Isles of Scilly

Travel Demand Study

Marco Kouwenhoven, Charlene Rohr,
Stephen Miller, Hidde Siemonsma, Peter Burge,
James Laird (ITS LEEDS)

The research described in this report was prepared for the Cornwall County Council.

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

RAND® is a registered trademark.

© Copyright 2007 RAND Corporation

Executive Summary

The Isles of Scilly are located 28 miles off the south west coast of England. The Isles comprise five inhabited islands, with a combined population of about 2000, and many smaller uninhabited islands and rocky islets. The main industry on the Isles is tourism, which is highly dependent upon the transport links to and from the mainland.

At present there are three commercial services operating between the Isles and the mainland: a sea ferry, a helicopter service and fixed-wing aircraft services. However, the boat used for the ferry service is now nearing the end of its operational life and if nothing is done, the sea ferry will be taken out of service after 2014. In response, Cornwall County Council, on behalf of the Penzance to Isles of Scilly Route Partnership, are preparing a Major Bid Submission for capital funding support for improved transport links to the UK Department for Transport. As part of this bid, a robust Cost Benefit Assessment was required to quantify whether a replacement ferry between the Isles and Penzance is justified. As part of this assessment a travel demand model was required to examine travellers' responses and quantify their benefits from different ferry service options, including the option of abandoning the ferry service. The study is unique as a multi-modal study in addressing links to an isolated island community, with modal choice between sea vessels, fixed wing aircraft and helicopter.

The Data: Both observed and hypothetical choice data were required

Both stated preference (SP) and revealed preference (RP) data were collected to develop the transport models. The strength of SP data is in deriving the *relative* importance of the different aspects of service (price, crossing time, comfort, etc.). However, to derive elasticities and forecasts it is necessary also to estimate the absolute scale of response and in this respect RP data is required. Current best practice is to combine SP data with RP data wherever possible and this methodology was undertaken in the present study. In a joint analysis, the main information concerning the relative importance of price and service comes from the SP data, while information concerning the overall likelihood that a traveller will choose a particular mode is derived from the RP data. Joint analysis exploits the specific strengths of the two data types, using each to reduce the weakness of the other.

A programme of SP and RP surveys were therefore undertaken during the summer operating season in 2005. The surveys were conducted with non-resident visitors and residents of the Isles.

The Design of the SP Survey

Respondents participated in three experiments in the stated preference survey:

- a *within-mode experiment* in which respondents were asked to choose between two hypothetical ferry alternatives for travel;

- a *between-mode experiment* in which hypothetical ferry, airplane and helicopter alternatives were compared;

- a *between-mode experiment* in which hypothetical airplane and helicopter services only were available (no ferry was available).

The choice cards for each experiment were specifically generated for each respondent so that the attributes in each experiment were realistic for respondents. This was particularly important for presentation of fares, which reflected the fare for the group of persons who were travelling together to the Isles.

The within-product experiment was designed to provide valuations for differing ferry attributes, e.g. ferry journey time, frequency of travel and schedule, quality of boat, harbour-side characteristics and Penzance and St. Mary's and price. An example within-mode choice is presented below.

Choice 5

If only a ferry service was available when you travelled to the Isles of Scilly,
which of the following would you have preferred?

Ferry A	**Ferry B**
Journey time is 2 hours 40 minutes	**Journey time is 2 hours**
Penzance - St. Mary's 08:00 **St. Mary's - Penzance 17:30**	**Penzance - St. Mary's 07:00** **St. Mary's - Penzance 10:30** **Penzance - St. Mary's 14:00** **St. Mary's - Penzance 17:30**
Existing boat, passengers may be prone to seasickness in rough conditions	**Modern boat, passengers less prone to seasickness**
New passenger terminal building and covered walkway to the vessel at Penzance	**No passenger terminal building and exposed quayside area at Penzance**
New shelter canopy at St Mary's	New shelter canopy at St Mary's
The return ferry fare for your journey is £148.75	**The return ferry fare for your journey is £127.50**

