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### **Managing congestion on Gold Coast beaches: An economic evaluation**

*Karin Andersson, Nathan Brierley, Feliks Hedstroem, Daniel Herr and Joshua Risson*

No. 2015-04

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## Table of contents

EXECUTIVE SUMMARY .....	4
1 Introduction and context.....	5
2 The costs of congestion .....	6
3 The pooled travel cost /contingent behaviour method.....	7
3.1 The travel cost method.....	7
3.2 The contingent behaviour method.....	7
3.3 Survey design and application .....	8
3.4 Analytical approach .....	8
4 Results .....	11
4.1 Consumer surplus associated with current visitation .....	11
4.2 Contingent behaviour estimates.....	12
5 Potential solutions.....	15
5.1 Raising parking costs .....	15
5.2 Introducing a beach tax.....	15
5.3 Building an artificial reef .....	16
6 Conclusion .....	18
References .....	19
Appendix A: Analytical approach.....	21
Appendix B: Survey instrument .....	22
Appendix C: Congestion photos.....	23

## EXECUTIVE SUMMARY

### AIM

This report investigates the costs of beach congestion, with an emphasis on surfers and general beach goers. The estimates of the costs of beach congestion are used to assess the cost effectiveness of measures to reduce congestion. Specifically, we seek to answer the following questions:

- How does beach congestion affect beach visitation rates of surfers and general beach goers?
- Does the benefit of reducing beach congestion exceed the cost of measures to reduce beach congestion on the Gold Coast?

### METHOD

Information on people visiting beaches was collected via online and on-site surveys conducted at Surfers Paradise beach and Rainbow Bay beach during April 2015. From this survey data, the travel cost method was used to estimate the economic cost of congestion on the Gold Coast.

Total changes in consumer surplus are used to assess the cost effectiveness of three proposed measures to reduce congestion: increasing parking costs, implementing a beach tax and building an artificial reef.

### RESULTS

The cost of beach congestion is sizable - an estimated \$7,878,458 reduction in consumer surplus per annum. This represents around \$5.96 per person per trip. This cost represents about 14% of the total consumer surplus derived from beach visitation at Gold Coast beaches.

### CONCLUSION

There are few realistic options to tackle beach congestion, given implementations costs and enforceability issues associated with measures aiming to reduce the demand via increasing parking costs or by imposing a beach tax. We, therefore, recommend the construction of an artificial reef as the most cost-effective solution to this issue. This solution expands the supply of prime surfing beaches and has the greatest impact on surf-specific congestion at wave breaks. In contrast, increasing parking fees and beach taxes are unpopular and may not be effective in reducing congestion where it matters the most.

## 1 Introduction and context

The Gold Coast's 53 kilometres of pristine beaches are one of Australia's most popular tourism assets. The Gold Coast's beaches attract more than 11.8 million visitors per annum, with visitor numbers increasing by more than 700,000 between 2011 and 2012 (Gold Coast Tourism Annual Report, 2013).

The increasing popularity of the Gold Coast's beaches has led to a rising number of complaints regarding congestion. If left unaddressed this issue has the potential to undermine the Gold Coast's highly important tourism industry, which currently comprises of approximately 20% of the City's total economy (City of Gold Coast, 2011). Two beaches in particular receive very high levels of visitation and suffer from congestion at peak periods:

- Surfers Paradise beach - receives approximately 1,463 beach visitors per day, with in excess of 5,000 people visiting per day during peak periods.
- Rainbow Bay beach – receives approximately 2,200 beach visitors per day, with in excess of 7,000 people visiting per day during peak periods.

ProBonoEconos Griffith were commissioned by the Gold Coast Surf Council to investigate the negative impact of congestion on Gold Coast beaches and the potential benefits of alternative management strategies. This report summarises the findings of our investigation and is structured as follows:

- Section 2 discusses the costs of congestion;
- Section 3 describes the method employed to calculate the welfare costs of congestion – the pooled travel cost / contingent behaviour method;
- Section 4 presents results;
- Section 5 discusses potential solutions; and
- Section 6 concludes.

The report is written for a non-technical audience and, as such, further details regarding the modelling and estimation approach are provided as Appendix A.

