Draft Appendix C: AMHS Regression Models

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Prepared by

Northern Economics

Anchorage
800 E Dimond Boulevard
Suite 3-300
Anchorage, Alaska 99515-2049
Phone: 907.274.5600
Fax: 907.290.2464

Seattle
1455 NW Leary Way
Suite 400
Seattle, WA 98107
Phone: 206.747.8475

www.northerneconomics.com

PROFESSIONAL CONSULTING SERVICES IN APPLIED ECONOMICS AND SOCIAL SCIENCES

Principals:
Patrick Burden, M.S. – Chairman
Marcus L. Hartley, M.S. – President
Michael Fisher, MBA – Vice President
Diane Sauer – Office Manager

Consultants:
Leah Cuyno, Ph.D.
Michael Downs, Ph.D.
Brock Lane, M.S.
Don Schug, Ph.D.
Katharine Wellman, Ph.D.

Administrative Staff:
Terri McCoy, B.A. – Editor

Northern Economics

800 E Dimond Blvd., Suite 3-300
Anchorage, Alaska 99515
Phone: 907.274.5600
Fax: 907.290.2464

1455 NW Leary Way, Suite 400
Seattle, WA 98107
Phone: 206.747.8475
Email: mail@norecon.com
www.northerneconomics.com

Preparers

Team Member	Project Role
Michael Fisher	Project Manager
Marcus Hartley	Principal Investigator
Brock Lane	Analyst
Emilie Franke	Analyst
Terri McCoy	Editor

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1 Introduction and Methods

The purpose of this appendix is to summarize the regression models which serve as a basis for the AMHS reshaping study revenue models. Regression models are a statistical method of analyzing data that are used for predictions and forecasting in a variety of industries. Regression modeling uses actual data to create an equation which isolates the effects of variables on a specific variable of interest, the dependent variable. In the case of AMHS data, the study team estimates the number of passengers onboard a vessel or the combined length of vehicles on the car deck (dependent variables) as a function of other important independent variables including time of year, services available at the departure and arrival ports, number of sailings, and fare prices.

Regression models provide a standardized way to estimate revenues for different combinations of assumptions. Since each model is derived from historical travel patterns, they provide a mathematical and objective basis for comparing each set of conditions. This study compares several quantitative assessments with unique AMHS schedules, levels of service, and operating parameters; however, each assessment relies on the same underlying data and model structure as the basis for revenue estimates.

The mathematical models presented in this appendix use an ordinary-least-squares estimation method[1] to perform the regression, which was completed using the statistical analysis software STATA (version 12). The regression models are derived from vessel data provided by DOT&PF. The data were reorganized into the structure shown in Figure 1 below, where each row represents one month in a given year, and a unique pair of AMHS port cities. For each year-month and city-pair combination, the data summarizes vessel and revenue characteristics such as the number of sailings performed, the number of passengers, cabin rentals, and car deck occupancy, as well as the revenues collected for each.

Figure 1. Sample of AMHS Regression Model Data

CityPair	PORT_FROM	PORT_TO	YearMonth	Sailings	PaxCount	PaxFares	CabinCount	CabinFares
BELHNS	BEL	HNS	7/1/2008	3	366	106592	102	44463
BELHNS	BEL	HNS	8/1/2008	5	423	128480	119	55101
BELHNS	BEL	HNS	9/1/2008	4	201	62652	78	34048
BELHNS	BEL	HNS	10/1/2008	5	328	42184	114	53399
BELHNS	BEL	HNS	11/1/2008	4	158	20418	56	25972

The model compares all points in the data set (July 2008–December 2019) to estimate how much the dependent variable is affected by each independent variable. The model uses the data to recognize that sailings during summer months will have more passengers and vehicles than during winter months. Similarly, the models use historical changes in key variables, like prices and the level of AMHS service, to allow the study team to make predictions based on changes to those variables.

