will be used in this study since the variation in choice of site based on the water quality parameter is of interest. This model allows for incorporation of multiple sites that differ in quality attributes and evaluation of the choice of the consumer between these sites. As opposed to the travel cost method, the random utility model firmly grounds the recreation decision in a utility maximization framework. Several studies have previously used this method to estimate water quality improvements at different locations around the world.

Two studies in Sweden have investigated the recreational user benefits of improved water quality. A study conducted by Soutukorva for the Beijer Institute of Ecological Economics developed a random utility model to estimate the value of improved water quality as measured by site depth in two Swedish counties. The analysis revealed a consumer surplus of between 59 million SEK and 351 million SEK, depending on the year of the survey and the specification of the model, for a simulated improvement of 1 meter in secchi disk depth (Soutukorva 2001). In a separate study from the Stockholm School of Economics, secchi disk depth was linked with nutrient load and a random utility model was used to estimate the impact of secchi disk depth upon visitation to seaside locations in Sweden (Sandstrom 1996). Interestingly the results revealed that for those arriving by non-boat methods, increasing sight depth had a positive impact upon the probability of choosing a site while the result was negative, although not statistically significant at the 10-percent level, for those arriving by private boat. The author hypothesized that this may be because those using a boat are not as concerned about the water quality and also travel through multiple sites on their journey, making the quality at any one site less important. In a simulated model, he found that the consumer surplus for a 50-percent reduction in the nutrient load would range from between 140 million SEK and 330 m SEK, depending upon the model specifications.

Multiple revealed preference studies have also been conducted in the United States. San Diego beaches were evaluated using a recreational demand model by Lew and Larson that sought to determine what the impacts of oil spills, stormwater runoff, and other conditions that could affect the beachgoer experience (2005). Results from their survey indicated that water quality parameters did not significantly influence the choice of beach sites in the county. Amenity variables were significant predictors of beachgoer behavior, including availability of parking, length of beach, and presence of an on-beach lifeguard. Researchers suggested that the reason for the lack of significance of water quality may be that the beachgoers spend most of their time on the beach itself rather than in the water.

An investigation of beaches in the Great Lakes sought to determine the role of water quality advisories on beachgoer choice using a random utility model; authors found the estimated model parameter of advisories to be negative and significant. They estimated that a one-unit decrease in the number of advisories would result in an increase in value to individuals of $1.85 per trip and a average benefit of $227,598 per beach (Murray and Sohngen 2001). An implication of this finding is that the recreational ecosystem services provided by the beaches are diminished when investments or policies are not undertaken to impact the number of advisories issued on a beach during the year.

Combinations of Revealed and Stated Preference Methods

Aside from conducting either a revealed preference or stated preference study, it is also possible to create a study that combines elements of both approaches. Hanley et al. (2003) combined a revealed and stated preference method to determine the potential impact of water quality impacts in an area of Scotland that had failed to meet EU Bathing Water Quality Directive standards. The methodology combined the actual visitation behavior with stated changes in visitation patterns under different hypothetical scenarios. Investigators found that an increase of 52 trips per year for the entire population sample (increasing from 3954 to 4006 trips) would be predicted from improvement in water quality with a mean increase in consumer surplus of 5.81 BP per individual per year.

Impact of Various Water Quality Attributes

Using a range of methods including property value assessment, travel cost, and productivity analyses, a study conducted in the Peconic Estuary System on Long Island found sizable benefits for swimmers from 10-percent improvements in secchi disk depth ($752,423), brown tide cell counts ($319,378), total nitrogen ($147,399), and total coliform ($80,653) (Johnston et al. 2002). The much higher value observed for secchi disk depth suggests that water clarity, a visible characteristic unlike high bacteria level or high nitrogen concentrations, will have a higher impact upon the benefits to swimmers. The study by

Mourato et al. (2003) described previously also found that non-water quality characteristics (avoiding the presence of some litter/dog scat on the beach and improvement in amenities) are valued more highly than improvements to bathing water quality (introduction of an advisory note system and reduction in the risk of a stomach upset). These studies suggest that selection of the water quality attributes included in the model may be important in determining the values obtained for benefits from improved water quality.

In contrast to the high values that have generally been found in the U.S. and Western European countries, a study conducted in the Philippines estimated mean WTP sums for water quality improvements (using travel cost and contingent valuation methods) to be between US$1.20 and US$2.04. This may be a result of water quality improvements not being a high priority for residents of low-income developing countries (Choe et al. 1996). It is also possible that the water quality is already very high so that marginal improvements in water quality are not valued much. As noted above, if the water is crystal clear, there may be no public perception of a need for water quality improvements and thus limited WTP for those modifications. Taken as a whole, these studies suggest that coastal and beach resources do provide value to the consumer and that changes in water quality can therefore impact the benefits and utility enjoyed by users of beach resources.

Economic Value of Water Quality in Croatia

To date, no study has addressed specifically the economic benefits of the recreational services offered by the water quality at Croatian beaches. A WTP study conducted by Taylor et al. (2003) asked Croatian and non-Croatian visitors to the island of Hvar about the sum of money they would be willing to pay per day for improvement to the Hvar environment. A Croatian visitor was willing to pay 61 Euro cents per day while the non-Croatian visitor would pay 68 Euro cents per day. While this study provided important information concerning the value placed on the environment in Croatia, the question that was asked did not focus on specific environmental improvements in water quality. The current research expands the work done in this are by specifically focusing on the role of water quality as revealed by the decision of which Croatian beach to visit.

The availability of multiple beach sites along the Adriatic coast suggests that water quality could be an important determinant in the decision of which beach to visit. Water quality on a beach may impact the decision of a household to plan future trips to that beach or community. As a result, water quality can have an important impact upon the future development and benefits from the tourism industry in a specific locale or region. As Croatia is an economy in transition, an interesting result of the study will be determining if the values placed on Croatian beach water quality are closer to those of the United States or those of the Philippines (see above). In addition, as the water quality is generally very high and the sea bottom is visible at nearly all Croatian beaches, it is uncertain if there will be a high WTP for additional improvements in water quality.

3.1.4. Local knowledge

For the purposes of this study, local knowledge is defined as the knowledge about environmental conditions that is held specifically, but not necessarily uniquely, by local residents of the study location. Multiple studies have attempted to use the knowledge of local inhabitants about the environment in formulating policies or conducting analysis of the state of the environment. Research working with local farmers in the Macabu River watershed in Brazil found that farmers' knowledge of the state of ecosystem services in the watershed was complementary to scientific knowledge in some regards, but limited in others, such as appreciating the link between clearing of land and water quality problems (Silvano et al. 2005). In a study of a national park in the Czech Republic, local respondents were able to identify the need for waste management as a concern for tourism development (Cihar and Stankova 2006).

An interesting study by Harrison et al. (Harrison et al. 2004) investigated the knowledge about the Irukandji syndrome caused by jellyfish stings in North Queensland, Australia. The research demonstrated that locals were much more aware of the Irukandji syndrome and that 63.7 percent of those who indicated awareness of Irukandji modified their use of the coastal waters, either by avoiding swimming or wearing a lycra suit. This suggests that local knowledge can be important in assessing environmental risks. In this study, local knowledge about the environmental quality of coastal waters will be collected to determine whether it is predictive of beach visitation decisions.

3.2. Model and Methods

3.2.1. Model Development

The model that will be used for the evaluation of beachgoer utility in this research will be the random utility model that has been implemented in several of the studies discussed above. As described by McFadden (McFadden 1974) and Bockstael et al. (McFadden 1974; Bockstael et al. 1987), the random utility model can be presented in the following general form:

(3.1) $Pr_i = \exp(V_i)/\sum\exp(V_k)$

where Pr_i = probability of choosing site i from the k available sites;

V_i = indirect utility from selecting site i; and

V_k = indirect utility from visiting other available sites.

A consumer will choose the recreational location that possesses the attributes (cost for travel, site characteristics) that maximize their utility (V_i). The situation is analogous to the purchase of a certain product; a consumer will choose the product that has the attributes they desire most, one of which is its price. Statistically, the model is estimated using a logistic regression and maximum likelihood estimation. The model of particular interest to the current research separates site attributes into water quality/environmental attributes and amenity attributes so that

(3.2) $Pr_i = f(tc_i, tt_i, x_i, y_i, z_i)$

where tc_i = travel costs, tt_i = opportunity costs of time travel, x_i = water quality attributes (2005 total coliform, 2005 reported percentage of samples with poor water quality (yellow or red coding from government matrix), blue flag presence), y_i = beach amenities (restaurant, camping available, beach length, beach width, urban versus non-urban location), and z_i = beachgoer attributes (knowledge of water quality report, participation in swimming, diving, sunbathing). The full regression model is estimated by maximum likelihood estimation, which estimates the parameters of the model to maximize the probability of obtaining the data observed, such that

$$(3.3)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 coli+\beta_4 PPWQ+\beta_5 BF+\beta_6 rest+\beta_7 camp+\beta_8 length+\beta_9 width+\beta_{10} urban+\beta_{11} island+\beta_{12} pebble+\beta_{13} industry+\beta_{14} know+\beta_{15} swim+\beta_{16} sun+\beta_{17} diving)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 coli+\beta_4 RWQ+\beta_5 BF+\beta_6 rest+\beta_7 camp+\beta_8 length+\beta_9 width+\beta_{10} urban+\beta_{11} island+\beta_{12} pebble+\beta_{13} industry+\beta_{14} know+\beta_{15} swi\ m+\beta_{16} sun+\beta_{17} diving)}$$

where P(i) is the probability of beach i being chosen from the set of N available beaches, and βs represent the coefficients derived for the travel cost (tc), travel time (tt), beach water quality characteristics (coli = total coliform level, PPWQ = percentage samples with poor water quality, BF = dummy variable for presence of blue flag), beach amenity characteristics (rest = dummy variable indicating presence of a restaurant, camp = dummy variable indicating presence of camping, length = estimated length of the beach, width = estimated width of the beach, urban = dummy variable indicating if the beach is in an urban environment, island = dummy variable indicating if the beach is on an island, pebble = dummy variable indicating if the beach is predominately pebble in composition), and beachgoer attributes (know = knowledge of government water quality reports, swim = dummy variable indicating participation in swimming, sun = dummy variable indicating participation in sunbathing, diving = dummy variable indicating participation in diving).

This model will be evaluated using the data from Split-Dalmatia County surveys and Krk Island surveys described below in order to address Research Questions 1 and 2. Differences between the terms included in the model based on study site will be discussed in the Results section. Models will be run focusing only on those individuals who indicated that the sole purpose of their trip was to visit the beach, so as not to confound results with other non-beach attributes that may be driving visitation to Croatia and avoid some of the challenges of multipurpose trips mentioned in the literature review above.

To determine average compensating variation (CV_i) for the sample population, or what they would be willing to pay for a simulated positive change in one of the water quality attributes, this study will use

(3.4) $CV_i = [\ln[\exp(V_1(wq_1))]-\ln[\exp(V_0(wq_0))]]/\beta_1$

where $V_1(wq_1)$ equals the summed indirect utility after the simulated water quality change, $V_0(wq_0)$ equals the summed indirect utility before the simulated water quality change, and β_1 is the parameter estimate for travel cost for the population of interest from equation 3.3. Research has established that this parameter may be used for estimation of the CV welfare measure in discrete choice models (Hanemann et al. 1999). This estimate of individual CV will then be averaged over the entire surveyed population.

Although the government-published water quality rankings are publicly available on the Internet and in print, it is possible that there is local knowledge that may better describe the quality of the water. In order to account for information that locals may possess about the environmental quality of a town's beaches and address Research Question 3, a model incorporating "local knowledge" as a measure of environmental quality will be evaluated on the island of Krk so that

(3.5) $Pr_i = f(tc_i, tt_i, lk_i, y_i, z_i)$

where tc_i = travel costs, tt_i = travel time, lk_i = local knowledge about water quality, y_i = beach amenities as above, and z_i=beachgoer attributes as above. The regression estimation will take the form

$$(3.6)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 lkclarity+\beta_3 lkhealth+\beta_4 lkoverall+\beta_5 rest+\beta_6 camp+ \beta_7 length+\beta_7 width+ \beta_9 urban+ \beta_{10} island+\beta_{11} pebble+\beta_{12} industry+\beta_{13} know+\beta_{14} swim+\beta_{15} sun+\beta_{16} diving)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt + \beta_3 lkclarity + \beta_3 lkhealth+\beta_4 lkoverall+\beta_5 rest+\beta_6 camp+ \beta_7 length + \beta_7 width + \beta_9 urban + \beta_{10} island + \beta_{11} pebble + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving)}$$

where lkclarity = local knowledge about water clarity, lkhealth = local knowledge about health of the bathing waters in a town, lkoverall = local knowledge about the overall bathing experience in a town, and all other variables are as defined previously.

To address Research Question 4, a logistic regression will also be used as above to determine if the self-evaluations of intercepted visitors of water clarity, water health impacts, and beach cleanliness impact the decision to revisit a beach. The model is

(3.7) Pr(choosing to revisit beach i) = f(tc_i, tt_i, sr_i, bf_i)

where tc_i = travel costs, tt_i = travel time, sr_i = self-reported water clarity, water health impacts, and beach cleanliness measures, and bf_i = blue flag presence. The model will again be estimated using maximum likelihood regression of the form

$$(3.8)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean)}$$

where P(i) equals the probability of choosing to revisit beach I, srwq = self-reported water clarity rating, srhealth = self-reported health ranking, and srbeachclean = self-reported beach cleanliness ranking.

To answer RQ5 investigating whether local residency status on Krk impacts the choice of a high versus low bathing water quality site, a correlation analysis and chi-squared analysis will be used (Baum 2006).

3.2.2. Site Selection

3.2.2.1. Study Beach Selection in Primorsko-Goranska County

Instead of examining the relationship between water quality and tourism development on the county level, the island of Krk was selected for the travel cost survey in Primorsko-Goranska County in order to gain a local perspective, or local knowledge, about the quality of the beaches on the island. The island is relatively small (407.28 km^2 (DZS 2005)) and has a limited number of towns so residents of the island would have higher familiarity with all of the towns on the island and would be better able to complete a survey about the water quality at beaches in each of the main coastal towns on the island. Attempting to do such a survey in a large geographic area with many towns and only a few selected study sites may be difficult as the odds of local residents being familiar with all of the selected study sites may be lower. This local knowledge component will be collected through surveys as described below.

The study site locations on the island of Krk were the municipalities of Omisalj, Njivice, Malinska, Krk, Punat, and Baska. Population data for these towns are listed in Table 2.2. The figure for Omisalj also includes the population in Njivice, since Njivice is considered a settlement of Omisalj.

Table 3.2 Residential population of town survey locations (DZS 2001)

Town	Residential Population
Omisalj and Njivice	2,998
Malinska	2,726
Krk	5,491
Punat	1,876
Baska	1,554

As is evident by the population data, the towns on the island of Krk, and the island of Krk as a whole, has a small permanent residential population. This small residential population stands in contrast to the large number of tourists that visit the island each summer. A toll bridge connects the island to the Croatian mainland, and ferries leave from the island to other tourist destinations within the Kvarner Gulf. Figure 3.2 shows the location of the study towns on the island of Krk.

Figure 3.2. Map of island of Krk with six town study locations (Source: GoogleEarth)

In terms of town beach characteristics, all of the towns except for Punat have at least one beach that flies the Blue Flag; the Blue Flag can be displayed on beaches that meet the criteria of the International Blue Flag program and will be described in the variables section below. The beaches in Krk and Punat are predominately concrete with some pebble, the beaches in Baska, Malinska, and Njivice are almost entirely pebble, and the beaches in Omisalj are predominately pebble. Camping is available adjacent to the beaches in all of the towns except for Omisalj, and hotels and apartment housing are available adjacent to the beaches in all of the towns.

Omisalj was divided into two study sites in order to conduct evaluation of the correlation between local residency status and the choice of bathing location. Omisalj was chosen for this study because it beaches are located on an enclosed bay and one site has a Blue Flag and historically good water quality, while, in close proximity, a second site has no Blue Flag, immediately adjacent hotels, and worse water quality in 2002 to 2005. Omisalj is the most industrialized town on the island and is home to a petrochemical plant, which is easily observable on the long peninsula in Figure 3.3. Figure 3.3 also shows a map of Omisalj Bay and the two different study locations described above.

Figure 3.3. Omisalj Bay with study locations 1 (unpolluted in 2004-2005) and 2 (polluted in 2004-2005) (Source: GoogleEarth)

3.2.2.2. Split-Dalmatia County

Study Beach Selection in Split-Dalmatia County

Since there are 134 beach locations in Split-Dalmatia County with water quality monitoring and not all could feasibly be visited during the study period, cluster analysis was used to group similar beaches based on the similarities and differences in their characteristics and amenities. Eight-five of the 134 monitored locations in Split-Dalmatia County were visited and the respective beaches were classified using a series of characteristics that might influence the decision of beachgoers (see Appendix 1). Table 3.3 shows the results obtained in terms of the beach characteristics that were evaluated during the beach visits.

Table 3.3. Summary of Visited Beach Characteristics in Split-Dalmatia County

Characteristics	**Percentage of Beaches with Characteristic**
Beach width	
Less than 25 feet	85
Between 25 and 50 feet	13
Greater than 50 feet	2
Beach length	
Less than 50 feet	2
Between 50 and 100 feet	19
Between 100 and 200 feet	32
Between 200 and 500 feet	33
Greater than 500 feet	14
Private beach	2
Island beach	32
Urban beach	14
Semi-urban beach	81
Non-urban beach	5
Adjacent to another beach	61
Pebble beach	75
Sand beach	6
Concrete beach	19
Playground	27
Camp	6
Hotel	55
Apartment	95
Marina	51
Restaurant	54
Café	75
Toilet	72
Shower	55
Public Transit Accessible	46
Drainage/Discharge Present	27
Poor Water Quality in 2005	13
Blue Flag in 2005	7

Beaches were classified as urban, semi-urban, or non-urban according to the following criteria: Urban beaches are in the center of a populated area with access to multiple restaurants, shops, and hotels; semi-urban beaches were located in less developed village locations with a more limited number of restaurants, cafes, and other amenities, which were primarily seasonal in nature; and non-urban beaches were located away from developed settlements with no adjacent restaurants, hotels, or apartment/holiday housing, A restaurant was classified as having a full menu, while a café only offered drinks. Beaches were classified as pebble, concrete, or sand depending upon the primary substrate on that beach. Finally, poor water quality in 2005 was determined if a beach received a yellow (3) or red (4) rank at any point during the 2005 bathing season. The remaining variables in Table 2.3 are self-explanatory and were scored on the survey indicating the presence or absence of those characteristics.

Following on-site collection, beach characteristics were then entered into STATA statistical software (Stata 2003) and analyzed using cluster analysis with complete linkage clustering and binary matching distance measures. Hierarchical cluster analysis uses the differences and similarities between the subjects (the beaches in this case) in order to develop indices of relatedness. The specific calculation uses the matrix

		beach j	
		1	0
beach i	1	a	b
	0	c	d

where a=the number of observations where the characteristic was present on both beaches, b=the number of observations where the characteristic was present on beach i but not beach j, c= indicates the number of observations where the characteristic was absent on beach i but present on beach j, and d=the number of observations where the characteristic was absent on both beaches. The simple distance measure is calculated as (a+d)/(a+b+c+d).

Cluster analysis has been used in multiple applications and fields (e.g., genetics, environmental attributes) (Erickcek and McKinney 2006; Tuomainen et al. 2006; Harino et al. 2007; Tapio et al. 2007). The goal of using cluster analysis was to select beaches that were alike in all characteristics other than specific selected differences that the study was seeking to evaluate that may have influenced the beachgoer decision (presence or absence of a Blue Flag, history of poor water quality or no history of poor water quality, and location on mainland or island).

As a result, the selection process considered both the cluster of the beach and the need to have each of the following beaches in the final set of surveyed beaches:

(1) Mainland beach with history of poor water quality

(2) Mainland beach with Blue Flag and no history of poor water quality

(3) Mainland beach with no Blue Flag and no history of poor water quality

(4) Island beach with history of poor water quality

(5) Island beach with no history of poor water quality

Using the cluster analysis as a guide, the five beaches that were selected (with the category from above that they represented in parentheses) were Zlatni Rat in Bol on the island of Brac (5), Cvitacka in Makarska (3), Sulavi in Kastela (1), Banj in Supetar on the island of Brac (4), and Punta Rat in Brela (2). Table 3.4 summarizes the residential population in each of the towns where the beach is located. It is important to note that as opposed to visits to each of the town's beaches, the surveys in Split-Dalmatia County were conducted only on the specific beach noted above. The location of these beaches is shown in Figure 3.4.

Table 3.4. Residential Population of Towns Where Beach Study Sites are Located (DZS 2001)

Town	Residential Population
Bol	1,661
Brela	1,771
Kastela	34, 103
Makarska	13, 716
Supetar	3, 889

Figure 3.4. Map of Locations of Beach Study Sites in Split-Dalmatia County (Source: GoogleEarth)

3.2.3. Data Collection

Travel Cost Survey

The travel cost survey (Appendix 2) was conducted in both study locations in June and July of 2006 in five languages: English, Croatian, German, Italian, and French. Surveys were customized for each of the study locations by changing the towns that beachgoers could indicate they had visited. The survey was pilot tested prior to the beginning of the study (n=15). A few modifications were made thereafter to make the questions more understandable.

During the actual study, beachgoers were randomly intercepted on the target beaches. On the survey, respondents were also asked to rate the water cleanliness, health of the bathing water, and beach cleanliness on a scale of 1 to 4; for water cleanliness and beach cleanliness, higher values indicated higher ratings and a perception of better conditions, while for health of the bathing water, higher values indicated worse rating of the water health.

Local Knowledge Surveys

Two types of local knowledge surveys were conducted on Krk Island in June and July of 2006 to determine the predictive value of local knowledge in beach visitation decisions. The first survey was conducted in each of the towns on the island of Krk; local residents ranked the towns on the coast on a scale of 1 to 6 in terms of water clarity, water health impacts, and overall beach-going experience (see Appendix 3). No ties were allowed and a higher number indicated a worse evaluation of that criterion.