### Rainbow Bay beach too crowded for world champ

"It's really, really tough for one person to get space in the water and it's mostly not fun... It's really unsafe - there's just people all over the place"

Kelly Slater, world champion of surfing (Ardern, 2014).



## 2 The costs of congestion

As the popularity of the Gold Coast's beaches grow, so too does pressure on the beaches and the surrounding environment. This pressure manifests itself in congestion and potentially damage to the natural environment, both of which serve to reduce the value of the experience to visitors. The Gold Coast City Council, therefore, is faced with the very difficult task of accommodating an ever-increasing number of tourists, while preserving the very qualities that tourists and others value. Specifically, there are a number of negative consequences of the popularity of Gold Coast beaches:

- Increased injuries: Data provided by the Gold Coast Lifeguards indicates that there is a positive correlation between congestion and accident rates. Overcrowding in the water can lead to increased collisions among surfers, as well as between surfers and swimmers.
- Increased traffic: During the most congested days the traffic routes towards the beaches can become chaotic and dangerous. Local residents have expressed concerns regarding reckless driving resulting from over congestion of local motorways and roads (Waymes, 2014).
- Crime: Frustration at the congestion has in some cases resulted in people being physically and verbally attacked by others (Stolz, 2014).
- Pollution: Increasing visitor numbers is likely to lead to increasing litter - between 2010 and 2011 the amount of litter found along the shores in Queensland increased by 100% (Calligeros, 2011).

These congestion-related issues have the potential to negatively affect a number of key stakeholders, including:

- Beach users and tourists, via a decline in the quality of the beach experience;
- Residents faced with increased travel times and potential declines in real estate value;
- The hospitality industry, as congestion could tarnish the international reputation of the Gold Coast and long term visitation rates (Opperman 1995);
- Local and state governments, and ultimately taxpayers, who carry the burden of congestion via increased strain on public infrastructure;
- Emergency services, including police and the hospital sector that are affected by increases in injury rates and crime;
- Voluntary organizations, such as the Australian Surf Lifesavers who are responsible for patrolling beaches; and
- The Gold Coast surfing industry, as surfers seek less congested beaches.

### 3 The pooled travel cost /contingent behaviour method

The method and practice of placing monetary values on environmental goods and services for which a conventional market price is otherwise unobservable is one of the most fertile areas of research in the field of natural resource and environmental economics. Initially motivated by the need to include environmental values in benefit-cost analysis, practitioners of non-market valuation have since found further motivation in national account augmentation and environmental damage litigation.

By convention, valuation techniques are divided into two modelling approaches. The *revealed preference* approach relies on observations about peoples' behaviour in markets that are somehow related to the environmental good or service under consideration, while the *stated preference* approach uses surveys to question how respondents value that good or service. Techniques can be further divided into direct and indirect, depending upon whether a value is directly measured or inferred.

In this report we employ both the revealed preference travel cost method and the stated preference contingent behaviour method.

#### 3.1 The travel cost method

The travel cost method seeks to place a value on recreational sites by using consumption behaviour in related markets. Specifically, the travel cost method is a non-market procedure whereby a value for a recreation site is obtained by considering how much people are prepared to spend to reach the site.

The travel cost method operates by explaining a frequency of visitation (either of an individual or a population segment) in terms of the travel costs incurred and other site relevant characteristics and socio-economic factors. The amount of opportunity costs incurred and visitation rates determines the recreation values of the site (or sites) under consideration (Prayaga, Rolfe & Stoeckl, 2010).

The travel cost method has become widely accepted and is generally regarded as one of the success stories of non-market valuation.

#### The history of the travel cost method

In 1947, responding to a request from the United States National Parks Service, mathematician and economist Harold Hotelling outlined a method whereby the distance a recreationist travelled to visit a particular site could be used as a proxy for the 'price' of the trip, thereby allowing the visitor's consumer surplus to be estimated.

It was another decade before Hotelling's 'travel cost method' was developed. Wood and Trice (1958) used it to estimate the recreation value of reservoirs in the Upper Feather River Basin, California. Greig's (1973) study of the Grampian Mountains in Victoria represents one of the earliest applications of the travel cost method in Australia.

Greig, P. (1973). The Management Decision-Making Process in the Multiple Use of Forested Lands, with Particular Reference to Outdoor Recreation, Master of Science thesis, University of Melbourne, Melbourne.