In addition to the vessel data, the regression models account for several exogenous traits that are specific to AMHS port cities. Ridership on AMHS trips will likely be higher when either the departure or arrival city has important transportation infrastructure or services, which are treated as indicator or "dummy" variables—those that take a value of either 1 or 0 in the data set. Table 1 shows the

[1] Ordinary Least Squares is a common linear regression model that estimates the effects from an explanatory set of variables on the dependent variable. The model is based on minimizing the sum of squares of the differences between the observed and model-predicted dependent variable values. The difference between the actual and predicted values is also called a residual value.

indicator variable values for each city to account for the presence of hospitals, access to a contiguous road system head, access to a major metro area to account for grocery and major retail stores, access to a jet service airport, and an additional indicator if the city is considered a regional hub.

Table 1. Indicator Variable Coding

Area Name	Has Hospital?	Has Roadhead?	Access Major Metro Area?	Jet Service Airport?	Regional Hub?
Akutan city	0	0	0	0	0
Cold Bay city	0	0	0	1	0
False Pass city	0	0	0	0	0
King Cove city	0	0	0	0	0
Sand Point city	0	0	0	0	0
Unalaska city	0	0	0	0	1
Haines CDP	0	1	0	0	0
Angoon city	0	0	0	0	0
Gustavus city	0	0	0	0	0
Hoonah city	0	0	0	0	0
Pelican city	0	0	0	0	0
Tenakee Springs city	0	0	0	0	0
Juneau city and borough place	1	0	0	1	1
Homer city	0	1	1	1	1
Seldovia city	0	0	0	0	0
Ketchikan city	1	0	0	1	1
Kodiak city	1	0	0	1	1
Old Harbor city	0	0	0	0	0
Ouzinkie city	0	0	0	0	0
Port Lions city	0	0	0	0	0
Chignik city	0	0	0	0	0
Petersburg city	0	0	0	0	0
Kake city	0	0	0	0	0
Metlakatla CDP	0	0	0	0	0
Sitka city and borough place	1	0	0	1	1
Skagway CDP	0	1	0	0	0
Chenega CDP	0	0	0	0	0
Cordova city	0	0	0	1	0
Tatitlek CDP	0	0	0	0	0
Valdez city	1	1	0	0	0
Whittier city	0	1	1	0	1
Wrangell city and borough place	0	0	0	0	0
Yakutat CDP	0	0	0	1	0
Prince Rupert, BC	1	1		0	1
Bellingham, WA	1	1	1	0	1
Annette Bay	0	0	0	0	0

We note that variables are sometimes omitted from the models on the basis of collinearity, which is caused when there is too little variation in the data used to estimate the model. For example, the City of Homer has access to a roadhead (Seward Highway), access to a major metro area (Anchorage), access to a Jet Airport (TSAIA in Anchorage) and is also considered a regional hub. A model which estimates passenger and car deck ridership for segments that include Homer will always have a value of 1 for each of the four previously mentioned indicator variables. Since there is no variation between any of the included data for these variables, STATA will automatically omit the variables since there is no basis for estimating their effect on the independent variable. Within each of following tables omitted variables are denoted with a 0 for the variable coefficient and the word "Omitted" in the P-Value column.

The regression models shown in Table 2 are used in the AMHS reshaping study revenue models.

Table 2. Summary of AMHS Regression Models

Route Group	Model Specification
Mainline	All port-pairs
Mainline	Excludes port-pairs where to/from Port is Bellingham
Mainline	Excludes port-pairs where to/from Port is Prince Rupert
Mainline	Excludes port-pairs where to/from Port is Bellingham or Prince Rupert
SE Feeder	Includes port-pairs where to/from port is Juneau
SE Feeder	Includes port-pairs where to/from port is Sitka
Lynn Canal	Includes port-pairs where to/from port is Juneau
PWS	Includes Cordova-Whittier and Whitter-Cordova port-pairs
Hom-Kod	Includes Homer-Kodiak and Kodiak-Homer port-pairs
SW	Includes port-pairs where to/from port is Homer
SW	Includes port-pairs where to/from port is Kodiak
Metlakatla	Includes all port-pairs in a separate data set specific to the Metlakatla-Ketchikan route group
PWS	Includes Valdez-Whittier and Whitter-Valdez port-pairs
Lynn Canal	Includes Haines-Skagway and Skagway-Haines port-pairs
Cross Gulf	Includes port-pairs where to/from port is Chenega Bay, Ouzinkie, Port Lions, or Seldovia
Cross Gulf	Includes port-pairs where to/from port is Chenega Bay, Ouzinkie, Port Lions, or Seldovia and to/from port is not Bellingham