The second survey aimed at elucidating the role of local knowledge was conducted in the town of Omisalj only (see Appendix 4). In this survey, respondents were asked whether or not they were a resident of Omisalj and then asked to choose their preferred bathing location; as described in the site selection section, one site had poor water quality reported by the government in 2004 to 2005 while the other site possessed a Blue Flag and no reports of poor water quality in 2004 to 2005.

Water Quality Data

Total coliform data for 2005 and reported water quality for 2005 were obtained from the Institute of Public Health in Rijeka for Krk Island and from the Institute of Public Health in Split for Split-Dalmatia County. These data will be used as the water quality variables (described below) in the random utility model.

3.2.4. Variable Descriptions

Travel Variables Included in the Model

Travel Cost

The travel cost variable was calculated using an online mapping product specific for Europe for those trips using automobile transportation. This software calculates the cost of gasoline as well as tolls along the most efficient route. Travel cost was calculated both for the beach that was actually visited as well as for the other beaches in the constructed choice set that were not visited. For those arriving by bus or ferry, the average bus or ferry fare between destinations was used to calculate travel to the intercepted location as well as the sites that were not visited on that choice occasion. The self-reported travel cost was used for those arriving by airplane and the cost after arrival at the airport was estimated as above depending on the mode of transportation indicated. For those arriving by walking to the beach, travel cost was assumed to be 0, and they were assumed to use an automobile to visit the other beaches in their choice set.

Travel Time

The travel time variable was calculated by directly inputting the number of hours it would take to travel to each of the destinations. Given the continuing controversy about incorporating the costs of travel time, this method was selected to avoid arbitrary assignment of a fraction of the wage rate and because of limited data collected about the employment status of beachgoers[2]. The number of hours traveling was calculated by using the travel time stated by participants in their survey responses for the beach where they were intercepted. Using this time as a starting point, the time it would have taken to travel to each of the other beaches in the choice set was calculated using the previously described online mapping product.

Amenity Variables Included in the Model

As noted in equation 3.3, the overall model to assess importance of monitored and surveyed data in beach selection is

$$(3.3)\ P(i) = \frac{\exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_3 PPWQ + \beta_4 BF + \beta_5 rest + \beta_6 camp + \beta_7 length + \beta_7 width + \beta_9 urban + \beta_{10} island + \beta_{11} pebble + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving)}{\quad}$$

[2] The appropriate treatment of the opportunity cost of travel time is an ongoing topic of research and discussion. (Caulkins PP, Bishop RC, Bouwes N, et al. 1986; Luzar EJ, Hotvedt JE, et al 1992; Shaw WD, et al. 1992; Feather P, Shaw WD, et al. 1999; McConnell KE et al. 1999) Given the limited individual labor market data collected in this survey, the number of hours traveled was directly used for this variable.

$$\sum_{i=1}^{N} \exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_3 PPWQ + \beta_4 BF + \beta_5 rest + \beta_6 camp + \beta_7 length + \beta_7 width + \beta_9 urban + \beta_{10} island + \beta_{11} pebble + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving)$$

The amenity variables are included as rest, camp, length, width, urban, island, pebble, and industry.

Restaurant

The *rest* variable is a dummy variable that assumes a value of 1 if the beach had a restaurant directly adjacent to it.

Camping

The *camp* variable is a dummy variable that assumes a value of 1 if the beach or town provided facilities for overnight camping. None of the beaches in Split-Dalmatia County allowed camping; as such, it is not included in the full model for this county.

Beach length

Using GoogleEarth measurement function, the *length* was calculated in meters for beaches in the Split-Dalmatia County location. Previous research has found a significant influence of beach length upon the choice of beach. This variable was not included in the model for Primorsko-Goranska County as that study included all of the beaches in a town rather than a single beach.

Beach width

Width was also calculated in meters using GoogleEarth. As above, this variable was not included in the model for Primorsko-Goranska County given the fact that all the beaches in a town were considered.

Urban

The *urban* variable is a dummy variable that assumes a value of 1 if the beach is located in an urban center as opposed to the outskirts of a town or a less developed location.

Island

Island is a dummy variable that assumes a value of 1 if the beach is located on an island. This variable only entered the model for Split-Dalmatia County as all of the beaches on Krk Island are on an island.

Beach type

The beach type variable *pebble* assumes a value of 1 if the beach is a pebble beach and a value of 0 if the beach is concrete. For the Primorsko-Goranska County study location, this is equivalent to the composition of the majority of beaches in the study town. For example, in Punat the beaches are predominately composed of concrete so the variable would be 0 for this town. In Split-Dalmatia County, this represents the dominant beach type of the studied beaches.

Industry

The *industry* variable is a dummy variable that assumes a value of 1 if the beach is located in view of industry.

Water Quality Variables Included in the Model

The overall model also includes water quality variables potentially important in visitor beach selection. Recall the model,

$$(3.3)\ P(i) = \frac{\exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_3 PPWQ + \beta_4 BF + \beta_5 rest + \beta_6 camp + \beta_7 length + \beta_7 width + \beta_9 urban + \beta_{10} island + \beta_{11} pebble + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving)}{\sum_{i=1}^{N} \exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_3 PPWQ + \beta_4 BF + \beta_5 rest + \beta_6 camp + \beta_7 length + \beta_7 width + \beta_9 urban + \beta_{10} island + \beta_{11} pebble + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving)}$$

where coli, PPWQ, and BF are water quality attributes.

Bacteriological Data

The model includes *coli*, which is total coliform data as provided by the Institute of Public Health for Primorsko-Goranska and Split-Dalmatia counties. The value included in the model was the average total coliform count for the beach or town (on Krk Island) in 2005 as shown in Table 3.5.

Table 3.5. Average Total Coliform Levels on Beaches in the Two Study Locations

Beach/Town	Average Total Coliform (CFU/100 ml)
Krk Island	
Baska	3.8
Krk	8.9
Malinska	19.1
Njivice	4.5
Omisalj 1	3.1
Omisalj 2	26.9
Punat	3.3
Split-Dalmatia County	
Banj	23.3
Bol	12.4
Cvitacka	16.2
Sulavi	35.8
Punta Rat	22.5

Analysis of the water quality results indicated that there were no significant differences between the average total coliform levels at each of the locations. Also, it is important to note that, on average, none of the locations had total coliform levels exceeding the limit values of 1000 CFUs/mL.

MZOPU Reported Percentage of Samples Unacceptable for Swimming

This *PPWQ* variable represents the percentage of samples for 2005 reported by the Ministry of Environmental Protection, Physical Planning, and Construction as having poor water quality (yellow or red in the matrix shown in Figure 3.1) for the summer of 2005.

Blue Flag Program

The *BF* variable is a dummy variable that assumes a value of 1 if a blue flag is present on a beach (Split-Dalmatia County) or in a town (Krk Island). The Blue Flag Program is run by the Foundation for Environmental Education in Europe (FEE), a not-for-profit NGO consisting of 46 member countries. The program began in 1987 and is meant to be an "eco-label" for those visiting and using beaches and marinas. There are twenty-nine criteria for awarding of a blue flag, including compliance with EU water monitoring at the excellent level, presence of a beach management committee, and safety and security.(Foundation for Environmental Education 2007) A display must present water quality information to the public indicating the water quality on the beach and what the water quality determination means. The Blue Flag process for beaches begins with an application from the municipality to the Blue Flag Programme, which is then considered by a jury selection process (both national and international) managed by FEE. Criteria for participation in the program, last revised in 2006, are either imperative or a guideline and may be waived for certain sites if deemed not applicable. The Blue Flag is valid for one season and can be withdrawn from beaches that fall out of compliance with the program requirements. Guidelines indicate that the Blue Flag must be taken down if total coliforms exceed 10,000 cells/100 mL or if fecal coliforms exceed 2,000 cells/100 mL. In this research, a dummy variable was created to indicate whether or not a blue flag was present on the beach, in the case of Split-Dalmatia County, or in the town as a whole, in the case of Krk Island.

Local Knowledge Variables Included in the Model

Local rankings of water clarity, health impacts of water quality, and overall beachgoing experience are included in the model as the median of the local knowledge survey ranking given to a town's beaches on the island of Krk (described above).

3.3. Results

3.3.1. Krk Island

On the island of Krk, 233 travel cost surveys were conducted with a response rate of 88 percent. Table 3.6 summarizes the characteristics of the beachgoing population intercepted in towns on the island of Krk as determined from the survey information.

Table 3.6. Characteristics of Beachgoers at Krk Island

Characteristic	**Overall**	**Croatian Non-Local**	**Non-Croatian**	**Croatian Local**
Age	34	34	32	34
Income (euros)	18,944	13,609	24,208	10,353
Number in Family	2.4	2.3	2.6	2.0
Number car arrivals	200	80	113	7
Number bus arrivals	10	3	7	0
Number bicycle arrivals	1	0	1	0
Number ferry arrivals	1	0	1	0
Number "on foot" arrivals	18	0	3	15
Average number of days visiting beach	6.93	6.58	8.24	1
Percent visiting the beach only	86.8	91.6	82.3	95.5
Percent swimming	95.6	98.8	93.5	95.5
Percent sunbathing	97.4	98.8	96	100
Percent diving/snorkeling	15.2	20.5	14.5	0
Percent aware of government bathing water quality report	51.3	74.7	33.3	63.6
Percent aware of Blue Flag program	66.4	86.7	49.2	86.4

The majority of the visitors were visiting the beach where they were intercepted only and the average length of stay was slightly over a week. Swimming and sunbathing were by far the most popular activities, although 15.2 percent indicated that they participated in either diving or snorkeling. In terms of awareness about water quality reports, a slight majority of visitors were aware of the fact that the Ministry of Environmental Protection published a report about bathing water quality while approximately two-thirds had knowledge of the Blue Flag program.

For this location, the beach visitation model in equation 3.3 described in the Model and Methods section was estimated restricting to the subset of the total surveyed population that identified themselves as locals by limiting the model run to cases where the local dummy variable was equal to 1. In this case the model was unable to estimate parameters as locals (residents of the island of Krk) chose their own town's beach and were not observed visiting other beaches on the island, at least during the conduct of this study. As such, locals were excluded from the models described below.

The full model was slightly modified from equation 3.3 to accommodate the specifics of the Krk Island study location and include dummy variables multiplying each of the policy variables of interest (travel cost, travel time, 2005 total coliform count, blue flag presence and percentage of poor water quality samples in 2005) by 1 for non-local Croatians or 0 for non-Croatians to examine whether these parameters may vary based on the population considered but retain degrees of freedom. On Krk Island, urban, island, restaurant, and beach length and width were not included as the unit is the town as a whole rather than an individual beach.

As such the full model becomes

$$(3.9)\ P(i) = \frac{\exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_4 PPWQ + \beta_5 BF + \beta_6 camp + \beta_7 pebble + \beta_8 industry + \beta_9 know + \beta_{10} swim + \beta_{11} sun + \beta_{12} diving + \beta_{13} tcdummy + \beta_{14} ttdummy + \beta_{15} RWQ\ dummy + \beta_{16} colidummy + \beta_{17} BFdummy)}{\sum_{i=1}^{N} \exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_4 PPWQ + \beta_5 BF + \beta_6 camp + \beta_7 pebble + \beta_8 industry + \beta_9 know + \beta_{10} swim + \beta_{11} sun + \beta_{12} diving + \beta_{13} tcdummy + \beta_{14} ttdummy + \beta_{15} RWQ\ dummy + \beta_{16} colidummy + \beta_{17} BFdummy)}$$

Neither the amenity and beachgoer attribute variables nor the dummy variables emerged as significant predictive variables so only the policy variables of interest and significant variables were retained in model run that generated the results shown in Table 3.7 below. The full model results for equation 3.9 are included in Appendix 5. Numbers indicate the coefficient estimates from the maximum likelihood estimation with the respective signs. A negative sign indicates that the variable resulted in a decreased probability of the beach being selected.

Table 3.7. Logistic Regression Using Total Coliform Count, Percentage of Poor Water Quality Samples Reported in 2005, and Blue Flag Presence as Predictors

	Parameter Estimate (n=176)
Travel cost	-0.0001 (0.0001)
Travel time	0.0003 (0.0017)
2005 coliform count	-0.0133 (0.0153)
Blue Flag	-0.1332 (0.2318)
Percent of Time Poor Water Quality Samples in 2005	-.0006 (.0126)
Model p-value	0.8412

None of the variables for Krk Island nor the overall model were statistically significant. Evaluation of the model restricted to air travelers or Croatian residents visiting Krk Island indicated that a travel cost model may not be an appropriate model for those populations (yielding positive travel cost parameter estimates). As such, the above model was run another time excluding air travelers and Croatian tourists.

Table 3.8. Logistic Regression Using Total Coliform Count, Percentage of Poor Water Quality Samples Reported in 2005, and Blue Flag Presence as Predictors and Excluding Croatian Visitors and Air Travellers

	Parameter Estimate (n =100)
Travel cost	-0.0002 (0.0002)
Travel time cost	0.0033 (0.0021)
2005 coliform count	-0.0325 (0.0221)
Blue Flag	-0.3631 (0.2965)
Percent of Time Poor Water Quality Samples in 2005	0.1212 (0.1722)
Model p-value	0.2543

Exclusion of air travelers did not result in statistically significant values for the individual parameter estimates or for the overall model, although there was an improvement in the p-values for both the individual variables and overall model. Total coliform count (-0.0325, p = .141) had the expected negative sign for the non-Croatian population; however, the PPWQ (percent of samples with poor water quality in 2005) parameter was unexpectedly positive (0.1212, p = 0.482), though not statistically significant. An additional surprising result, though not statistically significant, was the negative sign on the Blue Flag parameter, indicating that presence of a Blue Flag in a town actually decreased the probability of that town's beaches being selected for tourist use. Both of these unexpected results should be interpreted with caution given the lack of statistical significance.

As a policy experiment, the impact of a 10-percent total coliform count improvement on the beach in zone 2 of Omisalj, where the highest average bacterial counts were reported in 2005 was evaluated for non-Croatian, non-air arrivals. This would mean an improvement from an average count of 26.9 CFUs per 100 ml to 24.21 CFUs per 100 ml. For the restricted population the stated improvement would result in an average WTP of 21.18 euros per trip.

To determine the role that local knowledge may play in predicting the beach visitation decision of foreign and domestic tourists for RQ3, Krk island residents were asked about their perceptions of the beaches in the towns on the island of Krk. A total of 150 residents on the island were approached and 135 surveys were conducted for a response rate of 90 percent. Table 3.9 summarizes the ratings assigned from the 74 complete, usable surveys.

Table 3.9. Median Local Rankings of Town Beaches on the Island of Krk

	Local Water Clarity Ranking	Local Water Health Impact Ranking	Local Overall Experience Ranking
Baska	2	2	2
Krk	3	3	3
Malinska	4	4	3
Njivice	4	4	4
Omisalj	6	6	6
Punat	4	3	3

In the same populations as in Table 3.7, the random utility model from equation (3.6)

$$(3.6)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 lkclarity+\beta_4 lkhealth+\beta_5 lkoverall+ \beta_6 camp+ \beta_7 pebble+\beta_8 industry+\beta_9 know+\beta_{10} swim+\beta_{11} sun+\beta_{12} diving)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 lkclarity+\beta_4 lkhealth+\beta_5 lkoverall+ \beta_6 camp+ \beta_7 pebble+\beta_8 industry+\beta_9 know+\beta_{10} swim+\beta_{11} sun+\beta_{12} diving)}$$

was run using the local knowledge variables about clarity, health, and overall experience instead of the blue flag, 2005 bacterial coliform, and average 2005 reported water quality variables. Variance inflation factor analysis (Baum 2006) confirmed that there was strong collinearity between the median local rankings of overall experience, health, and water clarity, (see Table 3.9) so only the local water health impact ranking was used in the final model. Health ranking is also most directly related to those objective measures (total coliform and reported 2005 water quality) included in the previous model.

Table 3.10. Variance Inflation Factor Analysis of Local Knowledge Rankings

Variable	**VIF**	**Tolerance**
Clarity Ranking	17.87	0.0559
Health Ranking	28.00	0.0357
Overall Experience Ranking	16.87	0.0593

As with the previous model, other beach and beachgoer attributes were not statistically significant so only the travel cost, travel time, and local health ranking variables are maintained in the final model

$$(3.10)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+_3 lkhealth)}{\sum_{i=1}^{N} \exp(\beta_1 tc + \beta_2 tt + \beta_3 lkhealth)}$$

summarized in Table 3.11 below. Full model results for equation 3.6 are included in Appendix 5.

Table 3.11. Logistic Regression Using Local Perception of Health as a Predictor

	Combined (n=176)	Non-Croatians (n=100)	Croatian non-locals (n=76)
Travel cost	0.0000 (0.0001)	-0.0001 (0.0001)	0.0013 (0.0014)
Travel time	-0.0011 (0.0011)	0.0009 (0.0011)	-0.040* (0.0168)
Local health ranking	-0.1051 (0.0623)	-0.1440* (0.0882)	-0.0623 (0.088)
Model p-value	0.2093	0.3595	0.1200

*significant at the alpha=0.10

As shown in the table, the results suggest that the non-Croatian beachgoing population is less likely to visit beaches that are rated by locals to have worse health quality. The impact of local health ranking on the odds of visiting a beach seems to be of greater magnitude (-0.1440) for the non-Croatian tourists than the Croatian non-locals (-0.0623) visiting the beaches, although this parameter is only statistically significant for the non-Croatian beachgoing population. In addition the positive travel cost parameter estimate for the Croatian beachgoing population again suggests that a travel cost model does not seem to accurately capture their beachgoing behavior on Krk Island. The negative parameter estimate for local health ranking for the non-Croatian tourist population agrees with the findings using the total coliform data collected by the public health department (also a negative parameter estimate (see Table 3.8). Thus, the answer to Research Question 3 seems to be that local knowledge can be used as a predictor of beachgoer visitation patterns.

RQ4 looked even more closely at the choice of locals in selecting between a higher (location 1) versus lower water quality bathing location (location 2) in the town of Omisalj. As there is no difference in travel time between the two locations, simple pairwise correlation and chi-squared analysis was used to determine if there was a different pattern in the visitation of locals versus non-locals. Analysis of data indicated a positive correlation between Omisalj residency and selection of the higher water quality site ($r = 0.1439$, $p = 0.2029$). The results from this study using chi-squared analysis are shown in Table 3.12.

Table 3.12. Chi-squared Analysis of Local Residency and Beach Site Choice

	Zone Choice	
Omisalj Resident?	1	2
Yes	39	22
No	9	10
Chi-squared statistic = 1.657, p = 0.198		

As the results indicate, no significant difference was observed, supporting the null hypothesis of random assortment between the two beaches.

RQ5 sought to determine if self-reported measures of water cleanliness, water health impacts, and beach cleanliness influenced the decision to return to a given beach. The average water cleanliness, water health impacts, and beach cleanliness rankings for Krk Island are shown in Table 3.13.

Table 3.13. Average Self-reported Water Quality by Beach on Krk Island

Town	Water Cleanliness (higher is better)	Water Health Impacts (higher is worse)	Beach Cleanliness (higher is better)
Baska	3.47	1.19	3.03
Krk	3.42	1.10	3.48
Malinska	3.62	1.06	3.12
Njivice	3.66	1.13	3.16
Omisalj 1	2.81	1.41	3.13
Omisalj 2	2.85	1.21	2.97
Punat	3.17	1.06	2.86

Using these rankings as predictive variables on the response variable of revisiting the same beach, a logistic model using equation (3.8)

$$(3.8)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean}$$

was estimated, leading to the results shown in Table 3.14 (srwq = self-reported water clarity, srhealth = self-reported health of bathing water, srbeachclean = self-reported beach cleanliness).

Table 3.14. Results of Logistic Regression Examining Odds of a Repeat Visit on the Island of Krk (n=199)

Variable	Parameter estimate
Travel cost	-0.0090 (0.0109)
Travel time cost	-0.02548* (0.0084)
Self-reported water clarity	0.0885* (0.0208)
Self-reported health of bathing water	-.1965* (0.0488)
Self-reported cleanliness of beach	-0.1776* (0.5938)
Presence of Blue Flag	0.0104* (0.0024)
Model p-value	0.0000*

*significant at alpha=0.001

Results indicate that all parameters except for beach cleanliness rating are in the anticipated direction. Higher rating of the health impacts of bathing water (worse rating) or water clarity (higher is better) were significantly related to a lower probability of higher probability of deciding to visit the beach again in the future, respectively. Unexpectedly, the higher the beach cleanliness was ranked (higher meaning cleaner), the less likely a beach was to be revisited. Presence of a Blue Flag significantly increased the probability of deciding to revisit a beach again in the future. These results seem to support a role for water quality in the beach visitation decision of tourists to Croatia.

3.3.2. Split-Dalmatia County

In Split-Dalmatia County, 184 people were approached and 166 agreed to complete the survey for a response rate of 90 percent. Beachgoer characteristics averaged from those surveys are shown in Table 3.15.

Table 3.15. Characteristics of Surveyed Beachgoers in Split-Dalmatia County

Characteristic	**Overall**	**Croatian Non-Local**	**Non-Croatian**	**Croatian Local**
Age	35	32	35	39
Income (euros)	26,754	13,356	33,461	11,513
Number in Family	3.4	2.7	3.7	3.1
Number car arrivals	101	26	70	5
Number bus arrivals	25	4	21	0
Number ferry arrivals	15	4	11	0
Number “on foot” arrivals	10	0	0	10
Average number of days visiting beach	6.71	6.41	7.65	1
Percent visiting the beach only	80.1	88.2	75.5	93.3
Percent swimming	97.3	97	97.1	100
Percent sunbathing	96.0	97.1	97.1	86.7
Percent diving/snorkeling	7.9	5.9	9.8	0
Percent aware of government bathing water quality report	41.1	94.1	15.7	93.3
Percent aware of Blue Flag program	54.3	91.1	38.2	80

As with the Krk Island study, the model could not be run for the subpopulation of local residents since locals would always choose the beach that was in their town and, as such, the model predicted the data perfectly. For this reason the models described below excluded the local population.