Trice, A & Wood, S (1958). Measurement of recreation benefits. *Land Economics*, 34, 195-207.

#### 3.2 The contingent behaviour method

Contingent behaviour models differ from the more traditional contingent valuation stated preference method in that the respondents are asked whether they would be willing to change their behaviour in response to changes in the environment instead of their reaction to cost increases. In a recreation context respondents are presented with the hypothetical scenario



with different site conditions (e.g. more or less congestion) and then asked if they would change their intended number of visits. By pooling the data about behaviour changes with the information about travel costs, estimates can be generated about the value associated with different hypothetical scenarios (Prayaga, Rolfe & Stoeckl, 2010).

### 3.3 Survey design and application

Environmental economists have long used surveys to gather information about people's preferences. This is particularly true in the field of non-market valuation, where techniques such as the travel cost method, contingent valuation and choice modelling invariably employ some form of survey instrument.

Choice of survey administration mode is one of the more fundamental issues that confront the non-market valuation practitioner when developing an appropriate instrument to elicit the values he or she is seeking. Conventional survey administration modes include mail, in-person, telephone and central site. More recently, the use of e-mail and web-based surveys has emerged as another option. The choice of survey mode requires consideration of several issues and, to date, no single mode has been proven unambiguously superior to the others (Fleming & Bowden, 2009). In this case, both a face-to-face and an online survey were employed (see Appendix B).

The survey was conducted at Rainbow Bay beach and Surfers Paradise beach during two weekends in April 2015. Surveys were also conducted at Griffith University's Gold Coast campus and via an online questionnaire. A link to the online questionnaire was published on several Griffith University course announcement pages, shared and sent to friends via Facebook and also posted on the Gold Coast Surf Council's Twitter and Facebook pages.

The survey investigated how the consumer surplus associated with beach visitation is affected by:

- Number of beach visitors and surfers at surf breaks;
- Parking availability; and
- The availability of amenities (toilets, showers etc.).

Specifically, respondents were asked to indicate how their frequency of beach visits would change in relation to a:

- 25% increase in congestion;
- 25% decrease in congestion;
- 25% decrease in the availability of parking; and
- 25% decrease in the availability of amenities.
- 25% increase in surfers in the water

Respondents were asked to estimate how each scenario would affect their future visitation rates over the next 6 months. To assist with calculating 6-month totals, the respondent was provided with a flash card. A second flash card containing three digitally altered photos was also provided to help the respondents visualise the hypothetical changes in congestion (Appendix C).

In order to elicit travel costs, the survey included a question about the mode of transport to the beach, the model of car, time travelled, postcode of home address and how long their stay was if they were there on holiday.

### 3.4 Analytical approach

The integer and non-negative nature of the data prompted the use of Poisson regression techniques, whose negative binomial specification assisted in terms of handling the problem

of overdispersion. These models assume a semi-log function which has the simple and attractive property of allowing the estimation of consumer surplus as the inverse of the travel cost coefficient (Prayaga, Rolfe & Stoeckl, 2010).

Travel cost is traditionally estimated using one of three methods; asking the respondent to provide their perceived travel cost, an estimation of fuel cost as a function of distance travelled or an estimation of full car costs (including insurance and maintenance etc.) as a function of distance. Numerous studies found the perceived cost method to provide grossly inflated or undervalued estimations (Mohammadi Limaei, Ghesmati, Rashidi & Yamini, 2014) so we decided against its implementation. The all-encompassing method would have been ideal, however, a good percentage of the respondents did not provide enough information about their vehicles to allow for accurate categorisation and therefore, for the purpose of maintaining consistency, we opted for the fuel cost estimation process.

There is a fourth, all-encompassing, method of travel cost calculation which involves considering the total travel costs of the respondent (with the inclusion of accommodation) however, like previous Griffith University researchers before us, we found that this was too intricate to quantify as many people have chosen to live on the Gold Coast in order to support their beach lifestyles.

Separate models were estimated for the base scenario and each alteration. The results of which were stacked to create a panel data set of up to 298 observations for each contingent behaviour scenario.

To indicate whether the data pertained to the base scenario of visits over the next 6 months (DUMMY=0) or the contingent behaviour (DUMMY=1), the panel data included a dummy.