For each model specification the study team constructed two regressions: one to predict passenger ridership and one to predict car deck ridership. These models are presented in a single table for each model specification, and show the variable coefficients as well as their statistical significance, using a P-value[2]. Model goodness-of-fit is measured using an R-squared value[3], provided at the bottom of each table along with the number of included observations from the data set. Each table is also preceded by an equation form of the regression models. The key variables in the models are the number of monthly sailings and the fare price paid by travelers. Additional model parameters are used in model estimation to account for seasonality and characteristics of individual ports.

[2] A P-value is the output of a statistical significance test called a Z-test which compares the mean value of two approximately normal distributions. In a regression, the Z-test compares data observations with differing independent variable values to measure the importance of the variable in explaining differences in the observed data. The P-value represents the likelihood or probability that the coefficient estimate for a variable is not statistically significant or important to the model. A P-value of 10 percent or less is widely accepted in econometric models and means that there is a 90 percent or greater chance that the variable is statistically significant.

[3] An R-squared value is a common measurement of model goodness-of-fit and provides an indication of model accuracy. A model with an R-squared value of 1.00 or 100 percent is one whose independent variable coefficients and equation perfectly explain all changes in the dependent variable within the data set. Declining R-squared values, measured as a percentage, indicate declining model accuracy and quality. For example, a model with an R-Squared value of 0.5 explains 50 percent of the observed variation in the dependent variable. The remaining 50 percent can be due to factors not accounted for in the model or random error in the residual values.

2 Regression Models

Equation 1. Mainline (All) Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 0.9 + 0.39 \cdot MS - 5.29 \cdot FP_{Passengers} + 6.79 \cdot PM - 2.37 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = -13.22 + 1.80 \cdot MS - 46.99 \cdot FP_{CarDeck} + 22.22 \cdot PM - 21.89 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 3. Mainline (All) Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	0.90	0.29	-13.22	0.09
Continuous	MS	Monthly Sailings	0.39	0.00	1.80	0
Continuous	FP	Fare Price	-5.29	0.00	-46.99	0.56
Indicator Variable	PM	Peak Months	6.79	0.00	22.22	0
Indicator Variable	WM	Winter Months	-2.37	0.00	-21.89	0
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	2.19	0.00	5.37	0.221
Indicator Variable	i=2	Has Road Head?	-0.26	0.53	31.27	0
Indicator Variable	i=3	Access Metro Area?	21.45	0.00	183.42	0
Indicator Variable	i=4	Has Jet Airport?	8.43	0.00	80.21	0
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
	Observations		9,301		9,301	
	R-Squared		0.29		0.31	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values of operating months within the modeled schedule are used as the input within the revenue model.