The model in equation 3.3 was modified to include all amenity and beachgoer variables (with the exception of camping and pebble variables, which did not vary between beaches in Split-Dalmatia County) as well as dummy variables multiplying each of the policy variables of interest (travel cost, travel time, 2005 total coliform count, blue flag presence, and reported 2005 water quality ranking) by 1 for non-local Croatians or 0 for non-Croatians. An additional modification from the Krk Island model was necessary since no beaches in Split-Dalmatia County had a reported water quality of 3 (yellow) or 4 (red) according to the government matrix. The PPWQ (percent of samples reported at poor water quality in 2005) was therefore modified to represent the percentage of samples during 2005 that a beach was at water quality of 2 (good) rather than 1 (excellent); this is represented by the variable PPWQ in the model below. The full model for Split-Dalmatia County is shown by equation 3.11

$$(3.11)\ P(i) = \frac{\exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_4 PPWQ + \beta_5 BF + \beta_6 rest + \beta_8 length + \beta_9 width + \beta_{10} urban + \beta_{11} island + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving + \beta_{17} tcdummy + \beta_{18} ttdummy + \beta_{19} RWQ\ dummy + \beta_{20} colidummy + \beta_{21} BFdummy)}{\sum_{i-1}^{N} \exp(\beta_1 tc + \beta_2 tt + \beta_3 coli + \beta_4 PPWQ + \beta_5 BF + \beta_6 rest + \beta_8 length + \beta_9 width + \beta_{10} urban + \beta_{11} island + \beta_{12} industry + \beta_{13} know + \beta_{14} swim + \beta_{15} sun + \beta_{16} diving + \beta_{17} tcdummy + \beta_{18} ttdummy + \beta_{19} RWQ\ dummy + \beta_{20} colidummy + \beta_{21} BFdummy)}$$

whose results are included in Appendix 5. The amenity and beachgoer attribute variables were again not significant at the 0.05 level. The policy-relevant variables and significant dummy variables for total coliform and reported water quality in 2005 emerged as significant predictive variables leading to a final model of

$$(3.12)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 coli+\beta_4 RWQ+\beta_5 BF+ \beta_6 PPWQ\ dummy + \beta_7 colidummy)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 coli+\beta_4 RWQ+\beta_5 BF+ \beta_6 PPWQ\ dummy + \beta_7 colidummy)}$$

with results shown in Table 3.16 below.

Table 3.16. Logistic Regression Using Water Quality Parameters as Predictors of Beach Visitation in Split-Dalmatia County

	Combined Population (n=107)
Travel cost	-0.00002 (0.00006)
Travel time	-0.00206 (0.00195)
2005 coliform count	-0.06996* (0.02469)
Blue Flag	0.31442 (0.41331)
Reported percent of samples of water quality 2	-1.2414 (1.7057)
2005 coliform count dummy	0.05533* (0.01941)
Reported percent of samples of water quality 2	-3.2211* (1.20444)
Model p-value	0.0116*

*significant at alpha = 0.05

The results indicate that 2005 total coliform count was a significant predictor of the probability of a beach being chosen and that the effect of total coliform count was dependent upon the residence status of the visitor. For the combined population, the presence of the Blue Flag has the expected sign, although it is not statistically significant. As with the model for Croatian non-locals on Krk Island and given the significance of the total coliform count dummy variable, the results in Table 3.16 seem to reinforce the suggestion that water quality as measured by total coliform count is influenced by whether the visitor is a Croatian or a non-Croatian tourist.

In order to determine the WTP for improvements in water quality, a simulation was run on a 10-percent improvement in total coliform levels on the Kastela beach surveyed, he most polluted beach and where on-going sewerage projects are underway. The improvement is estimated with the equation:

(3.13) $CV_i = [\ln(\exp(\beta_1 tc+\beta_2 tt+\beta_3 coli\text{-}improve+\beta_4 RWQ+\beta_5 BF+ \beta_6 PPWQ\ dummy + \beta_7 colidummy\text{-}improve) - \ln(\exp(\beta_1 tc+\beta_2 tt+\beta_3 coli+\beta_4 RWQ+\beta_5 BF+ \beta_6 PPWQ\ dummy + \beta_7 colidummy]/ \beta_1$

where *coli-improve* represents the 10-percent improvement in water quality; this will calculate an individual compensating variation (CV) that is then averaged over the entire population. This would mean an improvement from an average total coliform count of 35.8 CFU per 100 ml to 32.22 CFUs per 100 ml. The analysis revealed an average WTP for the combined population of 581 euros per trip. This result must be interpreted with caution as it is well above previous estimates of WTP for environmental improvements in

Croatia and the travel cost coefficient (-.00002, $p = 0.957$) was not statistically significant.

Given these concerns, the same model as equation 3.12 was run again excluding the population of beachgoers that arrived by air, where the calculated per person travel cost relied solely on self-reported survey responses. This exclusion is supported by estimation results of equation 3.12 with air arrivals only as shown in Table 3.16, which indicated a positive travel cost parameter and a large parameter estimate for the reported percentage of samples of water quality 2 (PPWQ). As such, these data may have adversely impacted the modeling of the other visitors.

Table 3.17. Logistic Regression Parameter Estimates for Split-Dalmatia County Including Only Air Arrivals to Croatia

Variable	Combined Population (N=13)
	Parameter estimate (standard error)
Travel cost	0.00004 (0.00006)
Travel time cost	-0.00225 (0.00311)
2005 coliform count	-.53911* (.25122)
Reported percentage of samples of water quality 2	-18.367* (9.143)
Model p-value	0.2855

*significant at alpha = 0.05

Results of the logistic regression estimation using equation 3.12 for the re-analysis excluding the population arriving in Croatia by air are shown in Table 3.18.

Table 3.18. Logistic Regression Parameter Estimates for Split-Dalmatia County Excluding Air Arrivals

	Combined Population (n=94)
Travel cost	-0.0003 (0.0003)
Travel time	-0.0039 (0.0027)
2005 coliform count	-0.0461* (.0252)
Blue Flag	0.3454 (.3803)
Reported 2005 percentage of samples at water quality 2	-0.3006 (1.363)
2005 coliform count dummy	0.0501** (0.0197)
Reported 2005 percentage of samples at water quality 2 dummy	-3.076** (1.227)
Model p-value	0.0360

**significant at the 0.05 level
*significant at the 0.10 level

The parameter estimates on travel time (-0.0039, p = 0.141) and travel cost (-0.0003, p = 0.196) have moved toward statistical significance when compared with the model including air travelers but are still not statistically significant. However, repeating the previous simulation of a 10-percent improvement from equation 3.13 in total coliform levels in Kastela, average WTP for the combined population is 26.67 euros per trip. The dummy variable on total coliform count was positive and significant (0.0501, p = 0.011), indicating that the negative impact of higher coliform levels was not present in the non-local Croatian population. When averaged for non-domestic tourists, the WTP for total coliform count improvements on the worst beach would be 42.86 euros. As an alternative, the addition of a Blue Flag to Kastela was evaluated as a policy objective. This change generated an average population WTP of 133.8 euros per trip; however, the Blue Flag parameter was not statistically significant in this model. These results seem much more reasonable than those estimates that included visitors arriving by air travel.

As for Krk island, RQ5 evaluated whether the odds of revisiting a beach are significantly impacted by the self-reported judgments about bathing water clarity, bathing water health, and beach cleanliness in Split-Dalmatia County.

Table 3.19. Average self-reported water quality by beach in Split-Dalmatia County (n=150)

Beach	Water Cleanliness (higher is better)	Water Health Impacts (higher is worse)	Beach Cleanliness (higher is better)
Banj	3.18	1.12	2.97
Cvitacka	3.22	1.10	3.03
Kastela	2.52	1.48	2.62
Punta Rat	3.79	1	3.48
Zlatni Rat	3.72	1.10	3.21

As the table indicates, Kastela, which was selected as a beach prone to pollution because of its water quality ranking in 2004 to 2005, received the least favorable ratings from people visiting the beach. Punta Rat, a Blue Flag beach, performed the best in terms of the respondents self-reported evaluations and Zlatni Rat, a non-Blue Flag island beach and perhaps the most well known outside of Croatia, ranked second overall. The logistic regression estimating equation 3.8

$$(3.8)\ P(i) = \frac{\exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean)}{\sum_{i=1}^{N} \exp(\beta_1 tc+\beta_2 tt+\beta_3 srwq+\beta_3 srhealth+\beta_4 srbeachclean)}$$

was run using these self-reported evaluations of water quality (srwq = self-reported water clarity, srhealth = self-reported health of bathing water, srbeachclean = self-reported beach cleanliness) as potential predictors of the decision to revisit a beach (P(i)), and results for the model are shown in Table 3.20.

Table 3.20. Results of Logistic Regression Examining Probability of a Repeat Visit (n=135)

Variable	Parameter estimate
Travel cost	-0.0013 (0.0098)
Travel time	-0.0218 (0.0553)
Self-reported water clarity	-0.5805 (0.6212)
Self-reported health of bathing water	-0.7693 (0.5942)
Self-reported cleanliness of beach	1.229* (0.4802)
Presence of Blue Flag	-0.0124 (0.0175)
Model p-value	0.01*

*significant at the alpha=0.05

As the results indicate, self-reported beach cleanliness was the only significant predictor of whether or not people said they would visit a beach again in the future. The sign of the parameter estimate indicates that the cleaner the beach was judged to be, the more likely people were to indicate that they would return. Self-reported health of bathing water had the expected sign since higher values indicate worse evaluation of that parameter, while self-reported beach water quality had an unanticipated, though not statistically significant, negative sign since higher values meant better evaluations of water quality. The interpretation of this variable would be that people were more likely to revisit beaches that they ranked as having worse water quality. Given the fact that these results are not statistically significant, this interpretation should be approached with caution.

3.4. Discussion

The results of this research appear to indicate that water quality can be a significant predictor of beach visitation patterns in certain beachgoing populations. In Split-Dalmatia County, the travel cost model predicted that increases in total coliforms at a beach would decrease the probability of non-Croatian tourists visiting that beach. This agrees with previous findings in the literature concerning the recreational behavior of coastal resource users (Bockstael et al. 1987; Goffe 1995; Sandstrom 1996; Murray and Sohngen 2001; Soutukorva 2001; Johnston et al. 2002; Mourato et al. 2003). While the percent of time that government reported poor water quality (PPWQ) was negative in nearly all of the models, it was positive, but not statistically significant for the non-Croatian tourists to Krk Island (when excluding air travelers). Total coliform count always had a negative sign in the models presented in this chapter. However, on Krk Island the travel cost model could not be run in the Croatian tourist population because of concerns with positive travel cost estimates. In Split-Dalmatia County, the dummy variable, which multiplies 1 times the 2005 coliform count for Croatians, was positive, indicating that Croatian tourists demonstrated an increased probability of visiting beaches with higher total coliforms compared to non-Croatian tourists. This result suggests that water quality as measured by total coliform count is not useful to predict the behavior of Croatian beach visitors. In Split-Dalmatia County, however, the reported 2005 percentage of samples of water quality 2 did demonstrate a negative relationship with the selection of a beach for Croatian non-locals, meaning that the worse that a beach had been ranked by the government, the less likely Croatian non-locals were to visit that beach. The parameters on that variable was not statistically significant, however, and, overall, the non-local Croatian population was the least well explained by the models presented. The reason for this may be that other forces are driving their beach visitation decisions such as tradition, family ties, and/0r familiarity with a particular locale.

Simulations estimated WTP for a 10-percent decrease in total coliform count ranging from 21.18-41.26 euros per trip, depending on the population considered. These values exclude the WTP results in Split-Dalmatia that included air travelers, given the abnormally high per trip values obtained when including this group. Still, these estimates of WTP are greater than that estimated from a previous study on the island of Hvar, which indicated a WTP of 0.68 euro cents for non-Croatian visitors for environmental improvements (Taylor et al. 2003). It is possible, however, that a more specific focus on a quantifiable water quality improvement would result in increased WTP in a contingent valuation survey since respondents would have a better idea of the good for which they would be paying.

Blue Flag was never a significant predictor of beach visitation behavior in the visitor population, although it had the anticipated positive sign in Split-Dalmatia County, meaning presence of a blue flag increased the probability of a beach being chosen. Interestingly, the Blue Flag parameter was negative, while not statistically significant, on Krk Island. This may be because the data was aggregated over beaches in the entire town on the island of Krk rather than on an individual beach level; the higher-level evaluation may have obscured the underlying local beach visitation patterns within a town. This may also be why the models on Krk Island did not perform as well as those in Split-Dalmatia County despite the larger sample size. Two potential reasons why Croatian and non-Croatian visitors may not regard the Blue Flag program highly include (1) anecdotal evidence that Croatians do not place much faith in the Blue Flag program, several indicating to the researcher that there are beaches with better water quality that have no Blue Flag, or (2) domestic and non-domestic tourists seeking to avoid destinations that are geared toward attracting large numbers of foreign tourists by participation in the Blue Flag program.

In terms of RQ 3, local knowledge appears to have some role in predicting the beach visitation decisions made by foreign and domestic tourists. Interestingly, non-domestic tourists and domestic tourists seem aligned with local information about health risks from the water. The magnitude of the impact of local health ranking seems to be greater for the non-domestic visitors; this seems surprising since one would expect that local knowledge would transfer most readily to the domestic population. One possibility is that domestic visitors may be aware of health impacts but choose to ignore that knowledge in favor of traditional beach visitation sites. Another option is that the facilities that are most successful at attracting tourists from the furthest distances are located in the more pristine locations or those locations where local reputation did not adversely impact the development of the tourism industry. Non-Croatian visitors may also seek out information from locals concerning the most desirable locations for beachgoing.

Although the correlation and chi-squared analysis for RQ4 did not indicate any difference in beach selection choice for residents of Omisalj and non-residents of Omisalj, it is interesting and somewhat supportive of the concept of local knowledge to note that nearly two times as many residents of Omisalj chose the higher water quality location while non-residents are split nearly evenly between the two locations. A larger sample size may have possibly resulted in observation of a significant difference between the resident and non-resident populations. This observation is somewhat contradictory to the notion that Croatians may be choosing traditional sites rather than the better water quality site. However, it is important to remember that this research question was addressed on a local scale in one town with two beach locations within 5-10 minutes of each other. Given the close proximity of a high quality site combined with local knowledge of the fact that the site is high quality, Croatians may make that their "traditional" site when visiting a local beach.

The results for the decision to revisit a beach are interesting given the differences in the strength of the models between the two counties. In both counties the rating of beach cleanliness were significant indicators of whether or not people would choose to revisit a beach. Surprisingly, this parameter had an unexpected negative sign on Krk Island; the cleaner a beach was perceived to be, the less likely beachgoers were to say they would revisit this beach. This could be because the water is the most important component of the beachgoing experience in these locations and the beaches are often concrete. On Krk Island the decision to revisit a beach was also significantly related to self-reported water clarity and health of bathing water measures. For these two variables, worse perceptions of water clarity or health of bathing water were related to a decreased probability of indicating the beachgoer would revisit that beach. These results suggest that while characteristics may not necessarily impact the initial decision to visit a beach, what a person sees upon visiting the beach may influence their decision to return to that beach.

When evaluating these results, however, it is important to consider the fact that people are on a vacation and may be hesitant to rank a beach or its water as having poor water quality. All of these self-reported measures, as well as the local rankings, are assuming that the beachgoer was honest and candid in their personal assessments and did not have ulterior motives in their assignment of values.

Limitations

Given the small differences in travel cost, a larger sample size may have assisted in obtaining more significant parameter estimates for travel cost. This would have assisted in the overall significance of many of the models. The presence of positive time costs in the populations on Krk Island seems to indicate potential concerns about the method for estimation of the time travel cost. Much has been written in the literature concerning the treatment of the cost of travel time in recreational demand models(Caulkins et al. 1986; Luzar and Hotvedt 1992; Shaw 1992; Feather and Shaw 1999; McConnell 1999). Multiple authors have suggested using models that more accurately depict the nature of labor force participation of the respondent in order to determine the true tradeoff that they are making between leisure and work. This study may have benefited from the collection of additional data concerning the employment status of the surveyed individuals, which may have allowed for a more accurate estimation of the cost of travel time. The tradeoff, however, would have been increasing length of interview time and the desire of individuals to release additional private information.

An additional limitation of this study was the assumption that individuals were staying in the town where they visited the beach. Although the models were limited to those who indicated they were going to the beach only, it may be that they traveled a significant distance from their hotel to visit the beach. Alternatively, it may be possible that they only traveled a short distance from the hotel to arrive at the beach. As such, assuming that they traveled to the beach from their permanent residence may confound the underlying choices that are being made. Future research could include survey questions about where the respondents are staying and then model their decision of town in which to stay followed by modeling of their subsequent selection of beach.

The study was also limited by the unexpected behavior of the travel cost estimates for those arriving by air in Split-Dalmatia County and on Krk Island. Also, positive travel cost estimates were observed for the Croatian non-local population on Krk Island. Typically, positive travel cost estimates are not observed as this indicates that the more expensive a location is to travel to, the more likely people would be to visit that location. Air travel costs, however, may be an independent decision from the choice of beach; once the choice has been made to travel to Croatia, these costs are considered as the price of enjoying that selected destination. A higher-level model could evaluate the choice of destinations presented to those who eventually choose to travel to Croatia. Future research and studies could continue to evaluate the behavior of those arriving by air as many of the studies in the literature have only focused on users from a confined geographical area (Bockstael et al. 1987; Sandstrom 1996; Parsons et al. 1999; Soutukorva 2001; Hanley et al. 2003; Lew and Larson 2005).

Future Directions

The results obtained from this study suggest that further examination of the role of water quality in Croatia is warranted. While results were not statistically significant in all cases, they provide preliminary evidence of a response of tourists to the quality of the water at beaches. An interesting area for future analysis would be to determine the process of information transfer about water quality from locals to tourists, both domestic and foreign. Does the water quality information transfer to tourists through the development of the reputation of the site? Does the fact that a site had poor water quality preclude the later development of the tourism industry in that locale? While the presence of dirty industry was not found to be statistically significant in this study, it is possible that the presence of dirty industry limits the development of the tourism industry, thereby resulting in less time and monetary investment in the maintenance of the coastal resource. Kastela Bay, where one of the beaches was located, has a history of heavy metal contamination, as described in the introduction. A choice experiment could be used in future research to determine the values placed on removing metal contamination versus improving total coliform levels; previous research has found a WTP for reduction in contaminants other than coliform bacteria (Parsons et al. 1999).

Since the local recreation decision could not be effectively modeled in this study, future research may seek to determine the attributes that guide locals in their decision-making. If they are always choosing the nearest beach, do they vary their behavior depending on the level of perceived risk from the water? It is possible that locals are avoiding use of the water during periods when there are lower water quality results published by the government.

If future studies find supportive evidence for the WTP of tourists for water quality improvements, it may be appropriate for policymakers to consider an economic instrument that would transfer the tourism revenue into infrastructure investments that would match the WTP of tourists for improvements in water quality. Wastewater taxes on tourist facilities are one potential mechanism, although implementation of additional taxes is often difficult from a political standpoint. An additional challenge in developing this instrument would be the fact that it seems that domestic tourists do not enjoy the benefits of water quality improvements in the same way as foreign tourists, As a result, distributional impacts of a tourism tax or similar measure would need to be considered.

Chapter 4: Tourism, Wastewater Discharge, and Total Coliform Levels

4.1 Introduction

Tourism can bring numerous benefits to a locale, but can also bring detrimental consequences for the natural environment if the locale is not prepared to accommodate the pressures created by tourists. A Croatian Ministry of Environmental Protection report on bathing water quality acknowledged the pressures placed on the coastal environment by the influx of tourists to Croatian seaside towns during the summer months.(MZOPU 2006) Connection to wastewater systems is limited, and most households rely on septic tanks, which may be ill designed and may not be very effective in the porous karstic geography (Elhatip 1997; Vaute et al. 1997).

Water Quality Impacts of Population Pressures

The interest of this analysis is primarily in the water quality impacts from increased tourism presence and development along the Croatian coast. Previous studies have evaluated the role of the development of land upon nutrient concentrations observed in coastal waters (Tong and Chen 2002; Jordan et al. 2003; Weller et al. 2003; White et al. 2004). Urban and agricultural land uses may be expected to contribute nitrogen and phosphorus loadings to the coastal environment because of the increased impervious surfaces and surface runoff in urban landscapes and fertilizer application and animal wastes on agricultural lands. Significant increases in nitrogen and phosphorus loading have been observed with increasing urban development, and it has been suggested that decreasing the amount of nitrogen from cropland land use may be counterbalanced by increases in urban land use (Weller et al. 2003). Other research suggested that rain events were important in determining whether distance from drainage locations resulted in significant increases in measured nitrate and orthophosphate levels (White et al. 2004).

In addition to analyses of nutrient fluxes from developed land, some studies have addressed the relationship between coastal land use and coastal bacteriological measures (Mallin et al. 2000; Lipp et al. 2001; Kelsey et al. 2004). Since coliform levels on beaches in Croatia can have an impact on the availability of a beach to the beachgoing population, this is of primary interest in this analysis. Beaches that are closed because of poor water quality are removed from the choice set of the visitor and may consequently impact the utility of the beachgoer visit.

Analysis of urbanization using regression analysis in a tidal creek system in North Carolina revealed a strong relationship between the percentage of impervious surface area and the enteric bacteria concentration observed (Mallin et al. 2000). Notably, 95% of the variance in estuarine fecal coliform level was explained by the percentage of impervious surface in the watershed. Population alone also performed relatively well in explaining the variance in enteric bacteria levels (85% of the variance explained). This suggests that population can be a relevant factor in explaining offshore water quality.

Research conducted in Murrells Inlet in South Carolina using multiple regression combined with GIS analysis revealed that distance from septic tanks as well as measures of urban area and 48-hour and 14-day rainfall were significant predictors of fecal coliform levels (Kelsey et al. 2004). These measures explained between 45% and 50% of the variability in fecal coliform levels depending on the season, reinforcing the notion that population and development pressures on coastal land can lead to deterioration in water quality. The authors of this study, however, did not feel that septic tank distance was the driving force behind fecal contamination, instead stating that urban stormwater runoff and pet wastes may be the most significant contributors to the observed fecal coliform levels. Other research has indicated significant inputs to fecal coliform from stormwater runoff, fowl, and contribution from septic systems to fecal coliform levels in groundwater, depending on the soil type and design of the septic system (Weiskel et al. 1996; Lipp et al. 2001).