For the purpose of maintaining consistency in the regressions, we retained all the explanatory variables from the travel cost model when estimating the contingent behaviours, regardless of their significance.

If the respondents did not drive to the beach, but travelled on a bus or tram, we collected data about their public transportation, and calculated the price of their trip with the assistance of Translink's website.

Interstate travellers were asked to specify their port of embarkation and approximations of their fares were calculated with the help of the 'Expedia' website and the cost of their ticket was apportioned to the percentage of their trip spend on the Gold Coast beaches.

A definition of all variables employed is provided in Table 1, descriptive statistics are provided in Table 2. A review of the descriptive statistics indicates that our surveys have targeted a diverse and representative subset of the beach-going population. The mean of 34.34 expected beach visits over the next 6 months indicates that most of our respondents are regular beach goers. The large standard deviation of 47.5 indicates that there is significant heterogeneity in the data and that a large proportion of visitors tend to visit the beach infrequently.

A mean age of almost 27 indicates that the general sample was quite young. However, this is not necessarily indicative of a bias as the beach-going population is commonly found to be younger than the average population (Nelsen, 2007).

**Table 1: Definition of variables**

Variable	Definition
VISITS	Dependent variable Travel cost model - number of trips to the beach over the last 6 months Contingent behaviour model - number of trips in the next 6 months under different hypothetical scenarios
DUMMY	Dummy variable identifying the source of data (0 = reported trips and 1 = contingent behaviour data)
TOTCOSTS	Total travel costs of a trip as reported by respondents
GENDER	Gender of the respondents (0 = female and 1 = male)
AGE	Age of the respondents in years, categorical variable
EDUCATION	Education level of the respondents, categorical variable
LOGINCOME	Log of annual Income of the respondents, categorical variable

**Table 2: Descriptive statistics**

Variable	Mean	Std. dv.	Minimum	Maximum
VISITS	35.52	48.49	2	220
TOTCOSTS (\$)	6.69	7.59	0	48.76
AGE	26.97	10.34	21	65
INCOME (\$)	52,932	2,666	7,800	104,000
LOGINCOME	10.6	0.85	8.96	11.55

## 4 Results

This section aims to estimate the total annual consumer surplus associated with visitation to Rainbow Bay and Surfers Paradise. Further, contingent behaviour models are estimated to measure the annual aggregate change in consumer surplus under five hypothetical scenarios.

### 4.1 Consumer surplus associated with current visitation

The signs of the estimated coefficients from the Poisson regression were consistent with prior expectations. Most importantly, the TOTCOSTS coefficient was statistically significant at the 1% level and had a negative sign. This indicates that the visitation rate will decline as the travel cost increases and therefore, a downward sloping demand curve can be identified.

The consumer surplus per person per current trip was estimated using Eq. (1) (Prayaga, Rolfe & Stoeckl, 2010). The consumer surplus estimated for the travel cost method (Table 3) is \$42.02. This is consistent with a similar study focusing on the value of recreational visits along Queensland beaches that estimated a consumer surplus per person of between \$12.99 and \$119.95 (Blackwell, 2007). Using a semi-annual average visit rate of 35.52 (Table 2), participants from the survey generated a consumer surplus of about \$2,985 annually.

**Table 3: Travel cost model estimated with Poisson regression (VISITS is the Dependent variable)**

Variable	Coefficient estimation	Std. error
Constant	1.1636*	0.6291
TOTCOSTS	-0.0238***	0.008
GENDER	0.2019**	0.1
AGE	0.0023	0.0049
EDUCATION	-0.0757	0.0581
LOGINCOME	0.0072	0.0612
Log likelihood	-245.1001	
Consumer surplus per person, per trip	\$42.02	
Observations	149	

\*\*\* Significant at 1%, \*\* Significant at 5%, \* Significant at 10%.

The annual number of trips to both Rainbow Bay and Surfers Paradise according to data provided by Gold Coast Lifeguards is estimated to be approximately 1,321,889. It follows that the product of the annual visits and the aforementioned consumer surplus comprises the total annual consumer surplus generated by these two beaches. Therefore, the annual consumer surplus is estimated to be approximately \$55.5 million. This is consistent with another study which estimated an annual consumer surplus of between \$21.5 and \$91 million along Gold Coast beaches (Raybould, 2007).

$$CS = -\frac{1}{\beta_{TC}} \quad (1)$$

## 4.2 Contingent behaviour estimates

The Contingent behaviour (CB) models (Table 5) for the different hypothetical scenarios were also estimated using a Poisson regression. Again, the estimated TOTCOSTS coefficient was negative, and was statistically significant at the 1% level across all models.