Equation 2. Mainline Excluding Bellingham Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = -0.24 + 0.43 \cdot MS - 1.63 \cdot FP_{Passengers} + 3.93 \cdot PM - 0.98 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = -7.08 + 1.79 \cdot MS - 18.72 \cdot FP_{CarDeck} + 14.76 \cdot PM - 18.38 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 4. Mainline Excluding Bellingham Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	-0.24	0.74	-7.08	0.23
Continuous	MS	Monthly Sailings	0.43	0.00	1.79	0.00
Continuous	FP	Fare Price	-1.63	0.17	-18.72	0.76
Indicator Variable	PM	Peak Months	3.93	0.00	14.76	0.00
Indicator Variable	WM	Winter Months	-0.98	0.01	-18.38	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	5.86	0.00	37.08	0.00
Indicator Variable	i=2	Has Road Head?	-1.33	0.00	18.56	0.00
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	4.11	0.00	39.06	0.00
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			7,590		7,590	
R-Squared			0.18		0.15	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 3. Mainline Excluding Prince Rupert Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 9.69 + 0.50 \cdot MS - 19.77 \cdot FP_{Passengers} + 5.89 \cdot PM - 2.33 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 67.87 + 2.28 \cdot MS - 717.45 \cdot FP_{CarDeck} + 11.69 \cdot PM - 16.51 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 5. Mainline Excluding Prince Rupert Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	9.69	0.00	67.87	0.00
Continuous	MS	Monthly Sailings	0.50	0.00	2.28	0.00
Continuous	FP	Fare Price	-19.77	0.00	-717.45	0.00
Indicator Variable	PM	Peak Months	5.89	0.00	11.69	0.00
Indicator Variable	WM	Winter Months	-2.33	0.00	-16.51	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	-10.12	0.00	-111.07	0.00
Indicator Variable	i=2	Has Road Head?	-5.00	0.00	-15.45	0.00
Indicator Variable	i=3	Access Metro Area?	31.47	0.00	284.16	0.00
Indicator Variable	i=4	Has Jet Airport?	15.37	0.00	149.26	0.00
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			7,476		7,476	
R-Squared			0.33		0.37	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 4. Mainline Excluding Bellingham and Prince Rupert Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 8.38 + 0.57 \cdot MS - 17.83 \cdot FP_{Passengers} + 1.75 \cdot PM - 0.47 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 68.78 + 2.42 \cdot MS - 728.48 \cdot FP_{CarDeck} - 1.46 \cdot PM - 11.05 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 6. Mainline Excluding Bellingham and Prince Rupert Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	8.38	0.00	68.78	0.00
Continuous	MS	Monthly Sailings	0.57	0.00	2.42	0.00
Continuous	FP	Fare Price	-17.83	0.00	-728.48	0.00
Indicator Variable	PM	Peak Months	1.75	0.00	-1.46	0.57
Indicator Variable	WM	Winter Months	-0.47	0.21	-11.05	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	5.40	0.00	37.67	0.00
Indicator Variable	i=2	Has Road Head?	-4.74	0.00	-15.41	0.00
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			5,771		5,771	
R-Squared			0.23		0.18	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 5. SE Feeder, To or From is Juneau Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 35.05 + 0.57 \cdot MS - 26.80 \cdot FP_{Passengers} + 15.27 \cdot PM + 1.73 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 192.50 + 5.80 \cdot MS - 609.65 \cdot FP_{CarDeck} - 0.93 \cdot PM - 20.95 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 7. SE Feeder, To or From is Juneau Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	35.05	0.00	192.50	0.00
Continuous	MS	Monthly Sailings	0.57	0.00	5.80	0.00
Continuous	FP	Fare Price	-26.80	0.00	-609.65	0.00
Indicator Variable	PM	Peak Months	15.27	0.00	-0.93	0.91
Indicator Variable	WM	Winter Months	1.73	0.09	-20.95	0.01
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
	Observations		1,195		1,195	
	R-Squared		0.19		0.10	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 6. SE Feeder, To or From is Sitka Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 20.55 - 0.57 \cdot MS - 32.03 \cdot FP_{Passengers} + 11.58 \cdot PM - 4.92 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 95.46 - 3.57 \cdot MS - 547.22 \cdot FP_{CarDeck} + 25.09 \cdot PM - 32.48 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 8. SE Feeder, To or From is Sitka Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	20.55	0.00	95.46	0.00
Continuous	MS	Monthly Sailings	-0.57	0.16	-3.57	0.04
Continuous	FP	Fare Price	-32.03	0.00	-547.22	0.00
Indicator Variable	PM	Peak Months	11.58	0.00	25.09	0.00