Prefer Ferry A	**Neither**	**Prefer Ferry B**
☐	☐	☐

Figure S.1:   Example of within-mode choice

The between-mode choices presented hypothetical options for each of the 3 modes of travel to the Isles. Access information for each of the alternatives was provided by the respondent (and was not varied in the experiment). In this experiment respondents always had the option available not to make the journey.
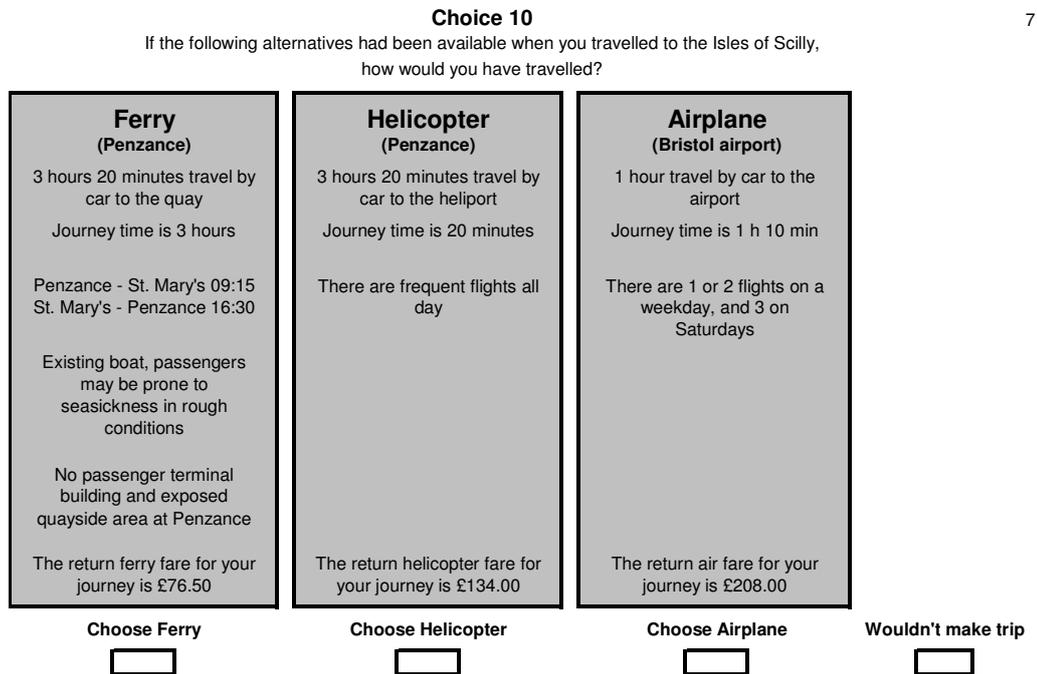
Choice 10   7

If the following alternatives had been available when you travelled to the Isles of Scilly,
how would you have travelled?

Ferry **(Penzance)**	**Helicopter** **(Penzance)**	**Airplane** **(Bristol airport)**
3 hours 20 minutes travel by car to the quay	3 hours 20 minutes travel by car to the heliport	1 hour travel by car to the airport
Journey time is 3 hours	Journey time is 20 minutes	Journey time is 1 h 10 min
Penzance - St. Mary's 09:15 St. Mary's - Penzance 16:30	There are frequent flights all day	There are 1 or 2 flights on a weekday, and 3 on Saturdays
Existing boat, passengers may be prone to seasickness in rough conditions		
No passenger terminal building and exposed quayside area at Penzance		
The return ferry fare for your journey is £76.50	The return helicopter fare for your journey is £134.00	The return air fare for your journey is £208.00

Choose Ferry	**Choose Helicopter**	**Choose Airplane**	**Wouldn't make trip**
☐	☐	☐	☐

Figure S.2:   Example of between-mode choice

In the third experiment, no ferry services were available in the between-mode choice experiment.

At the completion of the stated preference choice exercise, questions were asked about the respondent's current trip frequency to and from the Isles. These questions were followed by stated intention questions asking how the respondent's frequency of travel would vary under certain scenarios, specifically with an improved ferry service and with no ferry service. This information was used to estimate the trip frequency models.

Data Collection

Before the data collection commenced, sample size targets were set to ensure that traveller responses could be quantified for three traveller segments to and from the Isles: day-trip visitors, staying visitors and business travellers/residents/visiting friends and relatives (VFR). Staying visitors account for the majority of travel to the Isles of Scilly (62%) and for 37% of all ferry passengers. Day-trip visitors account for about 30% of all travel to the Isles, but for the majority of ferry travel (58%). Travel by residents, VFR and business travellers account for the minority, i.e. 8%, of travel to the Isles of Scillies, and about 5% of all ferry travellers[1] (see Figure S.3).