Table 4 estimates the effect of changes in conditions along Gold Coast beaches on the semi-annual number of visits. The effect on visits for the total survey and for surfers alone under each hypothetical scenario are presented. The results indicate that surfers visit the beach more regularly and are more sensitive to changes in congestion. When crowding is increased by 25%, surfers take on average 25.39 fewer trips, whereas the total sample takes 11.8 fewer. The most significant change in visitation for surfers was the result of a 25% increase in surfers in the water, decreasing the average amount of visits by 36.16.

**Table 4: Changes in the number of trips.**

	Average number of visits		Changes in average number of visits		Change in average number of visits (%)	
	Full sample	Surfers only	Full sample	Surfers only	Full sample	Surfers only
Crowding						
+25%	23.72	47.20	-11.80	-25.39	-33.21%	-34.97%
-25%	44.07	92.34	8.54	19.75	24.05%	27.2%
Surfers						
+25%	23.57	36.43	-11.95	-36.16	-33.65%	-49.81%
Parking						
-25%	29.64	67.32	-5.88	-5.27	-16.55%	-7.26%
Amenities						
-25%	31.35	67.52	-4.17	-5.07	-11.75%	-6.98%

Using the results from the contingent behaviour models in Table 5 and 6, the marginal effect of each scenario can be estimated. The marginal effect value indicates how much the predicted value of the consumer surplus will change with a unit change in the CB variable. Marginal effects are estimated using Eq. (2) (Prayaga, Rolfe & Stoeckl, 2010), where  $\beta_{cb}$  is the estimated coefficient of the DUMMY variable and  $\beta_{tc}$  is the estimated coefficient of TOTCOSTS.

$$ME = \beta_{cb} \cdot \frac{-1}{\beta_{tc}} \quad (2)$$

The estimated values of the marginal effects were consistent with expectations and are displayed in Table 7. As expected, a 25% increase in crowding resulted in the largest change in consumer surplus, decreasing it by \$5.96 per person per trip. Conversely, when crowding is decreased by 25%, the marginal effect on consumer surplus is positive, at \$3.63. Further, when the number of surfers in the water were increased, consumer surplus decreased by \$4.53. Decreases in parking availability and amenities also resulted in decreases of consumer surplus by \$4.55 and \$3.16, respectively.

**Table 5: Results for contingent behaviour models for alternative scenarios – Poisson regression.**

Variable	25% increase in surfers		25% decrease in parking		25% decrease in amenities	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Constant	0.9728**	0.472	1.3390***	0.4680	1.0926***	0.4658
Dummy	-0.1111	0.0731	-0.1015	0.0737	-0.0742	0.0720
TOTCOSTS	-0.0245***	0.0059	-0.0223***	0.0059	-0.0235***	0.0057
GENDER	0.2161***	0.0738	0.2054***	0.0748	0.2224***	0.0726
AGE	0.0045	0.0038	0.005	0.0036	0.005	0.0038
EDUCATION	-0.0640	0.0434	-0.0753**	0.0427	-0.7	0.0428
LOGINCOME	0.017	0.0458	-0.0167	0.0459	0.006	0.0455
Log likelihood	-464.2974		-470.3489		-477.3645	
Observations	284		280		286	

\*\*\* Significant at 1%, \*\* Significant at 5%, \* Significant at 10%.

**Table 6: Results for contingent behaviour models for changes in crowding – Poisson regression.**

Variable	25% increase in crowding		25% decrease in crowding	
	Coeff.	Std. error	Coeff.	Std. error
Constant	1.293***	0.4686	1.2204***	0.439
Dummy	-0.1509**	0.0739	0.0783	0.0689
TOTCOSTS	-0.0253***	0.006	-0.0216***	0.0055
GENDER	0.2203***	0.0744	0.1881***	0.0696
AGE	0.0045	0.0036	0.0031	0.0035
EDUCATION	-0.0557	0.0436	-0.0799**	0.0407
LOGINCOME	-0.0156	0.0456	0.0004	0.0426
Log likelihood	-464.0524		-495.0018	
Observations	282		296	

\*\*\* Significant at 1%, \*\* Significant at 5%, \* Significant at 10%.