In tourist areas, the population increases, often dramatically, during the summer bathing season; this is certainly the case in Croatian resort towns. Previous work using correlation and regression analysis in the Red Sea and along the coast of Greece have revealed an increase in bacterial levels during the tourist season (Maipa et al. 2001; El-Shenawy and Farag 2005). One study in Morocco suggested a link between wastewater output and bacterial levels, while not statistically testing this hypothesis (Mimouni et al. 2002). Research of beaches in Mauritius indicated that the most contaminated site was in a sheltered, highly urbanized location with a discharge pipe in close proximity (Daby et al. 2002). Using stable nitrogen isotope tracer methods, McClelland et al. (McClelland et al. 1997) suggested that an elevated $\delta^{15}N$ signal may be indicative of wastewater inputs to the Waquoit Bay in Massachusetts and propose a role for enrichment of this tracer as an indicator of wastewater N sources to estuaries. Additional work has suggested that sites may be clustered between high salinity/low bacterial indicator sites and low salinity/high indicator sites; this may result from either dilution with coastal waters or direct negative impact of saline levels upon wastewater inputs (Lipp et al. 2001). Taken together, this research indicates that wastewater output from human population pressure may be a significant factor in explaining offshore bacterial contamination variability.

For Croatia, wastewater infrastructure is a pressing problem. Less than half of Croatia's population is estimated to be connected to a sewerage system, primary treatment is extremely limited, and secondary or tertiary wastewater treatment is almost nonexistent. This means that the vast quantity of wastewater passes into coastal waters with removal of only large debris and no treatment for bacteria, nitrogen, or phosphorus removal.

As detailed spatial data including land use, current flow, and distances are currently not available in most tourist locations in Croatia, this chapter will use two multiple regression approaches to determine: (1) if there is a relationship between the volume of measured wastewater discharge for three locations along the Croatian coast and total coliform levels; and (2) if there is a relationship between tourist and residential numbers and total coliform levels. These regressions will answer the following research question:

RQ6: Are monthly wastewater discharge measures, residential population numbers, or tourist population numbers significant predictors of proximate total coliform measures?

The results of the analysis performed in this chapter will be used in the ecologic component of the ecologic-economic model developed in Chapter 5.

4.2. Material and Methods

4.2.1. Statistical Models

A multiple regression was used to determine the impact of monthly wastewater flows upon total coliform levels along beaches located in the town with the wastewater discharge outfall. Previous studies have employed linear models to evaluate the relationship between land-based factors (e.g., degree of urbanization, type of land use) and measures of water quality (Mallin et al. 2000; Lipp et al. 2001; Jordan et al. 2003; Weller et al. 2003; Kelsey et al. 2004). As the previous chapter focused on how total coliform levels influence the beachgoer visitation decision, the model utilized in this analysis will consider the impact of wastewater flows into the coastal environment on total coliform levels on beaches in the vicinity of the discharge location. The model is

$$(4.1)\ Coli_{it} = \beta_o + MWD_{it}(\beta_1) + PC_{it}(\beta_2) + PA_{it}(\beta_3) + PI_{it}(\beta_4)$$

where $Coli_{it}$ is the total coliform level on beaches in town *i* (where the wastewater treatment plant is located) at time *t*, MWD_{it} is the measured monthly wastewater discharge in town *i* at time *t*, PC_{it} is the percent of residents connected to the wastewater treatment system in town *i* at time *t*, PA_{it} is the average monthly precipitation in town *i* at time *t*, and PI_{it} is the monthly average precipitation intensity in town *i* at time *t*. The former precipitation variable measures the average intensity of precipitation events during a month while the latter measures the overall average precipitation in a month.

While wastewater outflow may prove to have a strong direct relationship upon proximate bathing water quality monitoring locations, tourist and residential numbers might also be expected to increase bacterial levels along local beaches given previous research about the impact of urban land use on water quality parameters. While impervious surface and land use data are not available for the study area, tourist and residential numbers may serve as a proxy for the level of development and residential/tourist infrastructure in a locale. Since tourist numbers and residential numbers are available for more locations than monthly wastewater data, an additional multiple regression was run testing the impact of tourist and residential numbers upon bacterial levels on the town's beaches. The model takes the form of a two-stage instrumental variable (IV) regression such that the first stage is

(4.2) $T_i=\beta_0+June(\beta_1)+July(\beta_2) + August(\beta_3)+ September(\beta_4)$

where T_i=the number of tourists to town *i* in each month of the summer of 2005 and June, July, August, and September = individual dummy instrumental variables for respective month during the summer of 2005 (May is the reference month). The second stage of the regression takes the form

(4.3) $Coli_{it}=\beta_0+T_{it}\beta_1+PCR_i\beta_2+PUR_i\beta_3+ PA_{it}\beta_4+PI_{it}\beta_5$

Where $Coli_{it}$=the average monthly total coliform level on the beaches in town *i* at time *t*, T_i=the number of tourists in a month to town *i* at time *t*, PCR_i=the number of residents in town *i*, PUR_i=the percent of residents not connected to the sewage system in town *i*, PA_{it}=the average monthly precipitation in town *i* at time *t*, and PI_{it}=the average monthly precipitation intensity in town *i* at time *t*. An instrumental variable regression was selected to control for possible endogeneity in the model: the number of tourists may not only be predictive of the total coliform level in coastal waters, but the total coliform levels in local waters may also impact the number of tourists observed in a given town. As the previous chapter demonstrated, total coliform levels may negatively impact the probability of a beach being chosen for a visit. The months of the summer may be appropriate instrumental variables in equation 4.2 since their relationship to coliform levels should primarily be through the tourist variable.

4.2.2. Data Collection

Monthly Wastewater Data

Monthly wastewater data for the regression analysis in equation 4.1 was available and provided by Hrvatske Vode, the government agency that manages water resources in Croatia, for three stations in Primorsko-Goranska County in Croatia. Although effort is underway to increase the number of stations reporting data on a daily or monthly basis, few plants have the technical capability to continuously monitor flow.

Number of Residents Connected to Wastewater System

The percent of residents connected to the wastewater system was provided by Hrvatske Vode for the towns in the regression analyses. The percent connected will directly be used in the regression in equation 4.1. For equation 4.3, the percent connected will be multiplied by the number of residents in the town to arrive at the number of residents connected to the wastewater system. This value will be used in the regression in equation 4.3.

Number of Residents not Connected to Wastewater System

Knowing the percent connected also allows for determination of the percent of residents not connected to the wastewater system. The percent unconnected to a wastewater system will be multiplied by the total number of residents to estimate the number of residents not connected to the wastewater system, This value will be used in equation 4.3.

Precipitation Data

The precipitation data for this analysis were provided by the Croatian Meteorological Institute. Daily rainfall totals as measured by rain gauges were used for the months from May to September of 2005 in order to calculate average rainfall during the month and average rainfall intensity. Average rainfall was calculated as the total amount of rainfall in a month divided by the total number of days in the month. Average rainfall intensity was calculated by dividing the total amount of rainfall by the number of days with rainfall occurring.

Tourism and Residential Data

Tourism data were provided by the Office of Statistics in Primorsko-Goranska County (for Krk Island data) and by the Office of Statistics in Split-Dalmatia County. Residential data were provided by the Central Bureau of Statistics of Croatia in Zagreb. These data will be used as the monthly tourist and residential numbers in equation 4.3.

4.4. Results

Wastewater Plant Characteristics

Characteristics of the three stations used in equation 4.1 were generally similar. The stations are located in Crikvenica, Selce, and Rijeka, and all are combined sewage stations, meaning that they receive both stormwater runoff and wastewater. Importantly, all only have preliminary treatment of the wastewater with coarse screening for removal of large materials in the wastewater; none of them have sedimentation tanks or any chemical or ultraviolet treatment of the wastewater that could remove bacteria.

Multiple Regression of Impact of Wastewater on Total Coliform Levels

A multiple regression model of wastewater discharge ($m^3 month^{-1}$) on total coliform levels (CFUs/mL) was estimated using random effects estimation for the summer of 2005. Data for measured wastewater discharge and total coliform levels were log-transformed in order to approximate a normal distribution for these variables. Full model results indicated that average monthly precipitation and average monthly precipitation intensity were not statistically significant at $\alpha=0.05$ and were thus excluded from the final model. Running the model without measured wastewater discharge (to consider the potential that the rainfall variables are confounded with the measured wastewater discharge variable in a combined sewage system) did not result in statistical significance for either of the precipitation variables. The use of a random effects multiple regression was an attempt to control for omitted variables that were constant over time but varied between stations as well as those that were constant between stations but varied over time, given the unavailability of land use and other potentially confounding data. Results of the full and limited (excluding precipitation variables) regression analyses are reported in Table 4.1.

Table 4.1. Regression Results for Impact of Wastewater Discharge, Percent of Residents Connected to Wastewater Discharge, Precipitation Intensity, and Monthly Precipitation Upon Total Coliform Levels

	Full Model	Limited Model
ln (Measured Wastewater Discharge)	0.5609* (0.2407)	0.6544* (0.1231)
Percent Connected to Wastewater System	0.0150 (0.0193)	0.0162* (0.0078)
Average Monthly Precipitation Intensity	0.0081 (0.1162)	
Average Monthly Precipitation	0.0001 (0.0016)	
Overall R^2 value	0.7205	0.7164

*Significant at the 0.05 level

As shown in the table, the natural logarithm of measured wastewater discharge was statistically significant, and the model including only this variable and the percent of residents connected to the sewage system explained approximately 72% of the variance in the log-transformed total coliform level. Interpretation of the log-transformed parameter estimate indicates that a 1% increase in measured wastewater discharge resulted in a 0.65% increase in total coliform levels. Results also indicated that a 1-unit increase in the percent of residents connected to the sewage system resulted in a 0.02 % increase in the total coliform level at the monitored beach locations in the town.

Tourism Data Results

To estimate the parameters of the multiple regression model that used tourism numbers as a predictor, it was necessary to obtain monthly tourism numbers for each of the towns included in the analysis.

Krk Island

The total number of monthly visitors (arrivals month^{-1}) to towns on Krk Island in 2005 is shown in Table 4.2.

Table 4.2. Monthly Tourist Arrivals (arrivals month^{-1}) to Krk Island in Summer of 2005

	Month				
Town	May	June	July	August	September
Baska	8583	17580	37344	38909	11366
Krk	10562	15910	39405	41975	14020
Malinska	3285	5965	18565	19958	4446
Omisalj*	9376	15293	28994	28688	12974
Punat	8104	13049	28906	32636	9191

*Government tourism figures combine data for Omisalj and Njivice since Njivice is considered to be a settlement within Omisalj.

These data demonstrate that the tourism numbers to the towns on Krk Island peak in July and August. Krk received the highest number of visitors while Malinska received the lowest number of visitors. However, numbers of tourists for Omisalj also include figures for the settlement of Njivice so each of these towns likely received a number of visitors similar to, or less, than Malinska.

Split-Dalmatia County

The monthly distribution of visitors to the towns where beach surveys were conducted in Chapter 3 and where both total coliform and residential data were available is shown in Table 4.3.

Table 4.3. Monthly Tourist Arrivals (arrivals $month^{-1}$) for Study Towns in Split-Dalmatia County During 2005

	Month				
Town	May	June	July	August	September
Bol	4377	7270	18269	18095	9236
Brela	6101	8675	16820	16240	7797
Gradac	2091	10710	27107	25106	7731
Hvar	11334	22657	33367	34046	21120
Kastela	3748	5411	10523	10237	5424
Makarska	6178	10705	28464	28085	9995
Omis	2926	8592	22761	24829	6311
Podgora	7994	16154	34694	33558	12967
Supetar	3963	6197	14141	14173	4857
Tucepi	6801	8805	18982	18733	9698

As these numbers indicate, there is a marked increase in visitors to towns and cities in Split-Dalmatia County during the summer season (peaking in July-August), allowing for testing of the relationship of these increases to bacteriological parameters. The data also reveal that, of the towns where the study beaches were located, Makarska received the highest number of visitors and Kastela the least. The town of Podgora, not included in the surveys in Chapter 3, received the highest number of tourist visits.

Two-stage Multiple Regression of Impact of Number of Residents and Tourists upon Total Coliform Levels in Coastal Waters

The results for the two-stage instrumental variable regression of residential and tourism numbers on total coliform levels are shown in Table 4.4. As with the previous multiple regression using wastewater discharge measures, average monthly precipitation intensity was not statistically significant at the $\alpha = 0.05$ level and was thus excluded from the final model. Tourist numbers, resident numbers (both connected and unconnected), precipitation variables, and total coliform levels were log-transformed to approximate a normal distribution for each of these variables.

Table 4.4. Results of Two-Stage Instrumental Variable Regression of Total Coliform Levels on Overall Numbers of Tourists, Numbers of Residents, Average Monthly Precipitation Totals, and Average Monthly Precipitation Intensity

Variable	Full Model	Limited Model
ln (tourist numbers)	0.6081* (0.2138)	0.6178** (0.2333)
ln (connected resident numbers)	0.9938 (0.6226)	0.9846** (0.2757)
ln (unconnected resident numbers)	-0.3350 (.4474)	-0.3362* (0.1982)
ln (average monthly precipitation total)	0.9336* (0.3476)	0.5021** (0.1936)
ln (average monthly precipitation intensity)	-0.0673 (.0535)	
R^2	Within town comparison: 0/2410 Between towns comparison: 0.3223 Overall: 0.2617	Within town comparison: 0.2181 Between towns comparison: 0.2777 Overall: 0.2441

**significant at $\alpha = 0.05$
* significant at $\alpha = 0.10$

The first-stage regression results for the limited model suggest that use of dummy variables for each of the months with May as the reference month resulted in statistically significant instrumental variables ($\chi 2=270$, $p < 0.001$). The full model was modified as shown above to remove precipitation intensity given its lack of statistical significance. Results of the second-stage regression (shown in Table 4.4) using this limited model reveal that tourist numbers, resident numbers connected and not connected to the sewage system, and average monthly precipitation totals were statistically significant predictors of total coliform levels. As these are log-transformed values, results indicate that a 1%

increase in tourist and connected residential numbers resulted in a 0.62% and 0.98% increase in total coliform levels, respectively. Results indicated that the number of residents not connected to the wastewater system had an inverse relationship with total coliform; a 1% increase in residents not connected to the sewage system actually led to a 0.33% decrease in total coliform levels observed at the town monitoring stations. Unlike the previous model (equation 4.1, Table 4.1) using measured wastewater discharge model, the average monthly precipitation variable was statistically significant and indicated that a 1% increase in average monthly rainfall resulted in a 0.50% increase in total coliform levels in the town. Despite the significance obtained for these variables, the overall R^2 value for the model is 0.2441, suggesting that only 24% of the overall variance is explained by the variables included in the model. Further, the model variables performed better in explaining the variability of coliform levels between towns than within towns (see last row, Table 4.4).

4.5. Discussion

The multiple regression results provide preliminary evidence that measured wastewater discharge can be a significant predictor of the total coliform levels observed in the Croatian coastal environment. The percent of residents connected to sewerage was shown to be a significant predictor of total coliform levels observed in the town where the wastewater treatment plant is located. Interestingly, the results indicated that a higher percent connected resulted in a higher total coliform level. This may result from the fact that the connected system with a single discharge point delivers a more concentrated plume of bacteria than occurs in cases where the contamination is more widely distributed through an unconnected system of septic tanks. Improvised septic systems may result in a lag between the time of waste discharge and the time at which an effect would be observed. The path of unconnected wastewater discharge is also uncertain, and it may eventually emerge in a location further removed from the location where the waste was generated. Karst flows are through cracks and fissures and the unpredictable nature of flow through these geologic units poses modeling challenges (Vaute et al. 1997). The measured monthly wastewater discharge is a collective volume of water that is specifically, at least initially, delivered to the coastal waters of the town where the discharge is located. As a result, the total coliform levels on the beaches in that town may be more immediately and directly impacted than with the diffuse impacts of unconnected wastewater discharge. The percent of residents connected may also be picking up on the level of urbanization in a location, which would be expected to have a directly proportional relationship to offshore total coliform levels.

As an additional indicator of the impact of population pressures upon bacteriological parameters of nearby coastal waters, the two-stage instrumental variable mixed effects regression revealed that residential and tourist populations can be significant predictors of total coliform levels on beaches in a town. This does not seem surprising since these values may serve as proxies for the degree of development and urbanization in a particular geographic area. Similar to the percent connected results for the model using measured wastewater discharge, the number of residents connected was a statistically significant predictor of offshore total coliform levels. In this case, the number of residents who were not connected to a sewage system was actually inversely related to offshore total coliform levels. This may result from the fact that the unconnected discharge is more diffuse than the concentrated plume from a sewage discharge point. Also, there is no treatment for removal of coliforms at these stations, so, in effect, a concentrated plume of bacteria is being delivered to the offshore environment rather than a diffuse, more random delivery of total coliforms. More information on the type of wastewater collection in those who are not connected to the sewage system would be necessary before drawing conclusions concerning this aspect of the data. As anticipated, higher amounts of precipitation in a month were related significantly ($p < 0.05$) to total coliform levels. These results suggest that the use of population parameters can be used to explain some of the variance in total coliform levels between towns. As more detailed topographic and land use information is collected, it will become possible to consider additional factors specific and particular to each town that may result in variation in total coliform levels.

The lack of a statistically significant impact of precipitation intensity upon measured total coliform levels is somewhat unexpected given the expected role of impervious surface runoff in determining water quality parameters. Previous research has found that rainfall can be a significant predictor of water quality parameters; however, that work involved use of daily rainfall data, rather than monthly aggregate data (Kelsey et al. 2004). As such, it is possible that the averaging of precipitation values over the entire month to arrive at a figure for precipitation intensity has masked the causal relationship between a specific rain event and fluctuations in total coliform levels.

Limitations

The wastewater data are limited by the fact that monthly data are only available for three treatment stations for one summer only. Results will become more robust as additional years and additional wastewater station data become available for analysis. The model of measured wastewater discharge also did not include specific land use and geographic characteristics for the towns where the stations are located as these data are not presently available. Local topography information could provide information about expected rates of runoff in the area, and it may be possible to evaluate interactions of slope with land use type. Additionally, spatial information would be ideal to map the distance from the wastewater outfall to the coliform sampling locations.

An additional limitation is the aggregated nature of the data by month. The analysis might be more focused and specific if data were available on a daily basis concerning the number of tourists and wastewater discharge. If data had been available for both wastewater discharge and tourists in any one town, the correlation between these two variables could have been estimated. As measurements of discharge at the wastewater stations become more prevalent in Croatia, further delineation of this relationship may become possible. Implementation of this data collection is expensive, however, and government resources in Croatia are limited. Additional challenges result from the fact that unreported tourism numbers may lead to underestimation of the actual tourist pressures in any one town; if the person providing a residence to visitors does not report the visit to avoid government taxation, that visit would not be included in numbers to the town.

Also related to potential aggregation challenges, a limitation of the analyses presented arises from the absence of daily total coliform levels that could be related to daily precipitation totals and intensities. If daily total coliform levels were available, the effect of a rain event upon total coliform levels would be more readily distinguished, or at least allow for estimation of lag times between precipitation events and any potential impact on total coliform concentrations. Combining daily coliform levels with information on land use could be used to create a more robust model of the contributors to variation in total coliform levels.

The tourist and residential population numbers are also limited because it is not clear that the reported residential and tourist populations would simultaneously be coexisting within the same space. Residents would be expected to take vacations, and they may actually rent out their home to tourists during that time. Consequently, there may be some variation in the effective total number of residents in each month. Data are not currently available concerning the magnitude of this variation; monthly collection of residential data would require a frequent census and would be difficult to implement.

Future Directions

Future research should work to develop a spatial database of the locations of bacteriological monitoring locations, wastewater pipe outfalls, and coastal land uses. Useful information would also include the location of unofficial drainage pipes and septic tank density and types. As this database grows to include additional information on the coordinates of the beaches and the coordinates of the wastewater discharge point, specific analyses can evaluate how the wastewater discharge impacts beaches depending on their spatial location relative to the discharge point. In addition, continuous monitoring of current flows would be useful in determining how alterations in water flow impact the patterns of total coliform distribution observed from wastewater discharge. Mapping the location of sewage discharge points in combination with current flow would permit analysis of effects downstream from sewage discharge. Theft of monitoring devices currently limits the use of continuous monitoring of current speeds and directions.

Additional future research might also conduct a focused evaluation in a specific town or development that looked at the relationship between septic tanks and total coliform levels. There may be a disproportionate use of facilities with septic systems by tourists versus residents, or vice versa. The specific fate and path of potential contamination from septic tanks would also be interesting to determine, as it would impact the location of the pollution signal in the marine environment.

Finally, future research could entail collection and analyses of total coliform data during periods outside of the typical tourist season. Availability of data for periods when there are not tourists present could allow for improved development of a baseline total coliform levels that could be attributed to the residential population. This would allow for more specific evaluation of the impact of changes in tourism numbers. In addition, the effect of precipitation in the absence of tourist pressures could also be more readily estimated. A challenge of this research would the fact that residents in the off-season may rent their house out in the summer season; this may be addressed by collecting more specific data concerning the informal tourist accommodation market. Despite the challenges of this future direction, the collected information would be useful in determining whether taxes on local residents or taxes on tourist arrivals may be a preferred approach.

The information provided in this chapter has provided preliminary evidence for a relationship between population pressures and total coliform levels. The correlation between tourist and residential numbers and total coliform levels in Table 4.4 will be used as the ecologic component of the economic-ecologic model in chapter 5.

Chapter 5. Interaction of Tourism Industry Growth with Water Quality and Beach Visitation

5.1. Introduction

The previous two chapters developed models to estimate the impact of water quality upon beachgoer utility and the relationship between the number of tourists to a town and the total coliform levels observed on the beaches in that town. The goal of this chapter is to combine the information from those two chapters to create one possible economic and ecologic model of how tourism industry growth can impact the utility of beachgoers over time. Information provided from linkages of economic and ecologic models may be useful to policymakers considering future plans for development of the tourism industry.