---

[1]   All figures presented here reflect percentages in 2003 (Hyder, 2004).
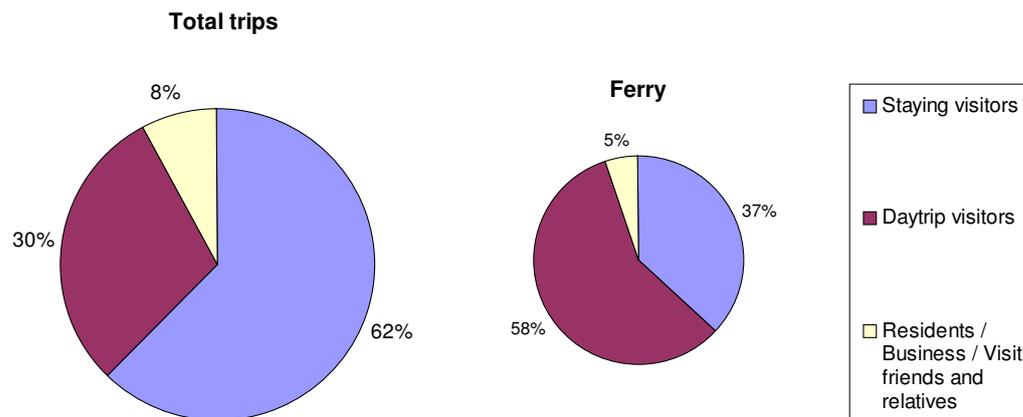
Total trips

Figure S.3   Segmentation of total trips and ferry trips

1891 face-to-face RP surveys were carried out with non-resident travellers to the Isles of Scilly distributed across day-trip and staying visitors, this was about 25% more surveys than was specified as the target in the set-up of this project (see Table S.1 for a comparison of the targets and recruited sample sizes for each survey segment). 401 SP surveys were conducted, meeting pre-specified targets for each mode and journey purpose category.

Residents were posted RP surveys in October 2005, after the main summer period. In total 251 RP questionnaires were returned by the Island residents, who reported details for 232 personal and 90 business journeys to the mainland in the 12 months previous to the survey. Again, this met the target of information for 300 journeys which had been set at the commencement of the research. 57 SP interviews were then undertaken with those residents who had returned RP interviews, these interviews were undertaken in the second half of November. With the inclusion of the 12 SP interviews undertaken with the non-resident business travellers, we obtained a total of 69 interviews in the residents/business segment, just short of the target of 75.

A number of detailed tests were undertaken to examine the quality of the RP and SP datasets. It was concluded that the quality of the RP and SP datasets was high.

	Target RP			**Number of respondents RP**		
	Ferry	*Helicopter*	*Airplane*	*Ferry*	*Helicopter*	*Airplane*
Non-residents stay	300	300	300	334	506	377
Non-residents day trip	300	300		331	248	
Non-residents business/VFR/other	300			95		
Residents				322		

	Target SP			**Number of respondents RP**		
	Ferry	*Helicopter*	*Airplane*	*Ferry*	*Helicopter*	*Airplane*
Non-residents stay	75	75	75	77	92	79
Non-residents day trip	75	75		77	76	
Non-residents business/VFR/other	75			(included in non-resident numbers)		
Residents				57		

Table S.1:   Target and final number of respondents for the RP and SP surveys

The Structure of the Model

In order to meet the DfT requirements, the model needed to represent two passenger responses as a result of changes in ferry services to the Isles: changes in modal shift and changes in total travel demand.

Our experience in modelling holiday markets indicated that it would be more accurate to think of these latter responses in terms of *frequency* of travel, i.e. those persons who have never travelled to the Isles may choose to make this journey and those who currently travel to the Isles who may travel more or less frequently depending on the travel characteristics to the Isles.

It is noteworthy that we have restricted our analysis to existing travellers to the Isles of Scilly and residents of the Isles of Scilly, because it was judged that it would be too costly, both in terms of time and money, to identify persons who currently did not travel but would consider making future trips to the Isles of Scilly. The model, therefore, explicitly does not consider trips that could be made by persons who currently do not travel to the Isles of Scilly who might make journeys with improved transport services.

The total annual trips by traveller segment for future years were produced as a separate exercise using trend analysis and other techniques[2]. These provide the basic inputs into the final calibrated model. It is then the task of the model to predict:

---

[2] "Isles of Scilly Link Major Scheme Bid, Part Two: Options for the Future" by Hyder Consulting, report no. RT/DV01104/25B/023.