To calculate the total annual change in the consumer surplus under each contingent scenario, the annual number of beach visits mentioned earlier (1,321,889) is multiplied by the

corresponding marginal effect. Table 8 displays these results and indicates that an increase in congestion of 25% will lead to a total annual decrease in consumer surplus of \$7,878,458, while a 25% decrease will result in a \$4,798,457 increase. 25% increases in surfers and 25% decreases in parking availability and amenities reduce total annual surplus by \$5,988,157, \$6,014,595 and \$4,177,169, respectively.

**Table 7: Estimates of marginal benefit**

Contingent scenario	Marginal effect (per person per visit)
25% Increase in Surfers	-\$4.53
25% Decrease in Parking	-\$4.55
25% Decrease in Amenities	-\$3.16
25% Increase in Crowding	-\$5.96
25% Decrease Crowding	\$3.63

**Table 8: Changes in consumer surplus**

Contingent scenario	Change in total consumer surplus (annual)
25% Increase in Surfers	-\$5,988,157
25% Decrease in Parking	-\$6,014,595
25% Decrease in Amenities	-\$4,177,169
25% Increase in Crowding	-\$7,878,458
25% Decrease Crowding	\$4,798,457

## 5 Potential solutions

In light of the estimated costs of congestion presented above, this section critically examines three alternative management strategies that could be implemented to reduce congestion from both the demand and supply side. As stated in the Gold Coasts shoreline management plan (2002) the objectives of the council is to enhance and maintain the quality and accessibility of Gold Coast beaches. As such each solution was evaluated by this criterion. Each strategy differs significantly in terms of their impact on stakeholders, cost of implementation and ability to raise revenue for governments. The three management strategies considered are:

- Raising parking costs;
- Introducing a beach tax; and
- Building an artificial reef with patrolled beach.

### 5.1 Raising parking costs

Our survey illustrated that the majority (approximately 69%) of beach users use their car as the primary means of transport to both Surfers Paradise and Rainbow Bay beaches. Therefore, increasing parking rates could be considered as a potential means of reducing beach congestion. The implementation cost of such a strategy is minimal. Furthermore, it has the potential to increase revenue for local governments that could be invested to safeguard the environmental quality of the beaches and/or invest in more local infrastructure.

However, while it seems plausible that increased parking rates may lead to a decrease in congestion, some studies have shown that increasing parking fees per unit of time may actually *increase* the number of people utilising the car park. For example, Glazer and Niskanen (1992) find that an increase in the price of parking induces each person to park for a shorter time, thus increasing the turnover of parking and thereby congestion. If increased parking rates did indeed lead to an increase in congestion, then the proposition is ineffective.

Moreover, increases in parking costs represent a general measure which would not discriminate between surfers and normal beach goers. From the above analysis, it appears that the greatest concern about congestion is among surfers who are concerned with the safety and quality of surfing at the breaks.

The effectiveness of raising parking costs also depends on the local government capacity to patrol and impose fines on cars that do not pay for the fees. In addition, it is likely that substantial increases in parking fees would stimulate many beachgoers to substitute towards other forms of transport, including bicycles and public transport.

As a result, such a measure may not be effective in reducing congestion on the actual beach - it may mere change the form of transportation beach goers use. Recent increases in the Gold Coast public transport system (the light rail system) have likely contributed to a greater willingness to switch between using the car and using public transport.

### 5.2 Introducing a beach tax

The introduction of a tax on beach usage may be an approach to help deal with congestion. This has been implemented in Italy with varied results (Kington, 2010). The benefits associated with a beach tax include revenues gained from the tax and a decrease in congestion, however, this policy may prove to be politically unfeasible and hard to enforce.