Previous research has demonstrated that the particular characteristics of the tourism industry in a given location (type of accommodations, infrastructure investments) may impact the future growth of the tourism industry in that location. A study by Thomas et al. (Thomas et al. 2005) built upon previous research evaluating tourism carrying capacity measures. These researchers evaluated the impact of tourism penetration ratios, used as a measure of the intensity of tourist use of an island, upon the number of visitors to islands in the Caribbean. Results indicated that the islands fell along a U-shaped curve when the penetration ratio for an island was graphed against the change in the number of tourists visiting the island. While some islands with higher penetration ratios experienced declines in tourist numbers, other islands experienced higher tourism numbers in combination with higher penetration ratios. Authors suggest that the location of the island on the U-shaped curve and thus whether greater tourism penetration led to future decline or growth in tourism may be linked to differences in the sustainability of the tourism industry and measures in place to protect the local cultural and physical environment. Those islands having developed policies for protection of the local cultural and physical environment could simultaneously have higher tourist penetration and growth of the number of tourists over time.

Several authors have suggested the importance of linking economic and ecologic analyses, and there have been efforts to link ecologic and economic analyses in the Rhine and Patuxent River basins (Bockstael et al. 1995; van der Veeren and Lorenz 2002). These models have evaluated the use of nutrient abatement practices and their impacts as well as considering the type of land use and its impact upon economic values. By including all of these factors in an integrated analysis, these types of economic-ecologic models attempt to capture all of the factors involved in the system.

As the Croatian coastline is experiencing a surging popularity and growth, the goal of this chapter is to link the results obtained in Chapter 3 and 4 in a preliminary ecologic-economic model. Consideration of the ecological model as well as the economic model will allow for an initial determination of how the two systems may interact. To achieve this objective, the following research question is asked:

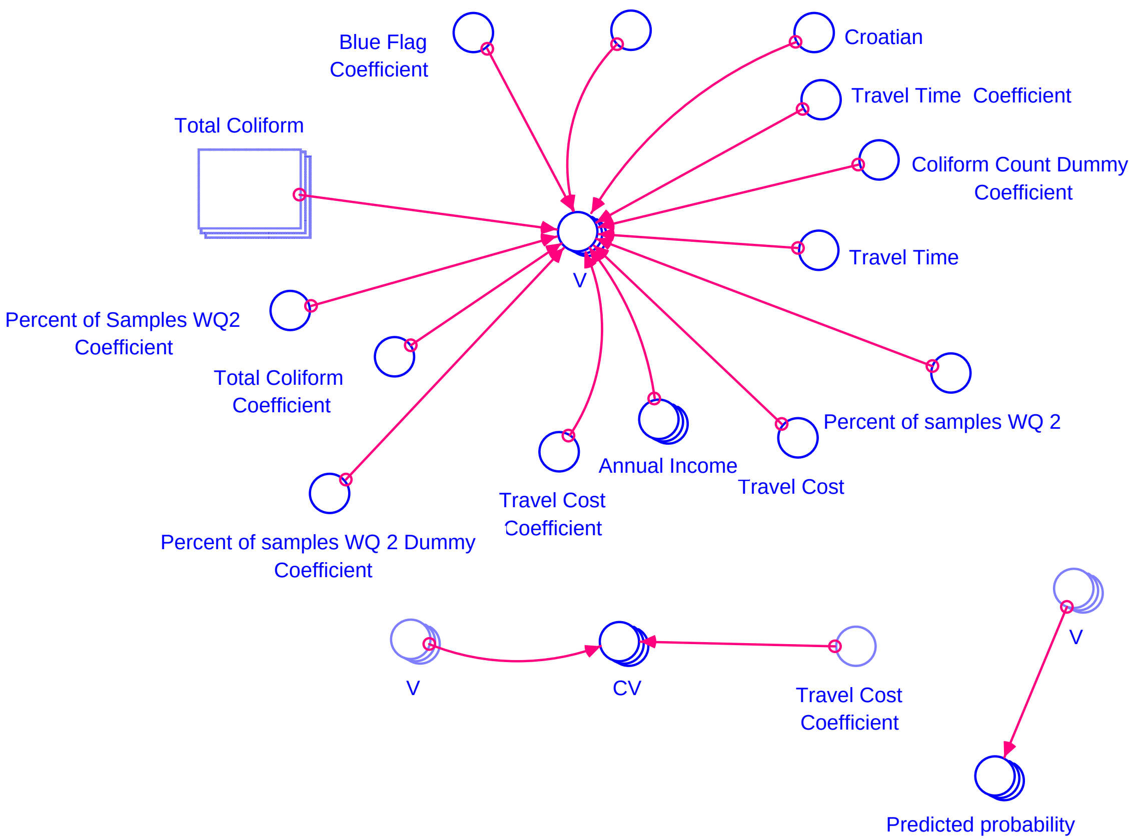
RQ7: What is the impact of continuing tourism industry growth over the next 25 years (at the average 2000-2004 Croatian tourism industry growth rate) upon water quality and the utility to visitors to two hypothetical beaches in Croatia that differ in (1) total coliform levels, (2) sewage treatment levels, or (3) presence of blue flag?

5.2 Materials and Methods

Economic Component

The economic component of this model uses the model estimated for Split-Dalmatia County (excluding air travelers) as this framework demonstrated the most robust results from the logistic regression (see Chapter 3). The economic submodel shown in Figure 5.1 was created by translating the regression parameters as well as coefficients for a hypothetical beachgoer into the Stella® modeling software.

Figure 5.1. Economic Submodel



As shown in the Figure 5.1, the model uses the formula utilized in Chapter 3, calculating

V=Travel Cost*Travel Cost Coefficient+ Travel Time*Travel Time Cost Coefficient + Total Coliform*Total Coliform Coefficient + Percent of Samples WQ 2 * Percent of Samples WQ 2 Coefficient + Croatian*Coliform Count Dummy Coefficient + Croatian*Percent of Samples WQ 2 Coefficient Dummy Coefficient.

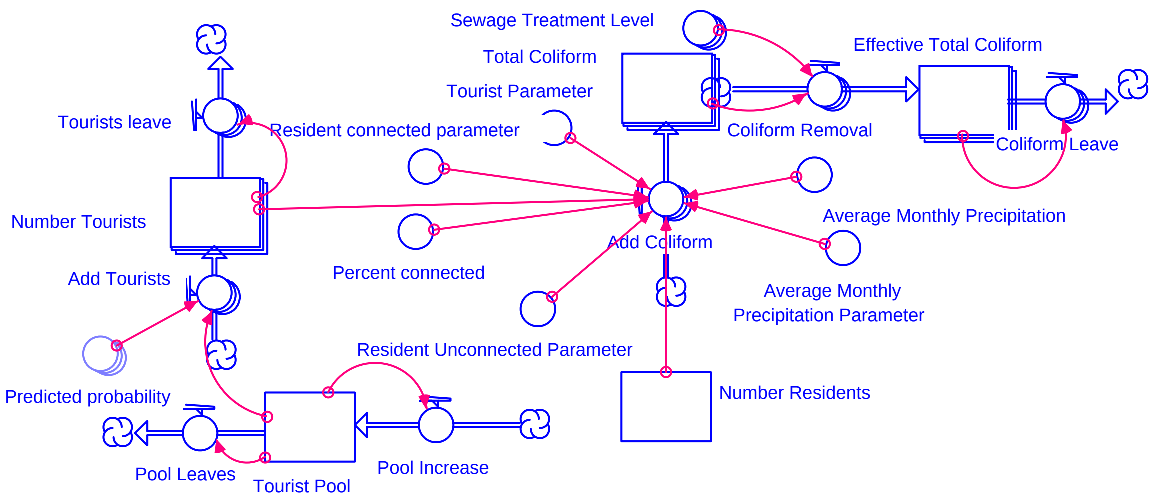
The compensating variation (CV) is calculated as in Chapter 3, as

$\ln(\exp(V_1))-\ln(\exp(V_0)$/Travel Cost Coefficient where V_0=V in the previous year and V_1 = the utility in the current year.

Ecologic Component

Having developed the economic submodel for this analysis, an ecological component was needed to model the changes in total coliform levels that would then impact the economic submodel through the "Total Coliform Coefficient." For the ecologic component, the relationship between the number of tourists and residents developed in Chapter 4 was used for this analysis. This component is illustrated in Figure 5.2.

Figure 5.2. Ecologic Submodel



As shown in Figure 5.2 the model included the variables described in the regression in Chapter 4, which demonstrated that a 1% increase in tourists to a given town in Croatia resulted in a 0.62% increase in total coliform levels on that town's beaches, a 1% increase in connected residents would result in a 0.98% total coliform increase, a 1% increase in unconnected residents (those not connected to the sewage system) would result in a 0.33% decrease in total coliforms, and a 1% increase in average monthly rainfall would result in a 0.50% increase in total coliform levels. This established the ecological relationship between tourism numbers and coastal total coliform levels

Aside from using the variables from Chapters 3 and 4, additional variables were added to link the indirect utility observed in the economic component with changes in tourist numbers in the ecologic component. The "Tourist Pool" variable was added as a measure of the total number of visitors who may choose to visit one of these two hypothetical beaches. Related to this variable, another additional variable is "Predicted probability" estimated by

$\exp(V_i)/\sum\exp(V_k)$

where V_i = indirect utility on beach *i*, and V_k represents the indirect utility observed on other beaches in the choice set. This variable comes directly from the random utility model estimation of indirect utility and can be used to estimate the numbers of tourists from the tourist pool choosing either beach 1 or beach 2 as the beach characteristics are manipulated. This variable provides a direct link between the economic and ecologic components as changes in variables in the ecologic component, such as total coliforms, will impact the predicted probabilities for visitation to the two beaches. The "Effective Total Coliform" variable was added to allow for variation in sewage treatment levels and is equal to the total coliform level minus any treatment that removes total coliforms. If the sewage treatment level is 0, for example, the total coliform and effective total coliform variables would be equivalent.

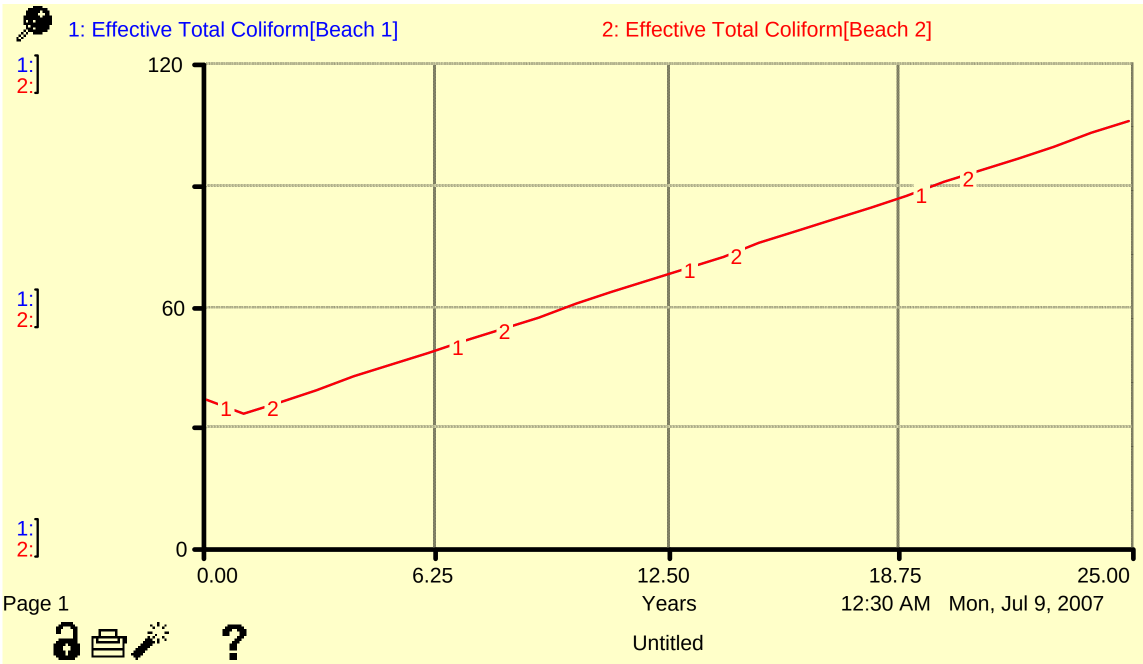
Model Formulation

Stella dynamic modeling software was employed to run the designed integrated model under a scenario where initial tourist numbers were equal at both beaches and separate scenarios where initial tourism numbers were initially greater at beach 2, initial total coliforms were greater at beach 2, sewage treatment levels were greater at beach 2, and percent connected levels were greater at beach 2. The model was run for a 25-year period.

5.3. Results

The initial scenario run on the model was having both of the beaches equal with the initial annual tourism pool of 11600 visitors (approximately two times the average annual number for a single beach in Croatia in 2005) and a tourism pool growth rate of 0.074 (the average growth rate of the Croatian tourist population between 2000 and 2004), an equal number of initial visitors, and an equal bacterial treatment level of 10% percent removal of total coliforms. This level of bacterial treatment was chosen to match the simulated improvement for Split-Dalmatia County in Chapter 3 of this study, and to allow the results to be interpreted as the WTP of the modeled population for a total coliform improvement. The Croatian dummy variable was set to 0 to indicate that the economic component is modeling the average non-Croatian tourist—the group that was negatively impacted by the increase in total coliform levels, as developed in Chapter 3. The travel cost, travel time, and blue flag variables were set to 116 euros, 6 hours, 3, and 0 (no Blue Flag present on either beach), respectively. The numbers for travel cost, travel time, and percent of samples at water quality 2 were selected as these are the averages for the Split-Dalmatia County analysis conducted in Chapter 3. Percent of inhabitants connected was set to 69 percent (the average for towns used in the Chapter 4 analysis) and average monthly precipitation to 3.68 mm (the average monthly precipitation for the surveyed beaches in Split-Dalmatia County during 2005). As Figure 5.3 indicates the graph of the total coliform level is equal for both beaches in the initial simulation. The graph shows that effective total coliform levels are increasing at both beaches over time as the tourist numbers grow at both beaches. Since total coliform count is equal, both indirect utility, CV, and predicted probability of beach visitation also are equal, as these variables rely on the "Effective Total Coliform" variable in their calculations.

Figure 5.3 Total Coliform Levels at Beach 1 and Beach 2 Under Equal Initial Conditions

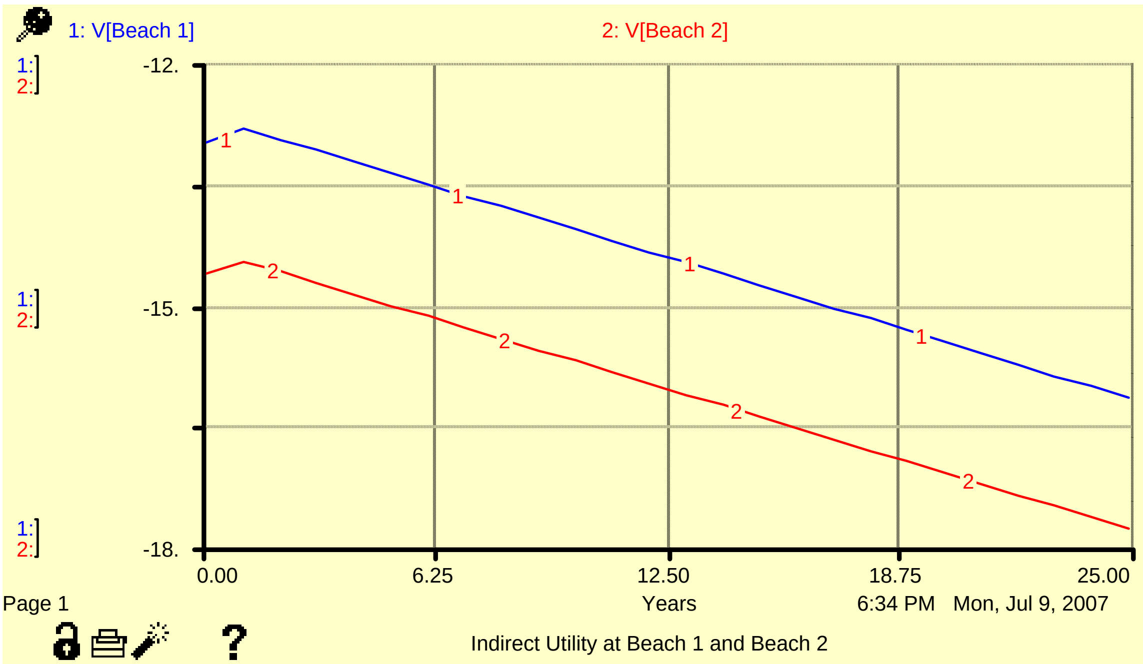


As Figure 5.3 demonstrates, the total coliforms increase over time despite the 10% sewage treatment occurring at both beaches.

Higher Baseline Total Coliform Count on Beach 2

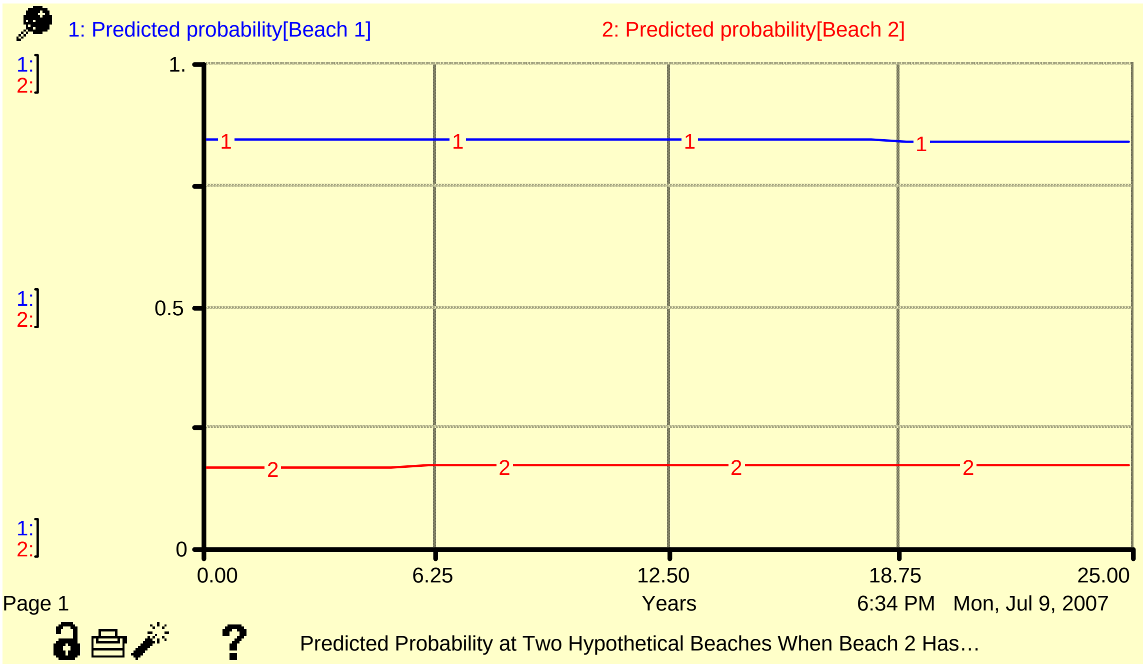
To answer the first component of RQ7 investigating the impact of different effective total coliform levels on beach 1 versus beach 2, baseline effective total coliform levels on beach 2 were increased to twice those on beach 1, or 72 CFUs per mL. The impact of this initial difference on indirect utility at each of the beaches is shown in Figure 3.4.

Figure 5.4. Indirect Utility to Two Hypothetical Beaches When Beach 2 has Persistently Higher Bacterial Levels



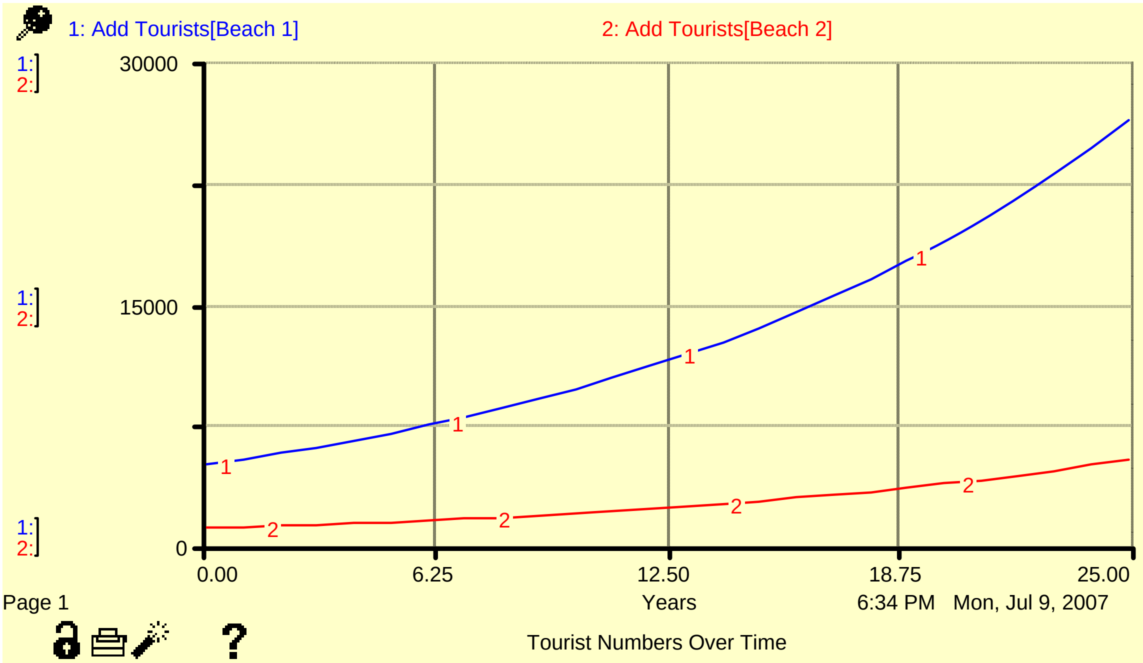
As Figure 5.4 illustrates, the indirect utility at beach 2 is lower over the entire 25-year period as a result of the consistently higher total coliform levels. The lower indirect utility for beach 2 compared to beach 1 would be expected to have a negative impact upon the probability of beach 2 being selected. Figure 5.5 demonstrates how the differences in indirect utility impact the predicted probability of beach visitation.