- the change in total forecast year demand by traveller segment as a result of changes in modal and personal attributes; and

- how the demand would be apportioned between available modes.

The information on reported journey frequency and the stated intentions data were used to estimate disaggregate models of changes in trip frequency as a result of changes in ferry service levels.

The Mode Choice Model Results

Disaggregate discrete mode choice and trip frequency models were developed for the traveller segments: day-trip visitors, staying visitors and Island residents, VFR and business travellers.

The RP and SP data have been used jointly to estimate the time, cost and frequency coefficients, taking explicit account of error variation between the data sets[3]. As part of the model estimation procedure we have explicitly tested for correlation between alternatives, through nested model structures, and for 'inertia', i.e. preference for the currently used mode.

A secondary estimation procedure has been employed to re-estimate appropriate mode-specific constants, using RP information only, as is recommended in the upcoming WebTAG advice on development of demand forecasting models for major public transport schemes (developed for DfT by RAND Europe).

In the models for the three traveller segments, the resulting model parameters were highly significant.

The best models, from a behavioural perspective, are those models which incorporate (household) income-specific cost sensitivity, resulting in income-specific values of time for access time (for the visitor models only) and ferry time. The day-trip model also incorporates separate values of time for business travellers. The resulting values of time are presented below.

	Day-Trip Visitors	Staying Visitors	Residents
Business Ferry Time	£24.07		
Personal Ferry Time			
£0-£60,000 per year	£11.82	£5.01	£9.85
£60,0000+ per year	£16.09	£22.22	£12.60
Unknown/not stated income	£14.71	£13.31	£11.41

Table S.2:   Ferry Values of Time (£/hr, 2005 prices). Note that the values for business and personal ferry time are combined for staying visitors and residents.

---

[3]   Bradley, M. A. and Daly, A. J. (1991) Estimation of Logit Choice Models using Mixed Stated Preference and Revealed Preference Information, presented to *6th. International Conference on Travel Behaviour*, Québec.

For non-business travel, the values of ferry time have been well estimated and we do not have any reason to disbelieve the resulting valuations. We have therefore recommended that the non-business values be incorporated in the appraisal procedure without adjustment. For business travel, we recommend adjustments to the model values of time to reflect WebTAG-recommended values. The user has the option of applying these amended values in the forecasting tool and we recommend that they do.

The resulting valuations for the quality improvements, both for the new ferry and for the harbour improvements at Penzance and St. Mary's, also appear to be reasonable. The following table compares the average willingness-to-pay to save 30 minutes of ferry travel time to the average valuations for the quality improvements investigated in the study, namely the introduction of the new ferry and for harbour improvements (both at Penzance and at St. Mary's together)

	Day-Trip Visitors	Staying Visitors	Residents
Faster ferry (30 min. less time)	£7	£5	£5
New ferry (less prone to seasickness)	£10	£13	£7
Harbour improvements	£6	£5	£10

Table S.3:   **Average Willingness-to-Pay for Ferry Time Savings and Quality Improvements by traveller segment (per one-way trip)**

Trip Frequency Model Results

For visitors, separate trip frequency models were estimated for day trip and staying visitors. For residents, separate models were estimated for leisure and business travel. It is noteworthy that the trip frequency term is not significant (at the 95% confidence level) in any of the models. It is our experience that it is difficult to identify significant relationships between trip frequency and level-of-service changes at a disaggregate level. The resulting trip frequency models do, however, generally reproduce the reported changes in trip making reported by the SP survey respondents, as shown below. As the table shows, both the visitors and the residents tend to predict much higher increases in trip making for the situation with improved ferry services than decreases as a result of the removal of ferry services. The models do not reflect this asymmetry, rather they reflect the average response. Additionally, for visitors we see that the day trip visitors are more sensitive to ferry accessibility changes and for residents we see that personal trips are more sensitive to ferry accessibility changes: both which we would expect.

	Improved Ferry Services		No Ferry Services	
	Model	SI Data	Model	SI Data
Day Trip Visitors	55% increase		19% decrease	
Staying Visitors	25% increase		9% decrease	
Overall Visitors	34% increase	30% increase	12% decrease	20% decrease
Residents – Personal	29% increase	20% increase	13% decrease	30% decrease
Residents - Business	16% increase	15% increase	8% decrease	20% decrease

Table S.4:   Trip Frequency Model Results: Model Results and Reported Figures

Cost-Benefit Analysis (CBA) Requirements

In order to achieve the main objective of the study the model must provide the necessary information for a CBA of the options in full conformance with the principles and practices set out in WebTAG[4], principally estimates of the traveller benefits and operator revenue.