Further associated problems with the policy include the possibility of movement of beachgoers from patrolled beaches to unpatrolled beaches potentially resulting in an increase



in beach related accidents (Stolz, 2014). The resulting unpopularity of such a policy may be large with polls conducted on the implementation of a beach tax resulting in a resounding 92% of people rejecting the notion (The Today Show, 2014). Furthermore the implementation of a beach tax may prove to be inequitable as it may unfairly affect those from lower socio-economic groups. The sensitivity of lower socio-economic groups to beach usage fees can be seen in Italy, where social unrest has risen as low wage earners cite the fees as a major contributor to lower beach usage (Kington, 2010).

### 5.3 Building an artificial reef

An alternative to attempting to restrict the demand for beaches is to expand the supply of suitable locations for recreational use. This could be achieved through the introduction of a patrolled beach with an artificial reef to improve an existing surfing location.

The idea of an artificial reef is by no means novel. In the surfing world, the Gold Coast is most famous for 'the Superbank', which is widely regarded as one of the worlds greatest waves- it is man-made, artificial and it was created in the early 2000's. Very occasionally, one wave can carry a surfer 1.97km (The Superbank: a joint venture between Man and Nature, 2015). The dynamics of this artificial wave are quite different to what we are proposing as it tailored to suit the environment in which it is situated. It relies on perpetual sand dredging to maintain the underwater sand bank, whereas we are proposing a rock-based reef.

The Superbank has been so popular that it has increased surf tourism dramatically, extreme crowding has become the norm and according to Kelly Slater, it is clear that the wave has reached capacity (Potts, 2014). There is strong local pressure and support for the installation of a new artificial reef and locations such as Miami, Mermaid and Palm Beach have been suggested (Potts, 2014). A well-engineered reef, combined with a patrolled beach, would encourage surfers and beach users to disperse from the crowded point breaks and utilise the new area, thereby reducing congestion.

Its very difficult to accurately budget the calibre of investment required for the construction of the reef as each reef faces its own engineering challenges, but similar projects have been successfully installed within Australia for approximately \$2,550,000 and represent a legitimate solution to congestion (Murphy, 2011). According to Surf Life Saving Australia, the cost per annum of patrolling a beach is approximately \$81,000 (Surf Life Saving Australia, 2015).

Although the majority of the Gold Coasts 53km of coastline is surf friendly, surfers concentrate heavily in five main surf breaks. These are the Superbank (from Snapper Rocks to Kirra), South Stradbroke Island, Currumbin Alley, Burleigh Heads and the Spit. Allowing the assumption of relative substitutability between these locations, if a sixth break is added, it has the potential to decrease congestion across the most heavily congested beaches by up to 20%.

Table 8 estimates a \$4,798,457 increase in annual consumer surplus as a result of a 25% decrease in congestion. We cannot simply scale this down to 20% as consumer surplus is not a linear but it is highly realistic to forecast an annual CS around the \$3 million mark. This implies that in one year alone, the increase in consumer surplus would outweigh the reef installation and patrolling costs.

Surfers and swimmers are not the only subset of the population to benefit from an artificial reef and patrolled beach. Communities such as spearfishermen, bodyboarders, SCUBA divers, and kitesurfers all have a vested interest. As we have seen with the creation of the Superbank, local businesses (such as surfboard shapers, restaurants, convenience stores), real estate owners and any local person who has a financial relationship with beach tourism stands to benefit substantially.

An artificial reef would be vitally useful in terms of reducing sand erosion, which is an area that the GCCC currently invests heavily in. Artificial reefs are so effective at controlling sand erosion that in late 2000, an artificial reef was installed at Main Beach (Narrowneck) for this purpose alone (Murphey, 2011).

One must take into consideration the potential drawbacks to this solution. The rebound effect of increasing supply is inevitable (Rebound Effects, 2014). The expansion of the Gold Coast surfing playground is likely to create a rebound effect and attract surfers and crowds, which, along with boosting the economy, could potentially mean that the increase in consumer surplus mentioned earlier may be marginally overstated. However, this is certainly still a viable solution to congestion when the annual consumer surplus is considered over a number of years.

## 6 Conclusion

Congestion on Gold Coast beaches decreases consumer surplus by \$5.96 per person per trip and an aggregated \$7,878,458 decrease in consumer surplus for beach users per annum. At the same time, it should be noted that this represents about 14% of total consumer surplus.