Figure 5.5. Predicted Probabilities of Beach Visitation at Two Hypothetical Beaches When Beach 2 Has Higher Total Coliforms



As shown, the predicted probability of visiting beach 2 is much lower than beach 1 throughout the 25-year period (14% vs 86%) as a result of the consistently higher total coliform levels and consequent reduced utility. Interestingly there is a slight decrease in the probability of beach 1 being selected as the increasing tourist numbers at this beach lead to an increase in total coliforms over time and decrease in utility. The difference in predicted probability of selection results in dramatic differences in the number of visitors to each of the beaches over the 25-year period (approximately 26,000 visitors at 25 years to beach 1 versus approximately 6,000 visitors to beach 2 at 25 years), as shown in Figure 5.6.

Figure 5.6. Number of Tourist Visits Over Time When Beach 2 Has Consistently Higher Total Coliforms



While the change of the predicted probability is interesting evaluate while assuming parameter estimates from the random utility remain constant, it may be interesting to evaluate how predicted probabilities would change between the two beaches of the total coliform parameter was not constant. To explore this possibility, the coefficient estimate on total coliform was increased from (-0.046 to -0.092), a doubling in its magnitude. This may be hypothesized to occur if beachgoers become even more sensitive to total coliforms in the future, whether through increasing awareness of the total coliform levels on the hypothetical Croatian beaches or increasing awareness of the health risks from total coliforms.

Figure 5.7. Predicted Probabilities of Visiting Two Hypothetical Beaches When Total Coliform Parameter Doubles in Magnitude

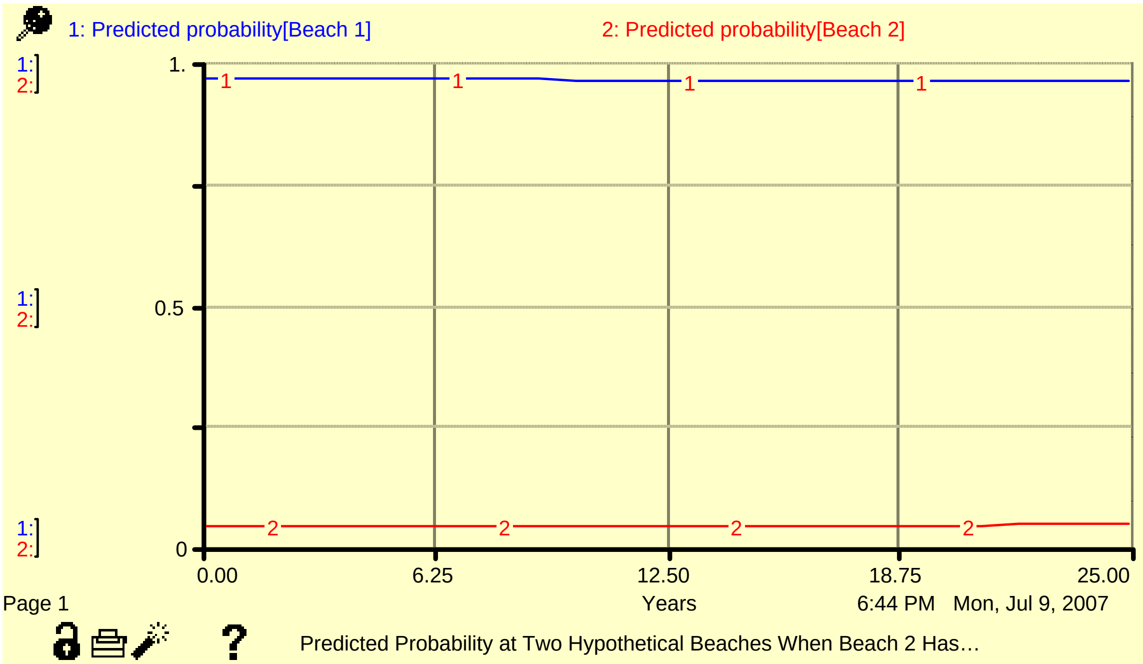
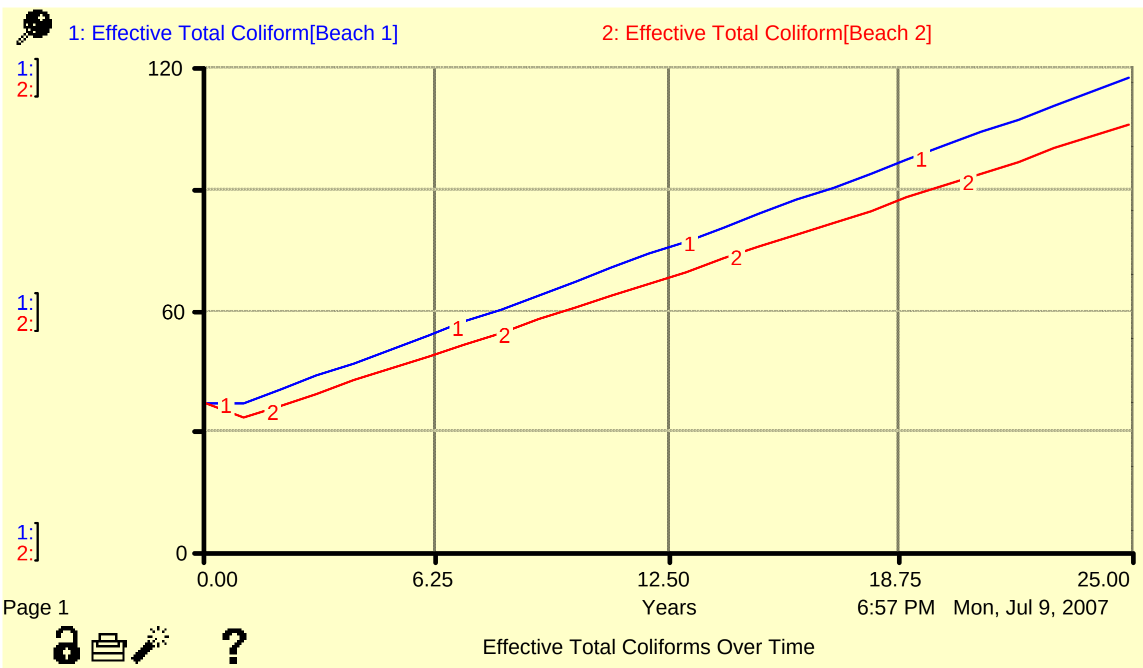


Figure 5.7 shows the impact of the doubling of the total coliform parameter on predicted probabilities and using a consistently higher total coliform level on beach 2. Compared with Figure 5.6, it is clear that there is a larger initial difference between beach 1 and beach 2 (97% versus 3%). This is because the higher total coliform count has a more negative impact upon the beachgoer utility to beach 2 than in the previous model run, resulting in a decreased probability of beach 2 being selected over time. Again, the predicted probability of selecting beach 1 decreases slightly (0.5%) over the 25-year time period as increasing tourist numbers lead to increasing total coliform levels on beach 1 and decreased beachgoer utility.

Increasing Level of Sewage Treatment at Beach 2

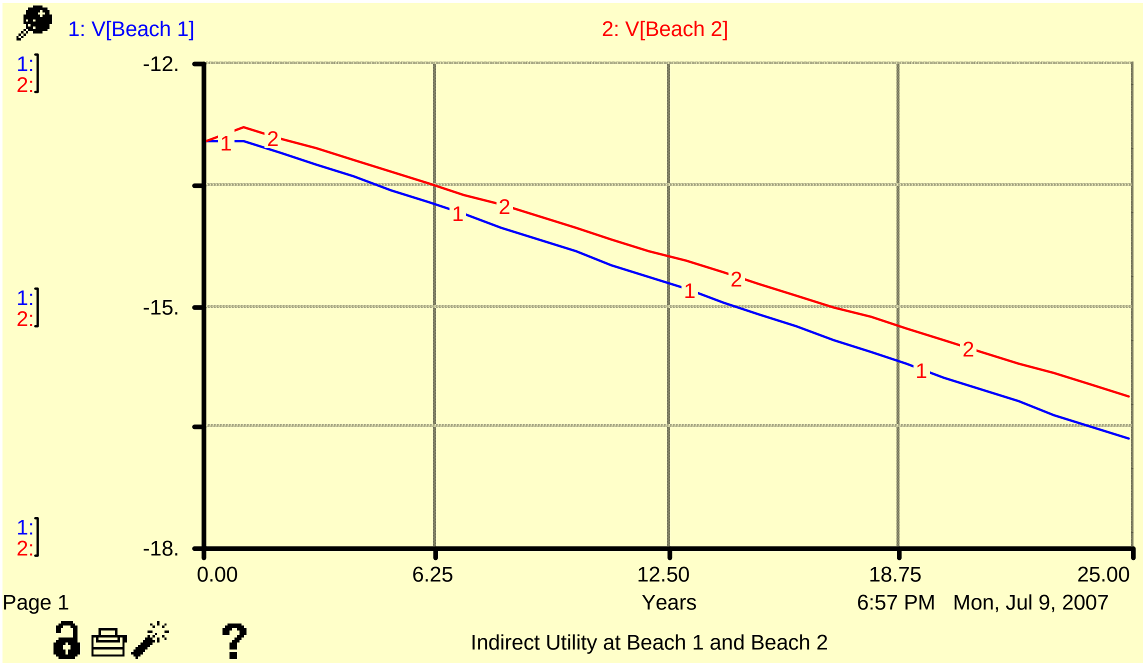
To estimate the second component of RQ7, the model was run keeping all variables the same between beaches, but allowing for an increased sewage treatment level on beach 2. The sewage treatment level was left at 10% on beach 2, compared with no treatment on beach 1. Figure 5.8 shows the changes in total coliform bacteria over time at the two beaches.

Figure 5.8. Total Coliform Levels Over Time With Higher Sewage Treatment at Beach 2



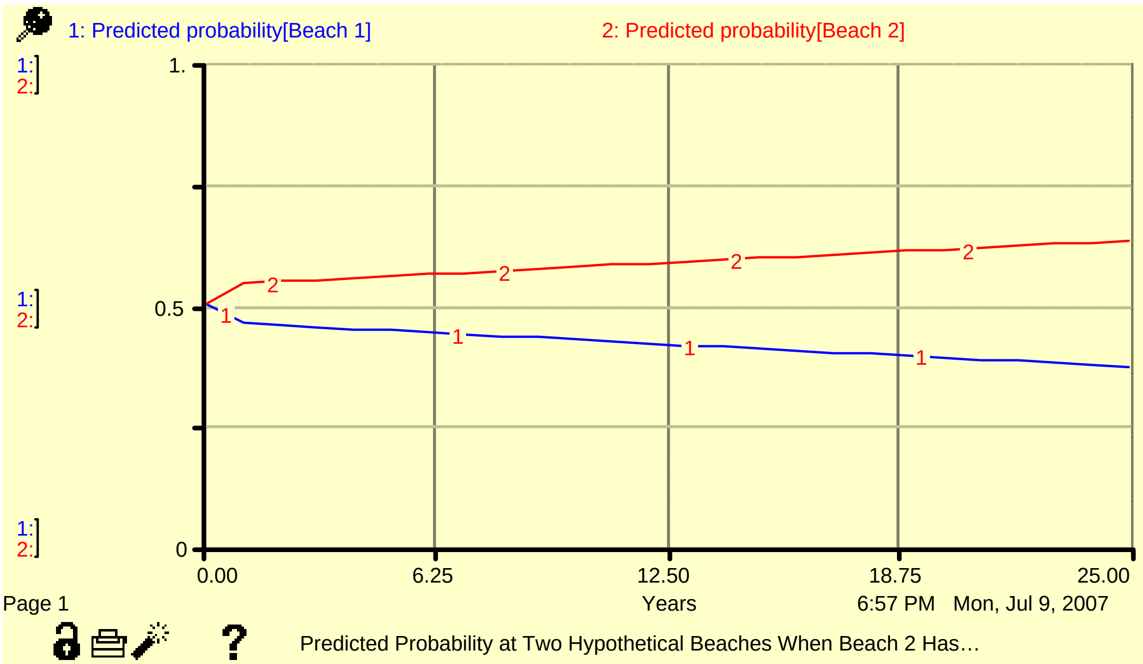
Total coliform is clearly increasing at beach 1 as a result of increasing tourist numbers (as the tourist pool expands) over time and no sewage treatment. While it begins with a higher total coliform level than beach 2, the magnitude of the difference in total coliforms increases over time as the tourist pool expands, even though beach 2 is getting a lower percentage of the tourist pool as visitors over time (see Figure 5.10). Figure 5.9 demonstrates the impact of the differences in total coliforms has upon indirect utility at the two beaches.

Figure 5.9. Indirect Utility Over at Two Hypothetical Beaches When Beach 2 Has a Higher Sewage Treatment Level



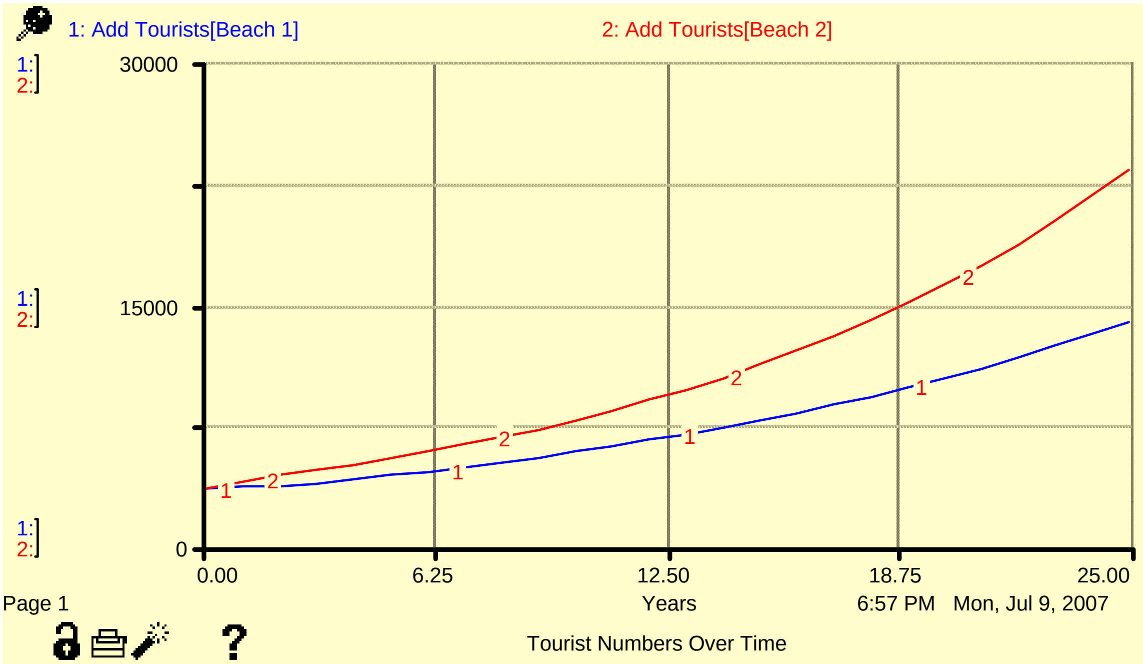
With no treatment for total coliforms, the beachgoer utility at beach 1 is lower than the beachgoer utility at beach 2 throughout the entire 25-year period of the model run. Figure 5.10 demonstrates the impact of these indirect utility differences upon the predicted probability of beach 1 or beach 2 being selected over the 25-year period.

5.10. Predicted Probabilities Over Time When Beach 2 Has a Higher Sewage Treatment Level Than Beach 1



As is evident from Figure 5.10, though the predicted probabilities of visitation were initially identical for both beaches at 50%, the higher total coliform count and lower beachgoer utility at beach 1 led to a decrease in the probability of that beach being selected over time. By year 25, the probability of beach 1 being selected was 37% while the probability of beach 2 being selected was 63%. These differences in predicted probability result in the anticipated differences in total number of tourists over time, as shown in Figure 5.11.

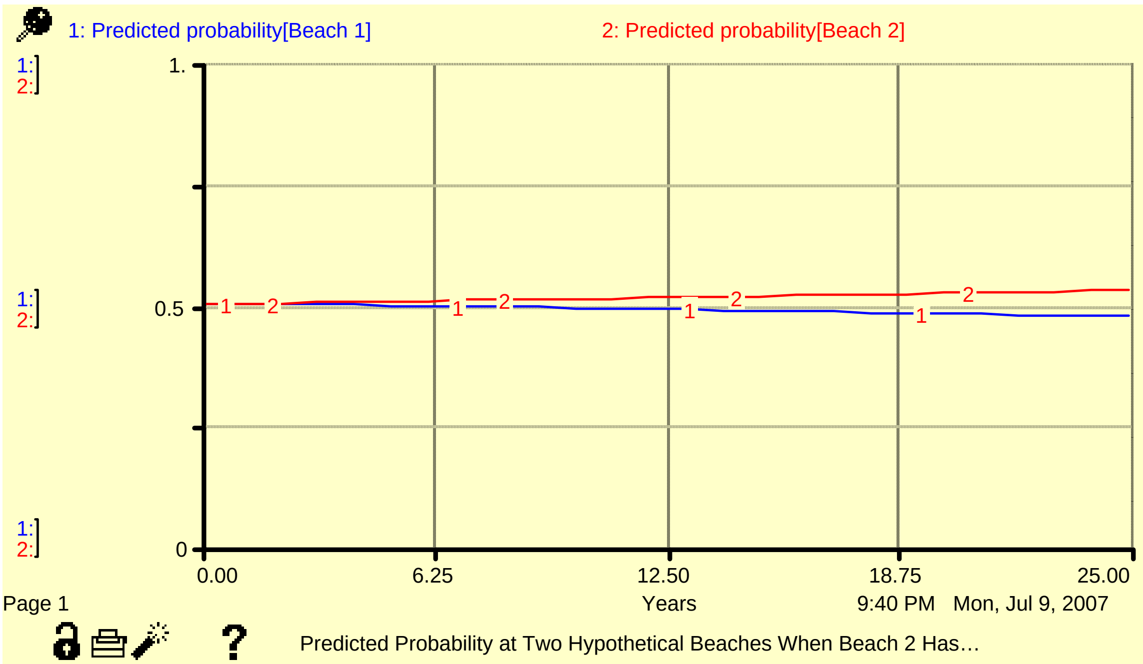
Figure 5.11. Tourist Numbers Over Time at Two Hypothetical Croatian Beaches When Beach 2 Has Higher Sewage Treatment Level



The number of tourists in year 25 is approximately 25,000 for beach 2 and 15,000 for beach 1.

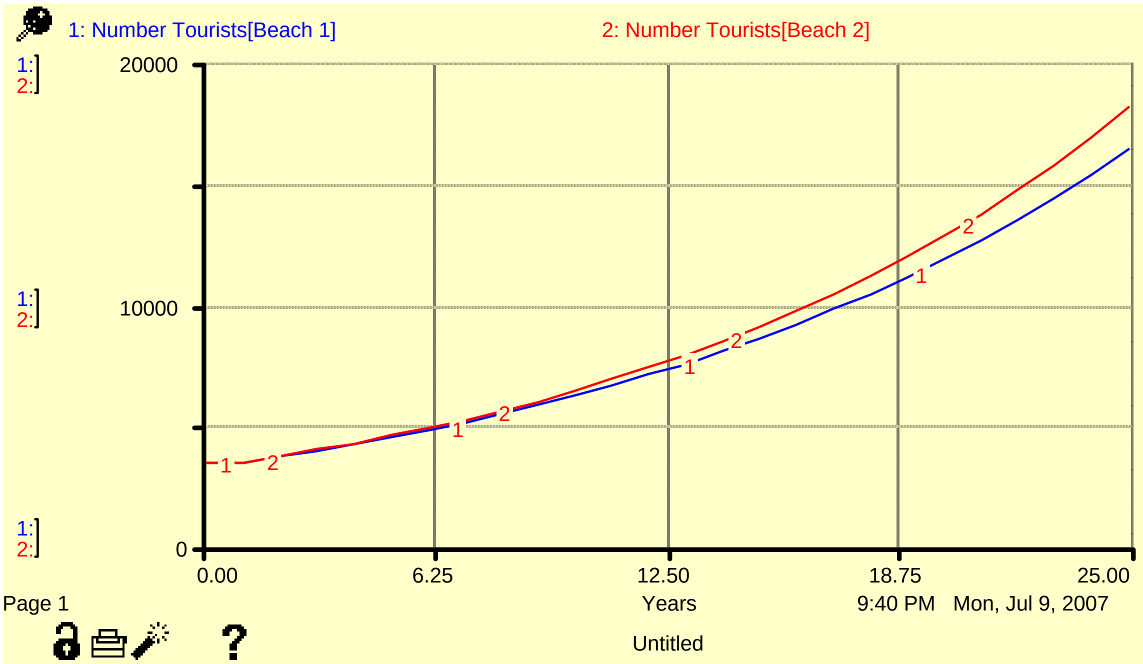
As a separate simulation related to sewage treatment, the impact of a change in the contribution of tourists to total coliform concentrations was estimated by manipulating “Tourist parameter” to halve the magnitude of impact of tourist numbers upon total coliform counts in coastal waters on beach 2. The tourist parameter was changed from .62 to .31, meaning that a 1% increase in tourist numbers now only contributes to a .31% increase in total coliforms, rather than a .31% increase in total coliforms on beach 2. This parameter was left unchanged on beach 1. This change in the parameter may be accomplished in the future by ensuring that tourist facilities are connected to treatment facilities prior to being discharged in coastal waters. This simulation assumes no sewage treatment beyond that which has reduced the impact of tourists on total coliforms.