The proposed changes to the ferry service are expected to alter the demand for the ferry and the competing air and helicopter services. WebTAG guidance suggests the use of the Rule of Half[5] for calculation of traveller benefits in such situations. However, the Rule of Half breaks down if a new mode is introduced or an existing mode becomes redundant. The Do Minimum scenario reflects the latter situation, as the existing ferry is removed from service in 2009 (for freight) and 2014 (for passengers). In this situation an estimate of the consumer surplus requires additional analysis using the travel demand model as an estimate of the demand curve. Specifically, in this study, the consumer surplus for a travelling group is calculated, in utility terms, using the exact integral of the demand function. This is converted into units of money using the model cost coefficients for the relevant demand segment.

The standard components of generalised cost from which user benefits are calculated usually include:

- changes in crossing time,

- changes in fares (if any); and

Additionally, for this study the user benefit calculations include a calculation for benefits associated with different timetables and quality benefits, both in terms of the boat and harbour-side improvements.

Placing an economic value on these characteristics represents an enhancement to a standard transport appraisal.

---

[4]   WebTAG is the UK Department for Transport's website for guidance on the conduct of transport studies, including advice on the modelling and appraisal appropriate for transport schemes.

[5]   The "rule-of-half" states that the benefits of each new passenger are equal to half the benefits of an existing passenger (the first new passenger has the full benefits, the last new passenger has no benefits; on average each new passenger has half the benefits).

Forecast Results

Future forecasts were produced using a sample enumeration procedure, where the demand model is applied for each travelling group in the (weighted) RP survey sample. This procedure allowed representation of the socio-economic variation in the sample, particularly in terms of group size (and characteristics) and household income.

In order to produce future forecasts, for each forecast year, the user is required to specify the ferry service characteristics, e.g. type of ferry, ferry journey time, ferry timetable, harbour-side quality and fares, and fare adjustments factors for the helicopter and airplane, if relevant. Other model inputs include information on future year volumes of travellers by segment are also input to the model (Hyder, 2004), information on ferry capacity, forecast changes in values of time, discount rates, etc..

The travel demand model then predicts for each observed travel group the probability of choosing a specific mode, given the characteristics of the ferry and other modes. Adjustments to the total number of trips are also calculated, depending on the overall travel accessibility, i.e. the mode choice model logsum, for the scenario. The following outputs are produced for each specified year: demand by mode and model segment, revenue by mode and model segment and consumer surplus by model segment (see Table S.4). The total consumer surplus for a 30 year projection periods are also output.

In certain forecasting scenarios the demand for ferry travel predicted by the models may exceed the ferry capacity. In these cases, the demand forecasts are adjusted by introducing a 'shadow price': a negative utility term for ferry that reduces overall demand to the exact capacity of the boat. The same shadow price term is applied to each model segment; it is not calibrated against any other utility term. The appropriate shadow price to match ferry demand to capacity is determined iteratively.

Tests have been conducted to examine the resulting ferry fare elasticities obtained from the model. These are presented below. Note that the ferry fare elasticity for day trip visitors is inelastic (i.e. elasiticity is between 0 and –1), implying that the revenues could be increased by increasing the day trip fare.

Model segment	Elasticity
Day Trip	-0.7
Day Trip (for VFR purpose)	-1.1
Day Trip (for business purpose)	-0.8
Stay Trip	-2.0
Stay Trip (for VFR purpose)	-1.9
Stay Trip (for business purpose)	-2.2
Residents (for leisure purpose)	-2.0
Residents (for business purpose)	-2.0
Total	-1.3

Table S.4:   Ferry Fare Elasticities

It is difficult to compare these fare elasticities with elasticities reported in other studies, since none of these other studies are directly comparable with the Isles of Scilly situation. Perhaps the most comparable are ferry passenger elasticities provided by the Scottish Office Industry Department[6] study on fare price elasticities, which ranged from -0.8 to –1.5 for specific Scottish ferry routes. For Eurotunnel[7] an own-elasticity to tariff for shuttle car use of -1.6 to -1.8 was found; while for the 'French Straits' the own-elasticity was -2.4. For Union Railways[8] an own-elasticity to fare for Eurostar train services of -0.5 was found. Certainly the elasticity figures found from this study are consistent with these figures, with higher elasticities for those traveller segments, i.e. staying visitors and residents, who may consider a wider-range of travel alternatives to the Isles.