Our results also revealed that the loss in consumer surplus was spread across consumers in a very uneven manner. Surfers care substantially more about congestion more than regular beach goers. This suggests that the greatest cost of congestion lies in congestion that occur at the wave breaks, rather than congestion on the sand.

The results were used to evaluate three different measures to reduce beach congestion: increasing parking costs, imposing a beach tax and building an artificial reef.

The first two are appealing in the sense that they are demand-side measures that seek to achieve reductions in beach visitation rates. However, both of these measures face substantial implementation and enforcement obstacles. Whilst the Implementation of a beach usage fee or increased car parking fees could raise revenue for the city council, the overall decrease in demand may be politically unfeasible. Furthermore unless adjusted for equity, the burden of costing measures aimed at reducing demand may fall hardest on those from lower socio economic groups.

To effectively target congestion at the surf breaks, we recommend increasing supply of recreational surfing and swimming areas. This increase in supply of patrolled surfable beaches represents a solution more in line with the objectives of the Gold Coast city council. Given that the increase in consumer surplus from the possible reduction in congestion is greater than the costed solution it represents a viable and cost effective solution.

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## Appendix A: Analytical approach

One of the reasons the Poisson, or count data, is attractive is because it assumes a semi-log function which translates to allowing the consumer surplus to be estimated as the inverse of the TOTCOSTS coefficient.

The demand for beach visitation takes the semi-log form below, and a brief description of the explanatory variables can be found in Table 1.

$$\ln VISITS = \beta_{CONSTANT} + \beta_{TOTCOSTS} + \beta_{GENDER} + \beta_{AGE} + \beta_{EDUCATION} + \beta_{\ln INCOME}$$

It follows that Consumer Surplus, per trip, per person is equivalent to the inverse of the TOTCOSTS coefficient:

$$CS = -\frac{1}{\beta_{TC}}$$

To calculate the total annual consumer surplus, CS needs to be multiplied by the total annual visits.

## Appendix B: Survey instrument

Q1. How many times have you visited the beach in the last 6 months?  
 times

Q2. How many times are you likely to visit the beach in the next 6 months?  
 times

Q3. Please describe how you got to the beach on this trip (If by car please include model)

Postcode:

Travel time (minutes):

Q4. How long (days) is your trip/holiday?

Out of these days, how many will be spent at the beach?

Q5. What is your main reason for being at the beach?  
 Meeting family / friends  
 Leisure  
 Surfing  
 Other

Q6. Look at pictures A, B and C. For each scenario, if the beach looked like this, how many times would you visit the beach over the next 6 months?

Changes in beach visit rates	Number of visits you are likely to make in the next 6 months
No Change (Pic. A, middle)	<input type="text"/>
Increase by 25% (Pic. B top)	<input type="text"/>
Decrease by 25% (Pic. C below)	<input type="text"/>

Q7. How would you respond to the following changes in beach conditions?

Changes in beach environment	Nr of times will you visit the beach the next 6 months?
Parking availability decrease by 25%	<input type="text"/>
Available amenities decrease by 25% (e.g. toilets, bins, showers etc)	<input type="text"/>
Surfers at the break increase by 25%	<input type="text"/>

Q8. If your beach visits were to decrease in any of the above, what would you do instead?

Go to another beach	<input type="checkbox"/>	<input type="text"/>
If you crossed the above, which beach?	<input type="text"/>	<input type="text"/>
Other activity	<input type="text"/>	<input type="text"/>

Please circle

Q8. Are you  Male  Female

Q9. What is your age?  
 18 – 24  25 – 34  35 – 44   
 45 – 54  55 – 64  65 and over

Q10. Please tick your highest level of education  
 Did not finish high school  High school certificate  Trade/Collage  University

Q11. What is your total household income before taxes for 2014? Please circle.

Nil income	\$0-\$15,599	\$15,600-\$51,999	\$52,000-\$103,999	\$104,000 or more
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Date / Time :

Surveyor:

Location:

## Appendix C: Congestion photos

Three photos labelled “Photo A”, “Photo B” and “Photo C” were constructed to illustrate to respondents “changes in beach visitation rate”. These photos were digitally constructed using the software Adobe Photoshop CC 2014. “Photo A” was used as a normal day at the beach followed by a 25 % increase “Photo B” and a 25 % decrease “Photo C”. Care was taken in each of the changes to seem as realistic as possible.