Figure 5.12. Predicted Probabilities of Beach Visitation When the Tourism Impact Upon Total Coliforms is Reduced on Beach 2



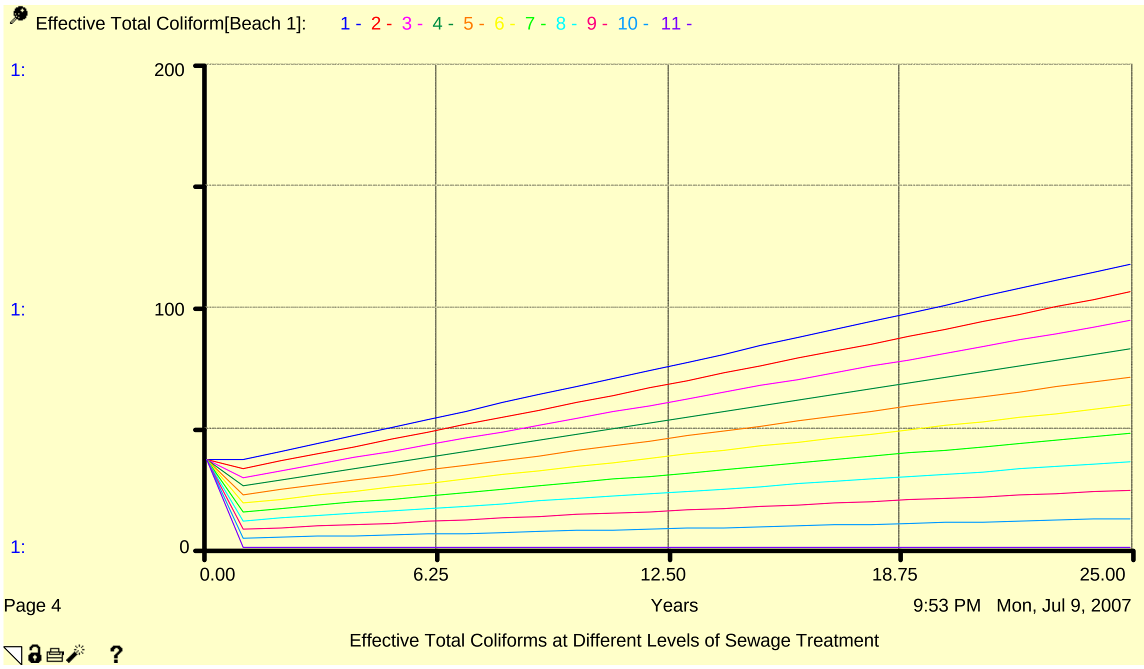
As shown in Figure 5.12, the reduction in the impact of tourists upon total coliforms on beach 2 has led to a decreased probability of beach 1 being selected over the 25-year time period. The difference, however, is less drastic than that observed when beach 2 had a 10% sewage treatment level and beach 1 had no sewage treatment (Figure 5.10). At year 25, the probability of beach 1 being selected is 47% while the probability of beach 2 being selected in 53%. Figure 5.13 also demonstrates that this manipulation resulted in a less drastic difference (compared with Figure 5.11) in tourism numbers on beach 1 versus beach 2 by year 25 (approximately 18,000 versus approximately 16,000 tourists, respectively).

Figure 5.13. Tourism Numbers Over Time When the Tourist Impact Upon Total Coliforms is Reduced on Beach 2



In Chapter 3, a 10% reduction in total coliforms was used to evaluate the WTP of beachgoers for such an improvement. As different levels of sewage treatment other than the 10% simulation used in Chapter 3 may be of interest to policymakers investigating decisions about infrastructure investment, the model was used to investigate the impact of sewage treatment ranging from 0-100% upon total coliform levels on one of the hypothetical beaches. The results of this analysis are shown in Figure 5.14.

Figure 5.14. The Impact of Sewage Treatment Ranging Between 0-50% upon Total Coliform Levels (1 = 0%, 2 = 10%, 3 = 20%, 4 = 30%, 5 = 40%, 6 = 50%, 7 = 60%, 8 = 70%, 9 = 80%, 10 = 90%, 11 = 100%)

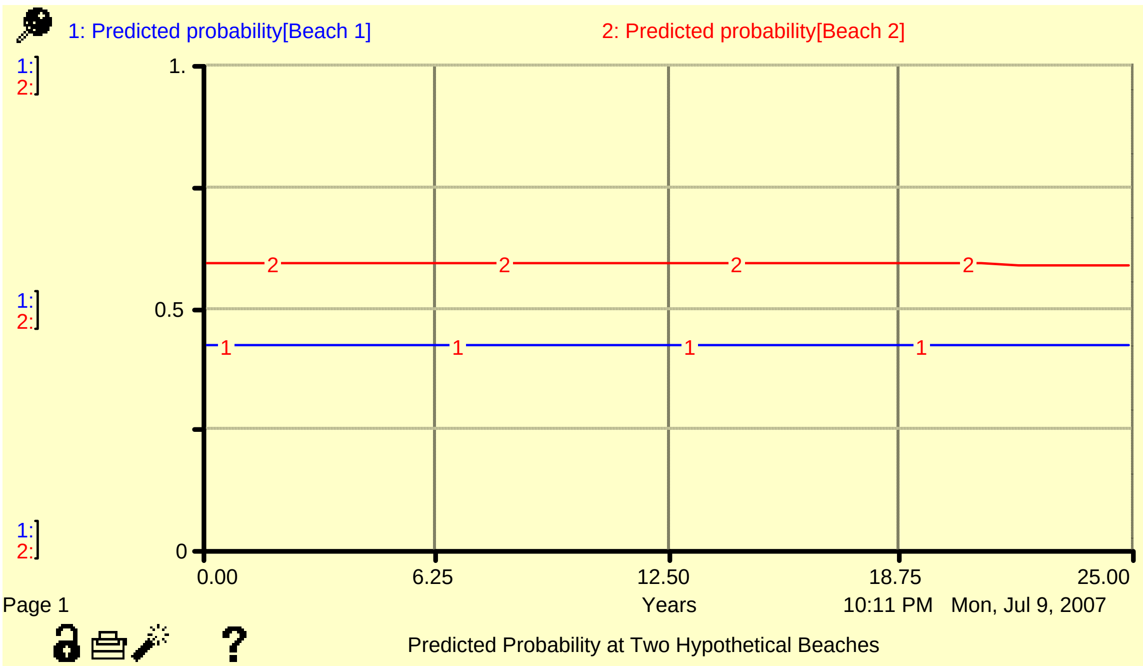


Each of the runs of the model indicates a 10% increase in sewage treatment level, with the blue line representing the initial level of 0%. As shown in the figure, treatment at any level less than 100% is not sufficient to counteract the increase in total coliform levels from increases in the number of tourists. Sewage treatment levels of 20% or higher, however, did prevent total coliform levels from crossing 100 CFUs over the 25-year period.

Addition of Blue Flag to Beach 2

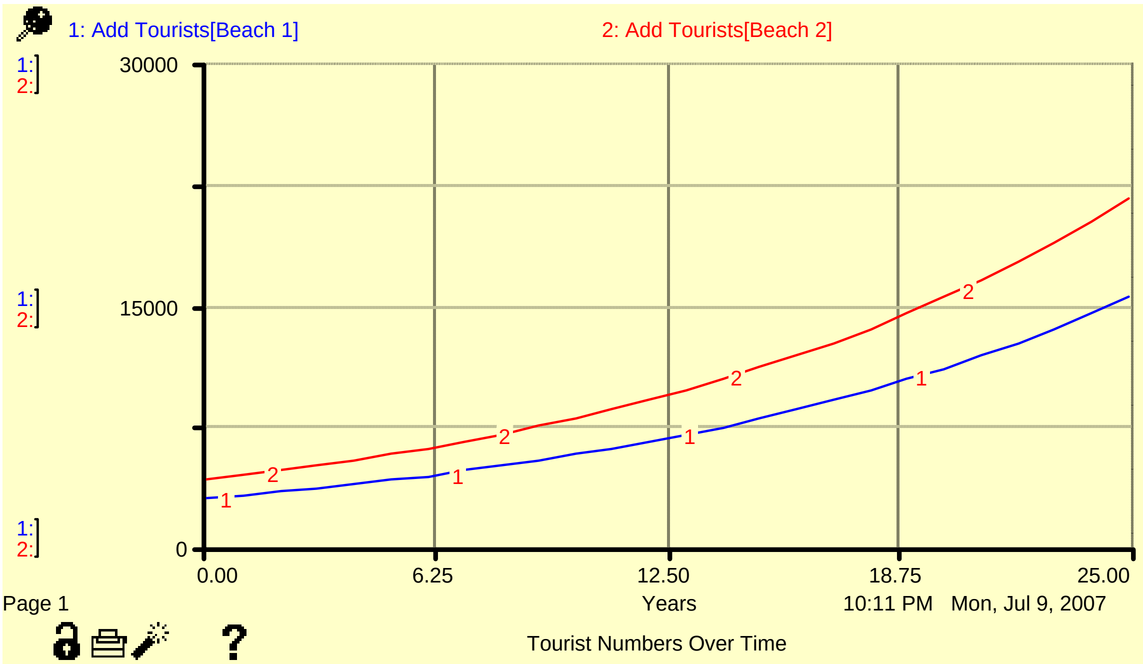
To address the third component of RQ7 investigating the impact of adding a Blue Flag, a Blue Flag was added to beach 2 by changing the Blue Flag variable to a value of 1 for beach 2. The predicted probability results from this simulation are shown in Figure 5.15.

5.15. Predicted Probabilities of Beach Visitation When Only Beach 2 Has a Blue Flag



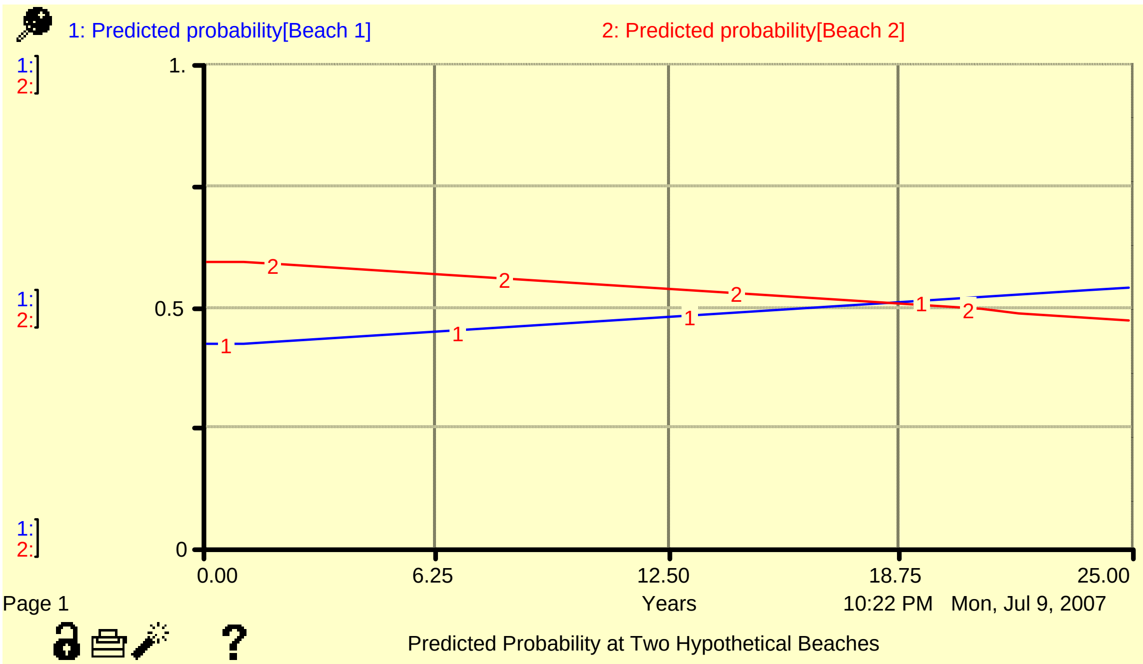
The results in Figure 5.15 indicate that the Blue Flag makes it more likely that beach 2 will be selected throughout the 25-year period of the model run. The predicted probability of beach 2 being selected is approximately 58% while the probability of beach 1 being selected is 42%. There is a slight decrease in the probability of beach 2 being selected over time as the level of total coliforms on beach 2 is slightly higher over time as it receives a greater share of the tourists over the 25-year period (see Figure 5.16).

Figure 5.16. Tourist Numbers Over Time at Two Hypothetical Beaches When Only Beach 2 Has a Blue Flag



The following assumes that the impact of total coliform increases is similar between the two beaches. A separate simulation was estimated assuming that beach 2 is more vulnerable to tourist impacts upon total coliforms than beach 1, perhaps because of its location in an enclosed bay rather than an open coast environment. This was accomplished by making the Tourist Parameter for beach 2 four times that of beach 1, meaning that for a 1% increase in tourists, there is a 2.4% increase in total coliforms on beach 2 compared with a .62% increase on beach 1. The Blue Flag was again assumed to be on beach 2.

Table 5.17. Predicted Probabilities of Beach Visitation When Beach 2 Has a Blue Flag But Also Has an Environment More Susceptible to Tourism Impacts



The results shown in Figure 5.17 are interesting because the predicted probabilities of beach visitation switch during the course of the simulation. While beach 2 begins with a predicted probability of 59%, it has a predicted probability of 47% by year 25. Further exploration of the total coliform (Figure 5.18) and beachgoer utility (Figure 5.19) patterns indicate the reason for this shift in predicted probabilities.

Figure 5.18. Total Coliforms Over Time When Beach 2 Has a Blue Flag But Also Has an Environment More Susceptible to Tourism Impacts

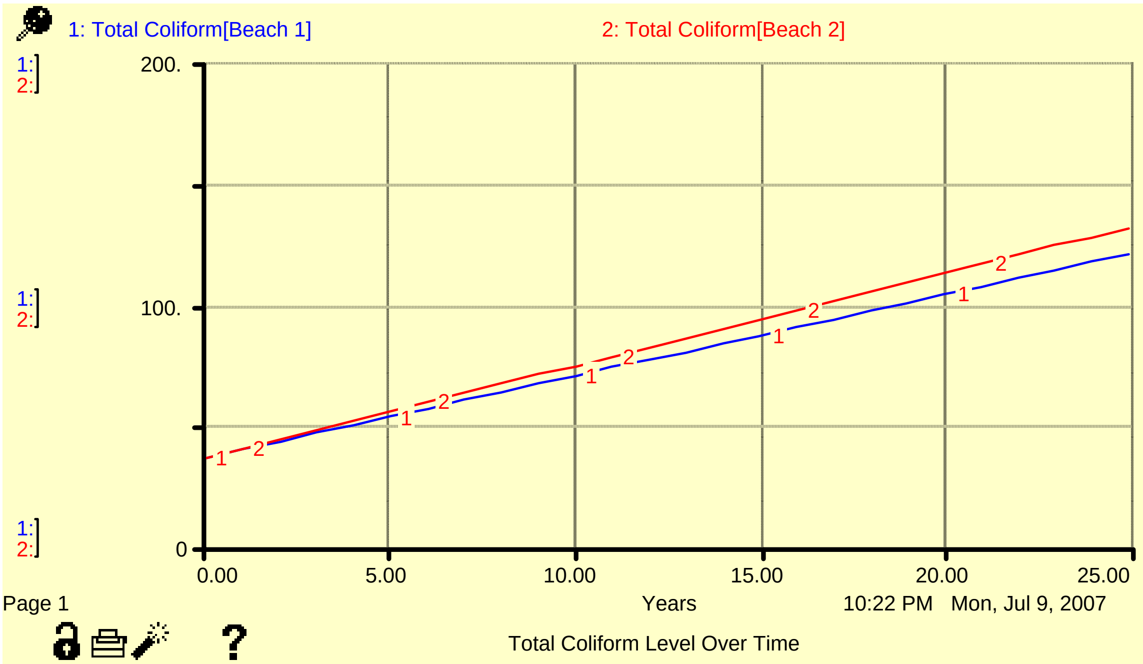
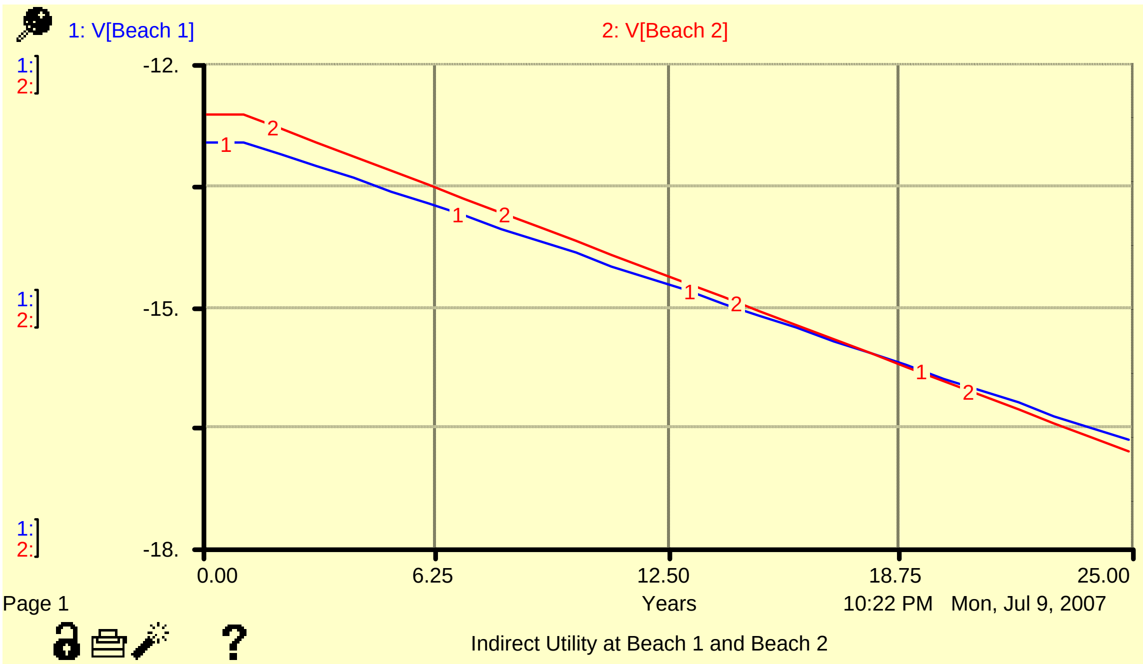
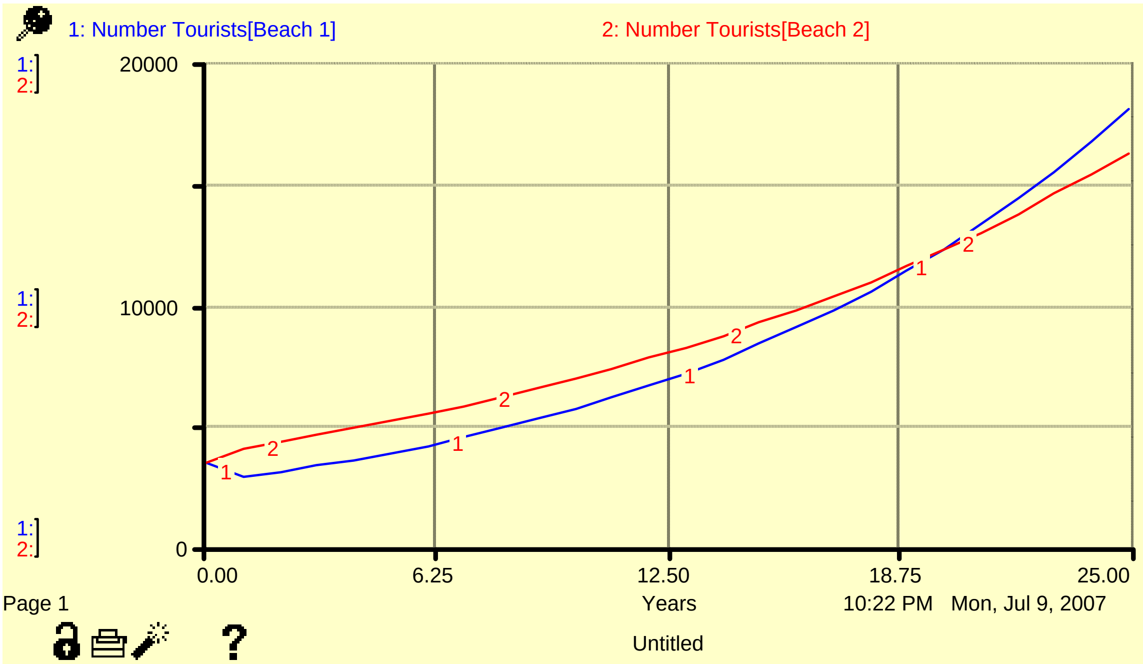


Figure 5.19. Beachgoer Utility Over Time When Beach 2 Has a Blue Flag But Also Has an Environment More Susceptible to Tourism Impacts



As demonstrated by the above figures, total coliform increases at a higher rate at beach 2, driven by the higher tourism numbers resulting from the presence of a Blue Flag (see Figure 5.20). The higher total coliform levels eventually lead beach 2 to have a lower utility to beachgoers than beach 1 and thus a lower probability of being selected.

Figure 5.20. Tourism Numbers Over Time When Beach 2 Has a Blue Flag But Also Has an Environment More Susceptible to Tourism Impacts



5.4. Discussion

The simulation run in this chapter is intended to be a descriptive presentation of one potential manner in which the economic and ecologic components may be combined to evaluate the evolution of the tourism industry over time. The runs of the model demonstrate that there can be shifts in the probability of beaches being selected depending upon the specific characteristics of the beaches over time. In both cases, despite the fact that there is a 10% removal of total coliform levels in the simulation shown, the tourism growth swamps the treatment effect, and the total coliform levels are always increasing (Figure 5.3). This has important implications for the Croatian tourist industry where treatment is, in fact, largely nonexistent. If growth of the tourism industry continues at the average 2000-2004 rate over the next 25 years without a concomitant investment in sewage treatment infrastructure, the integrity of the pristine coastal environment may be at risk and lead tourists to choose alternative destinations in the long run.

The simulation of a higher level of sewage treatment at one of the beaches indicated that the beach that does not have sewage treatment would have a decreasing probability of being selected over time (Figure 5.10). Similar, though less drastic results were observed if one beach was more susceptible to tourist impacts upon total coliforms (Figure 5.12). In both cases, the beach that had lower sewage treatment or was more significantly impacted by tourist numbers had a lower number of tourists over time. This could have important economic implications for the town or region where the beach is located. Fewer tourists would translate to fewer tourist dollars and less economic growth.

The simulation of a range of sewage treatment levels yielded useful information pertaining to the magnitude of infrastructure investment that may be necessary to lead to decreases in total coliform levels over time. Sewage treatment of 20% or greater manages to maintain the total coliforms below 100 CFUs. Increasing levels of sewage treatment decrease the total coliforms to a greater extent. This information could be useful in allocating limited financial resources when a range of investment options are available and a specific coliform target is available.