Scenarios

The model has been used to evaluate a few scenarios to demonstrate its use in a cost-benefit analysis.

'Do Minimum'   with no ferry services after 2014

'Do Something 1/2'   new modern ferry on which travellers may be less prone to seasickness, travel speed 15 knots (same as now), minor harbour improvements at Penzance and St. Mary's

'Do Something 3/4'   new modern ferry on which travellers may be less prone to seasickness, travel speed 20 knots (30 mins time savings), minor harbour improvements at Penzance and St. Mary's

The results for each scenario test are presented below.

In the 'Do Minimum' scenario, the ferry is taken out of service in 2014. As a result, it will become more difficult to travel to and from the Isles of Scilly (less service alternatives), making travel to the Islands less attractive. This results in an 8% decrease in trips in 2015, compared to 2014. The demand for day trips declines most substantially (–14.7%), largely because of the high ferry market share in 2014 (53.8%). The demand for trips by staying visitors and by residents drops relatively less (stay -5.3%, resident –9.6%).

The remaining demand is distributed over the airplane and helicopter. Both modes gain market share: the market share of the airplane will go up from 24.4% to 31.9% and the market share of the helicopter will go up from 49.1 to 68.1%.

---

[6] SOID (1992) *Fare Price Elasticities on the Caledonia MacBrayne Ferry Network*, Scottish Office Industry Department Research Paper

[7] HCG 312-2 (1993), p. 26
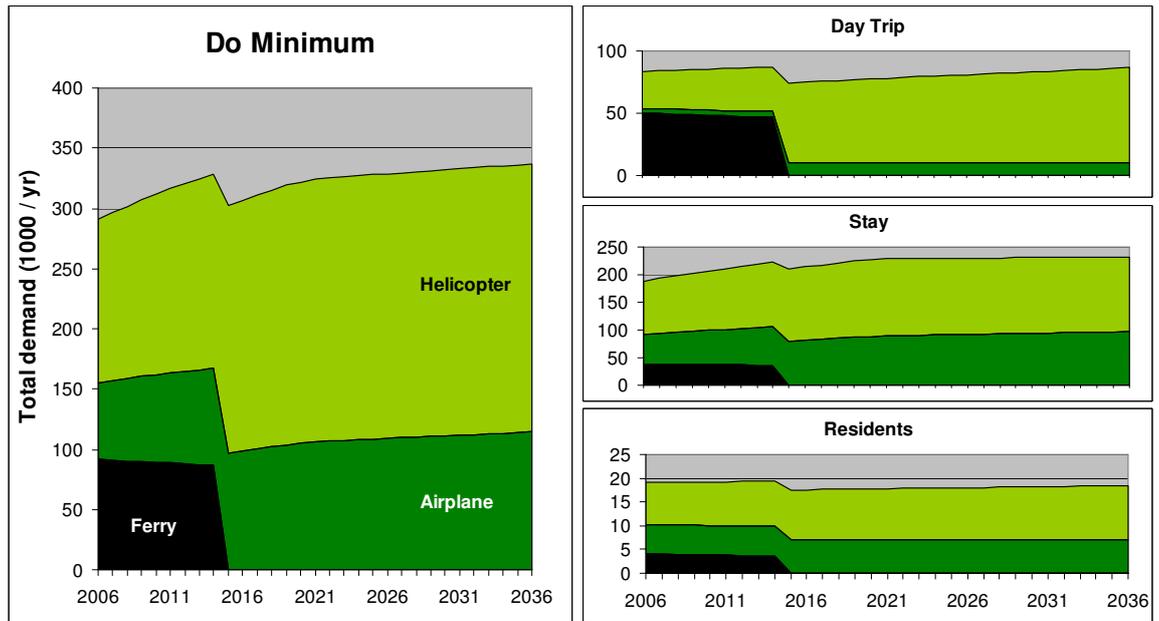
[8] HCG 345-2 (1994), p. 27-28

Figure S.4:   Model results for 'Do Minimum' scenario

In the Do Something 1/2 scenario, the model predicts a 7.4% increase in demand, as a result of the improved ferry services. This increase is largely due to increases in day-trip visitors (+18.0%), since the stay market cannot grow more rapidly (+2.5%) because of hotel bed restrictions. The number of resident trips grows by extra 11.1%. With this growth in travel demand and with these improvements the model predicts that the ferry will reach its capacity immediately (currently set at 158,400 passengers per year). The resulting airplane market share drops from 22.6% in 2008 to 16.7% in 2009. The helicopter share will also drop from 47.4% (2008) to 34.4% (2009).
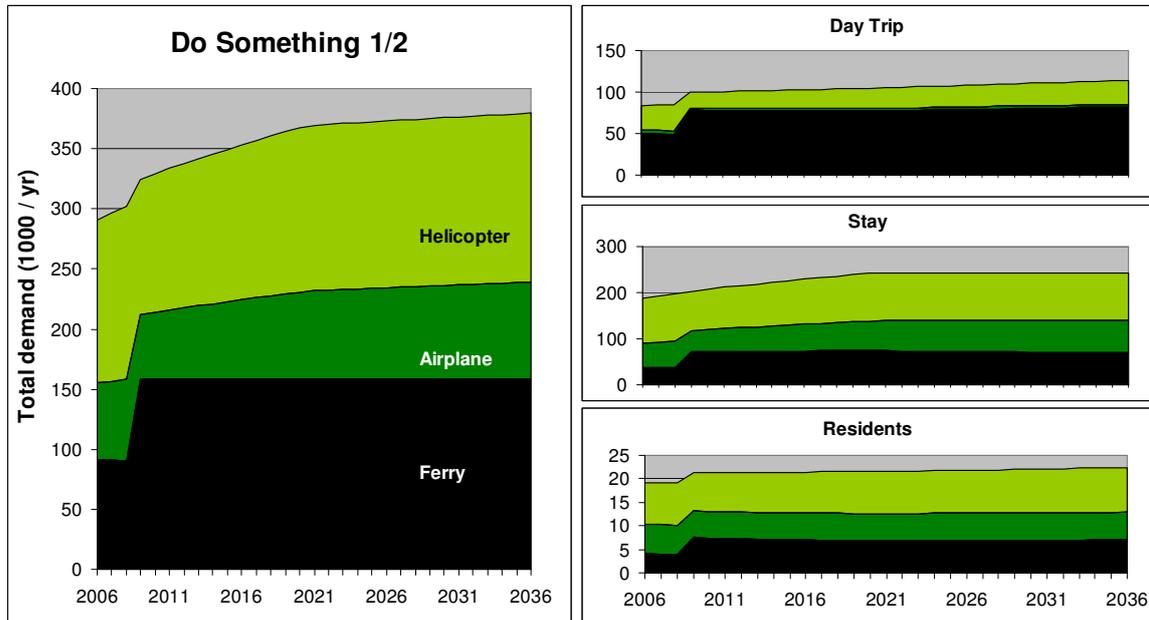
Figure S.5: Model results for 'Do Something 1/2' scenario

In the Do Something 3/4 scenario, the 30 minute time savings in ferry travel time makes the new ferry even more attractive, which leads to further growth of demand. However, since the ferry is already operating at maximum capacity, this does not increase the ferry market share.
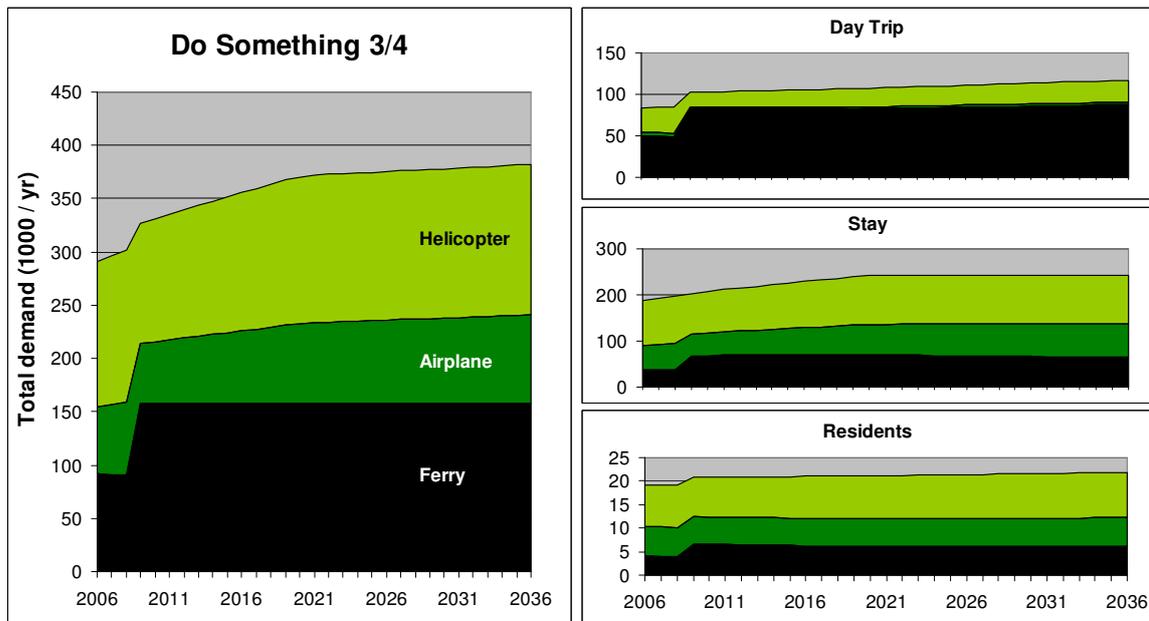