The final simulation with a Blue Flag was significant in demonstrating the benefits and drawbacks that can arise from increasing tourism growth. While the presence of the Blue Flag led to increased numbers of tourists initially (Figure 5.20), by adding the assumption that the beach where the Blue Flag is located is more susceptible to negative tourist impacts, tourists eventually chose the other beach in the absence of sewage treatment at either beach (Figure 5.17). This information is relevant since community planners will need to consider the consequences of using marketing approaches such as the Blue Flag to drive tourism growth in the absence of concomitant investments in wastewater infrastructure. This observation also points out the challenges that may arise when tourism growth is driven by global forces rather than local forces that may be more aware of the sensitivities of their particular locale.

Limitations

The model relied on multiple assumptions that would need to be verified with on-going data collection over several years. A more detailed evaluation of the functioning of the coastal ecosystem in terms of the relationship between coastal discharge and levels of total coliform in recreational waters is needed. The underlying ecologic model is limited by the fact that the number of tourists to a town only explained a small percentage of the variance in total coliform levels. Focusing on spatially-based measures of the sources of pollution and the monitoring of that pollution dispersal in coastal waters could assist in improving the accuracy of those estimates. These spatial measures, gathered into a GIS database, could provide information on the additional variables, including current flow and direction and wind speed and direction, that may influence the relationship of tourist numbers to coastal total coliform levels. Bockstael has argued that consideration of the spatial characteristics of sites and interaction of variables is important to consider (Bockstael 1996).

The model also restricted the evaluation to two hypothetical beaches. If a group of rational beachgoers judges there to be lower utility at one beach versus another, they would be expected by theory to choose the beach with higher utility in the future. Most likely the tradeoff would be between more than two different beaches, however, and there is some concern with translating measures of individual utility to the visitation behavior of what would be expected to be a range of visitors to each of the beaches. The model offers one potential mechanism to link measures of indirect utility for a hypothetical beachgoer to aggregate behavior by the population of tourists. Further work will be needed to determine if such aggregate-level behavioral "switching" between available beaches would occur. Investigation of a threshold level for beachgoers that leads them to abruptly change behavior in their choice of beach would also be informative.

Future Directions

As with all models, there is constant evolution and modification of the model as new data become available. Future work will entail more spatially specific data that evaluates the ecological functioning of the coastal ecosystem in terms of processing of total coliform. The ecological model is certainly much more complex than that presented above, but data limitations prevent consideration of additional variables for which measurements are not available. There is also the need for future research to look at the relationship between visitation patterns to beaches that differ in water quality over time. This would provide for a more explicit linkage between the decisions of individual beachgoers over time as water quality conditions fluctuate. As with the work done on penetration ratios and the evolution of tourism visits in the Caribbean by Thomas and colleagues, is there a similar measure of environmental damage level that can be used to determine the macro-level movement of tourists between beach locations? Such a measure could be developed by charting the number of visitors over time to beaches that differ in water quality.

The model presented in this chapter is intended as a starting point for further elucidation of the economic and ecologic relationships that should be considered when developing models of tourism industry growth. Continuing specification and refinement of such models could provide valuable information for policymakers as they consider investment and development decisions.

Chapter 6: Summary of the Overall Study and Future Directions

The analysis presented in this study provides a preliminary framework for examining the relationship between tourism industry growth and impacts upon the recreational ecosystem services received by beachgoers in Croatia. The evidence provided in this research highlights a rationale for considering the safeguarding of the marine environment when making development decisions concerning the tourism industry. The specific path of tourism growth and its interaction with the environmental resource base has been shown to have an impact upon the future success of the tourism industry (Thomas et al. 2005), and this study suggests that Croatia may need to consider the maintenance of the quality of its marine resources as tourism growth continues.

The results from Chapter 3 indicated that the total coliform levels on beaches in Split-Dalmatia County were inversely related to the probability of a beach being selected by visiting tourists. Interestingly, this effect did not extend to Croatian tourists, who may instead be hypothesized to choose the beaches they visit based upon family connections or traditional visit locations. Simulation of a water quality improvement in Split-Dalmatia County also indicated that tourists would be willing to pay 42.9 euros for a 10-percent improvement in total coliform levels on the most polluted beach (the Kastela Bay location); the overall beachgoing population had a WTP of 26.67 euros since results indicated that Croatian visitors to beaches are not responding to the levels of total coliform when making beach visitation decisions.

Analysis of the visitation patterns in Chapter 3 also indicated that local perceptions of the health of bathing water are important, since the local health ranking of bathing waters in a town on Krk Island was significantly and inversely related to the probability of the town being visited by non-Croatian tourists. This indicates that there is likely some method by which the reputation of a given town pertaining to the quality of its beaches is transmitted to the tourist population. It is also possible that global companies select the most pristine locations for placement of the major tourist infrastructure, thus driving tourists to choose that location.

Results also indicated that the probability of revisiting a town on Krk Island for its beaches was inversely and significantly related to the visitor's subjective evaluation of the health ranking of the bathing water and positively and significantly related to the presence of a Blue Flag in the town (see Table 3.14). This supports the importance of the impressions formed by beachgoers during their visit upon the future potential of the tourism industry in a given locale. Negative impressions of the water quality through visual or other clues may lead the visitor to doubt the health of the bathing water and choose a different town for the next visit. Surprisingly, the cleanliness of the beach did not seem to negatively impact the decision of beachgoers to choose a given town; it may be that once a certain town has been selected they choose the beach they believe to have the best water for bathing, rather than using cues concerning the cleanliness of the beach. The beach cleanliness ranking by the visitor in Split-Dalmatia County was positively related to the probability of a beach being visited again (the cleaner the beach, the more likely it would be selected), but self-reported measures of water quality, while having the expected sign, were not statistically significant predictors of a beach being revisited (see Table 3.20).

Chapter 4 sought to determine if there was a connection between measured wastewater discharge levels and offshore bacterial coliform levels. Results revealed that increases in measured wastewater discharge resulted in increases in total coliform levels in the town where the wastewater treatment plant is located; this result is not entirely surprising as there was no treatment for bacteria at any of the wastewater plants at the time of this study, and even small volumes of wastewater have been found to result in microbial pollution (Payne et al. 2004). The second regression in Chapter 4 indicated that increases in the number of tourists in a town were significantly related to increases in a town's offshore total coliform levels. A surprising result from this chapter was the indication that a higher number of residents connected to a sewage treatment system in a town resulted in a small, but significant, increase in total coliform levels offshore. This may result from the number of residents connected serving as a proxy measure for urbanization; more urbanized areas may have more significant impervious surface–derived and groundwater contributions and runoff and, consequently, higher bacterial levels offshore (Mallin et al. 2000).

The preliminary ecologic-economic model developed in Chapter 5 provided an initial framework for linking the economic values associated with total coliform level fluctuations with the ecologic relationship of the number of tourists to total coliform levels. One of the simulations evaluated in the model demonstrated that, over a 25-year period, the utility or benefit from recreational ecosystem services of an average hypothetical beachgoer would decrease over time because of total coliform increases from increasing tourists. In other words, the benefit of a trip to the average non-Croatian beachgoer would decrease as a result of the negative impact of increasing total coliform levels. This occurred at both of the hypothetical beaches and despite the fact that the first simulation included wastewater treatment that removed bacteria from the water. The fact that such treatment is in fact absent from nearly all wastewater treatment plants in Croatia highlights the risk of continuing development of tourism industry without concomitant investments in wastewater infrastructure. Model simulations comparing beaches differing in sewage treatment levels were revealing, as they demonstrated that increases in sewage treatment increased the probability of a beach being selected over time and drove more tourists to those beaches. The final simulation, evaluated the addition of a Blue Flag on a beach that was also more susceptible to total coliform pollution. The model predictably drove higher numbers of visitors to the beach because of the Blue Flag although eventually the increase in total coliforms from the increased susceptibility of its coastal environment resulted in the beach with Blue Flag having a lower probability of being selected by the end of the 25-yr period.

Future Directions

The results provided in this dissertation provide a rationale for pursuing multiple future research areas related to the relationship between the tourism industry and impacts upon water quality. As tourism growth is expected to continue to grow in Croatia, the pressure on the marine environment is likely to increase and raise important questions for government officials as they consider policy options.

Future work can expand upon this analysis by incorporating the market benefits and costs that accrue to the development of Croatian areas for tourism. In addition, it is advantageous to collect data concerning the cost of proposed sewage treatment upgrades and determine if the costs of sewage treatment infrastructure are greater than or less than the benefits that beachgoers would receive from improvements in water quality. The cost-benefit analysis would differ depending upon the particular site selected and the associated value of an improvement in water quality in that location. For example, in the context of limited funds, it may be more beneficial to select certain beaches that are highly polluted for improvement rather than globally improving water quality at all beaches in Croatia. Beaches that have high levels of flushing may not be as appropriate a focus of funding as beaches in semi-enclosed bays; more detailed oceanographic data would assist in evaluating local circulation patterns. Evaluations of the cost of improving water quality could also consider different mechanisms for securing funding, including taxes based on the amount of sewage discharged into the marine environment by a hotel, guest house, or other tourist accommodation.

The preliminary results observed in this study also suggest the need for further qualitative and quantitative analysis of the differences between the tourist and non-tourist population. Examination of the differing behavior of these two populations may reveal additional information concerning the internal mental model for beachgoers choosing between a range of potential locations. Continued research in Croatia could probe the attachment of Croatians to certain recreational sites; previous research has developed psychological models addressing an individual's attachment to a given location (Hailu et al. 2005).

While Croatians may not alter their behavior based on the water quality at a given site, it may make sense to invest in infrastructure improvements if the domestic population disproportionately uses environmentally degraded recreation sites. Also, as water quality becomes progressively worse, a threshold may be passed whereby it then becomes a significant factor for the beach visitation decision of Croatians. Croatians may also be visiting sites that were not included in this analysis as those beaches may be informal and not officially monitored by the government.

Spatial data collection is another potential area for future research on this topic in Croatia. Spatial context is clearly important in the ecological system as the dispersal of bacteria may be expected to depend on density and flow gradients as well as proximity to the point of entry into the aquatic environment. As Croatia continues development of a database of spatial and oceanographic data, more fully developed ecological models will permit evaluation of the fate of bacterial discharges in the nearshore environment. This type of spatial information would also allow for targeted evaluation of beaches that are most likely to be affected by bacterial pollution depending upon local population pressures, sewage plant locations, septic tank structure and locations, local geology, land use, and oceanographic and meteorological conditions. Specific locations of septic systems and tracking of any seepage would also be important in determining the fate of any seepage from those systems into the groundwater and eventually into the ocean.

Many of the results and analyses in this study were limited by the fact that daily, or even weekly, bacterial numbers are not available, which would allow for more precise estimation of the relationship between environmental factors and bacterial levels. The limited sampling conducted in coastal waters may need to be expanded to better characterize when pressures on the coastal environment are highest. Ideally daily tourist arrivals would also provide a more refined understanding of the ebb and flow of tourists to different towns along the coast. Spatial mapping of land use types would assist in determining potential relationships between the type of land development and the observed offshore total coliform levels. Specific information about the types of establishments connected to a sewage system versus septic system would assist in an analysis on relative contributions of a mix of septic systems to seasonal variations in flow.

Future research and analysis could focus on continuing to develop the preliminary economic-ecologic model proposed in Chapter 5. As with all models, this model would be expected to become more extensive and representative as additional data become available. The model can be modified by inserting different parameters and additional inputs and outputs; some examples include percentage of impervious land cover, a more developed bacterial persistence model, and a model including the economic market benefits arising from tourism industry development.

Finally, future work could employ stated choice methods such as choice experiments or a contingent valuation survey to determine the value that beachgoers place on different attributes of their experience. These studies would directly ask beachgoers as well as non-beachgoers the values they place upon components including bacterial levels in the water, the Blue Flag program, and presence of amenities. Since such an approach does not rely on only interviewing those who actually use the beaches, it may provide insight into the value to individuals who may never use the beach and thus give a greater understanding of the value of the beach to the population as a whole. The results obtained from such an analysis could be compared to the results obtained in the current study and provide initial evidence concerning the value of Croatia's coastal waters to policymakers and other stakeholders.

The results obtained in this study suggest that bacterial levels in Croatian coastal waters can have impacts upon the beachgoer decision for those who have decided to travel to Croatia. In the absence of infrastructure to reduce total coliform levels, this study suggests that tourism growth cannot increase continuously without negatively impacting the marine environment on which tourism depends. The significant implication from the research is that policymakers should consider the value of the environment to beachgoers when making development decisions. Although a new hotel or tourist resort may bring in added revenue, it may also lead to deterioration of the water quality and of the benefits beachgoers derive from the environment. All of the potential costs and benefits should be considered if the goal is development of a tourism industry that would continue to provide benefits to beachgoers in the years and decades ahead.

Appendix 1. Beach Characteristic Survey Form

Beach Name: ID Number ____

Approximate width 0-25 26-50 >50
Approximate length 0-50 51-100 101-200 201-500 >500

Private or Public Island or Mainland

Blue Flag in 2005 Yes No Urban Semi-Urban Non-Urban

Connected to other beaches by walkway? Yes No

If yes, where is beach on walkway? Beginning(north) Middle (specify, if possible) End (southern)

Camping available Yes No Playground available Yes No Sand available Yes No

Predominant Beach Type Sand Pebble Concrete

Hotel within 2000 feet Yes No Apartments within 2000 feet Yes No
Marina/harbor within 2000 feet Yes No Docks/moorings within 2000 feet Yes No

If yes, name of closest hotel and marina; if more than one equidistant, indicate both

Type of eating facilities (and number):

Restaurant ____ Snack Bar/Cafe ____ Snack Cart ____ Other (describe)____

Toilets Yes No Showers Yes No Parking Lot Yes No

Public Transit Accessible Yes No

Any obvious sewage pipe or discharge points? Yes No

Appendix 2. Travel Cost Survey

Beach name: Date and Time:

Please answer the following questions regarding your trip to this beach. It is important that you answer all of the questions for the results to be accurate. Thank you in advance!

1. What town or city and country are you from? ____________________

2. From your home, how did you travel…

…to Croatia?	Auto	Bus	Plane	Train	Ferry
…to this town?	Auto	Bus	Plane	Train	Ferry

3. If you came to Croatia by plane, train, bus, or ferry, where did you arrive? _________

4. How much time did it take you to travel here from home?____

5. What is your estimate of your one-way travel cost (tickets, gas, etc.)? Please indicate currency.

6. How many family members are traveling with you?_____

7. Is the purpose of this trip only to go to the beach and sea? Yes No

8. Have you visited other beaches in this part of Croatia before? Yes No

9. Is this your first visit to this beach? Yes No

10. Why did you choose this beach (circle most important reason)?
Location/Town Amenities (Hotels, restaurants, showers, etc.) Reputation Clean Water Tradition
Other:__________

11. How many days will you visit this beach this summer? ____

12. Did you or will you visit any other beaches in Croatia this summer? Yes No

If yes, please indicate the number of times you will visit or have visited the locations below for the beaches.

__Bakarac
__Baska
__Cres
__Crikvenica
__Dramalj
__Jadranovo
__Kacjak
__Kantrida
__Klenovica
__Kostabela
__Kostrena
__Kraljevica
__Krk
__Lovran
__Mali Losinj
__Malinska
__Martinscica
__Mosenicka Draga
__Novi Vinodolski
__Njivice
__Omisalj
__Opatija
__Pecine
__Povile
__Punat
__Rab
__Selce
__Sibinj
__Smokvica
__Veli Losinj
__Volosko
__Other town not listed (please write name):
____
___Split-Dalmatia County towns

Will the visits indicated above be on separate trips (returning home in between trips)? Yes No

13. If the beaches in this town were closed for swimming and bathing, would you go to another town? Yes No

If yes, which town would you visit? ____________

14. How would you rate the water clarity at this beach today?

1 2 3 4

Poor Moderate Good High

15. In terms of your health, how safe do you feel the water on this beach is for bathing today?

1 2 3 4

No risk for illness Low risk for illness Medium risk for illness High risk for illness

16. How would you rate the cleanliness of this beach today?

1 2 3 4

Poor Moderate Good High

17. Would you return to this beach on another visit? Yes No

18. Activities participated in while visiting the beach today (Please circle all that apply)

Swimming/Bathing Sunbathing Scuba Diving Sports other than Scuba Diving

19. Did you consult any media before choosing which beach to visit? Yes No

If yes, which media did you consult? ______________________________

20. Are you aware that the Croatian Ministry of Environmental Protection publishes a report about bathing water quality? Yes No

21. Are you aware of the Blue Flag Program? Yes No

22. For statistical purposes, please circle the range of your annual household income (euros, sterling, or dollars, please indicate which currency):

0-5.000 5.001-15.000 15.001-25.000 25.001-35.000 35.001-50.000 50.001-75.000 >75.000

23. Age___

Appendix 3. Local Knowledge Beach Ranking Survey for Krk Island

Please answer the questions below.

1. Are you a resident of the island of Krk?   Yes   No

2. If yes to either of these questions, in which town or city? _____________

3. Please rank the following towns in terms of your feelings about the overall quality of the bathing and swimming experience on their beaches (1 being the best and 6 being the worst):

Baska__
Omisalj__
Krk__
Punat__
Njivice__
Malinska__

4. From a health perspective, please rank the following towns in terms of your feelings about the cleanliness of the bathing water on their beaches (1 being the best and 6 being the worst):

Omisalj__
Krk__
Punat__
Njivice__
Baska___
Malinska__

5. Please rank the following towns in terms of your feelings about the clarity of the bathing water on their beaches (1 being the best and 6 being the worst):

Krk__
Punat__
Malinska__
Baska__
Njivice__
Omisalj__

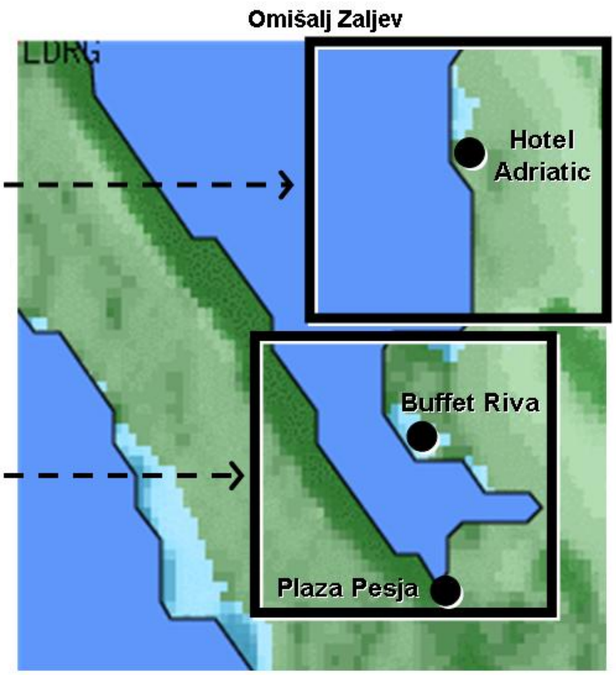
Appendix 4. Local Knowledge Survey of Site Selection in Omisalj on Krk Island

1. Are you a resident of Omisalj? _______ Yes _______ No

2. Where do you primarily swim and bathe?

______ **Zone 2**

______ **Zone 1**



Appendix 5. Full Logit Model Results for Krk Island and Split-Dalmatia County

Table A1. Krk Island Full Model Equation (3.9) Results

Variable	**Parameter Estimate (Standard error)**	**P value**
Travel cost	-0.0001 (0.0001)	0.378
Travel time cost	0.0004 (0.0007)	0.587
Total coliform 2005	0.0494 (0.0898)	0.582
Reported 2005 poor water quality	0.0046 (0.037)	0.901
Blue Flag presence	-0.1978 (0.3416)	0.563
Pebble	1.064 (0.8037)	0.186
Camping	1.142 (1.604)	0.476
Industry	0.4852 (1.437)	0.736
Swimming	-0.0688 (0.0376)	0.067
Sun	-0.1448 (0.0906)	0.110
Diving	-0.0244 (0.0086)	0.286
Knowledge of government publication	-0.0022 (0.0086)	0.795
Industry	0.4852 (1.437)	0.736
Travel cost dummy	0.0017 (0.0015)	0.270
Travel time dummy	--0.0387 (0.0165)	0.019
Total coliform 2005 dummy	-0.1087 (0.0793)	0.170
Reported poor 2005 water quality dummy	0.0034 (0.042)	0.934
Blue Flag dummy	0.3138 (0.4795)	0.513
Model p-value		0.3578

Table A2. Krk Island County Local Knowledge Equation 3.6 Full Model Results

Variable	**Parameter Estimate (Standard error)**	**P value**
Travel cost	-0.0000 (0.0001)	0.911
Travel time cost	-0.0009 (0.0006)	0.154
Local water clarity ranking	0.0320 (0.3101)	0.918
Local overall experience ranking	0.0738 (0.2669)	0.782
Pebble	-0.166 (0.2183)	0.593
Camping	0.2635 (0.3235)	0.415
Industry	-0.1750 (0.6205)	0.778
Swimming	-0.0003 (0.0007)	0.629
Sun	0.0028 (0.0019)	0.148
Diving	0.0006 (0.0009)	0.528
Knowledge of government publication	0.0023 (0.0015)	0.118
Model p-value		0.8980

*Local water health ranking dropped from model because of collinearity

Table A3. Split-Dalmatia County Equation (3.11) Full Model Results

Variable	**Parameter Estimate (Standard error)**	**P value**
Travel cost	0.0000 (0.0000)	0.478
Travel time	-0.0028 (0.0020)	0.115
Total coliform 2005	-0.1593 (0.0751)	0.034
Percent of 2005 samples water quality 2	0.0116 (0.0118)	0.329
Blue Flag presence	0.7894 (0.5546)	0.155
Swimming	-0.0432 (0.0534)	0.418
Sun	-0.0426 (0.0514)	0.407
Diving	-0.0174 (0.0118)	0.141
Knowledge of government publication	0.1857 (0.2294)	0.418
Travel cost dummy	-0.0002 (0.0003)	0.489
Travel time dummy	0.0098 (0.0104)	0.348
Percent of 2005 samples water quality 2 dummy	-0.0064 (0.0031)	0.039
Total coliform 2005 dummy	0.1188 (0.0800)	0.137
Blue Flag dummy	-0.5688 (0.9860)	0.564
Model p-value		NS

Note: Island, industry, beach length, beach width, restaurant, and urban dropped because of collinearity

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