Figure S.7: Model results for 'Do Something 3/4' scenario

The findings reported above are those predicted from the model that has been estimated from the RP and SP data. There are several reasons why the scenarios presented above might be too optimistic:

- people may have been too optimistic about new options;

- the findings may be subject to 'package effects', specifically that people have a willingness-to-pay threshold for a package of items, which is not measured when looking at the value of individual components of the package).

A 50% reduction of the effect of the new boat and of the harbour improvements approximately reflects the lower bound of the estimated parameters, considering the 95% confidence interval.

The model results, assuming 50% of the values for the new boat and harbourside improvements are presented below. From these results, it can be seen that demand does not grow as much as in the previous scenario. However, the ferry is still predicted to operate at maximum capacity in 2009; although due to the decreasing attractiveness of the ferry over time, the ferry demand is below capacity from 2026.
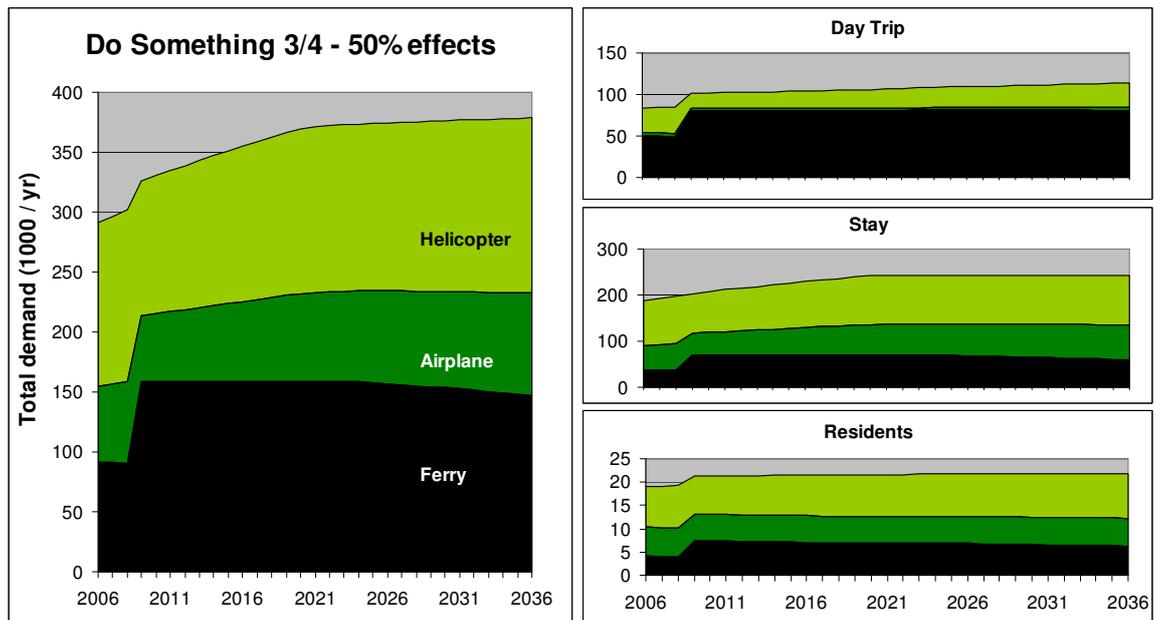

Figure S.8:   Model results for 'Do Something 3/4' scenario with 50% effects