Indicator Variable	WM	Winter Months	-4.92	0.00	-32.48	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			210		210	
R-Squared			0.31		0.27	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 7. Lynn Canal, To or From is Juneau Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 60.85 + 0.34 \cdot MS - 41.21 \cdot FP_{Passengers} + 19.69 \cdot PM - 8.33 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 765.13 + 1.10 \cdot MS - 5382.72 \cdot FP_{CarDeck} + 37.86 \cdot PM - 137.89 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 9. Lynn Canal, To or From is Juneau Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	60.85	0.00	765.13	0.00
Continuous	MS	Monthly Sailings	0.34	0.01	1.10	0.19
Continuous	FP	Fare Price	-41.21	0.00	-5382.72	0.00
Indicator Variable	PM	Peak Months	19.69	0.00	37.86	0.02
Indicator Variable	WM	Winter Months	-8.33	0.00	-137.89	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			504		504	
R-Squared			0.37		0.30	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 8. PWS for Cordova-Whittier and Whitter-Cordova Port-Pairs Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 47.20 - 0.23 \cdot MS - 12.27 \cdot FP_{Passengers} + 14.74 \cdot PM - 10.41 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 810.91 - 5.57 \cdot MS - 3875.96 \cdot FP_{CarDeck} + 75.43 \cdot PM - 158.54 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 10. PWS for Cordova-Whittier and Whitter-Cordova Port-Pairs Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	47.20	0.00	810.91	0.00
Continuous	MS	Monthly Sailings	-0.23	0.02	-5.57	0.00
Continuous	FP	Fare Price	-12.27	0.00	-3875.96	0.00
Indicator Variable	PM	Peak Months	14.74	0.00	75.43	0.00
Indicator Variable	WM	Winter Months	-10.41	0.00	-158.54	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			248		248	
R-Squared			0.51		0.46	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 9. Hom-Kod for Homer-Kodiak and Kodiak-Homer Port-Pairs Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 85.94 - 1.32 \cdot MS - 25.95 \cdot FP_{Passengers} + 25.34 \cdot PM - 26.76 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 1206.18 - 28.66 \cdot MS - 2982.73 \cdot FP_{CarDeck} + 135.42 \cdot PM - 255.28 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 11. Hom-Kod for Homer-Kodiak and Kodiak-Homer Port-Pairs Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	85.94	0.00	1206.18	0.00
Continuous	MS	Monthly Sailings	-1.32	0.00	-28.66	0.00
Continuous	FP	Fare Price	-25.95	0.00	-2982.73	0.00
Indicator Variable	PM	Peak Months	25.34	0.00	135.42	0.00
Indicator Variable	WM	Winter Months	-26.76	0.00	-255.28	0.00
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			250		250	
R-Squared			0.65		0.66	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 10. SW, To or From is Homer Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 7.05 + 0.03 \cdot MS - 3.93 \cdot FP_{Passengers} + 1.94 \cdot PM + 0 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 74.07 - 1.65 \cdot MS - 127.97 \cdot FP_{CarDeck} - 19.27 \cdot PM + 0 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 12. SW, To or From is Homer Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	**Abbreviation**	**Variable Name**	**Coefficient (β)**	**P-Value**	**Coefficient (β)**	**P-Value**
Key Variables						
N/A	N/A	Constant	7.05	0.00	74.07	0.00
Continuous	MS	Monthly Sailings	0.03	0.96	-1.65	0.59
Continuous	FP	Fare Price	-3.93	0.14	-127.97	0.06
Indicator Variable	PM	Peak Months	1.94	0.01	-19.27	0.00
Indicator Variable	WM	Winter Months	0.00	(Omitted)	0.00	(Omitted)
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			738		738	
R-Squared			0.01		0.04	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 11. SW, To or From is Kodiak Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 7.05 - 0.90 \cdot MS - 8.41 \cdot FP_{Passengers} + 1.50 \cdot PM + 0 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 7.05 - 0.90 \cdot MS - 8.41 \cdot FP_{CarDeck} + 1.50 \cdot PM + 0 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 13. SW, To or From is Kodiak Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	7.05	0.00	7.05	0.00
Continuous	MS	Monthly Sailings	-0.90	0.00	-0.90	0.00
Continuous	FP	Fare Price	-8.41	0.00	-8.41	0.00
Indicator Variable	PM	Peak Months	1.50	0.00	1.50	0.00
Indicator Variable	WM	Winter Months	0.00	(Omitted)	0.00	(Omitted)
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Access Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			746		746	
R-Squared			0.05		0.02	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 12. Metlakatla-Ketchikan and Ketchikan-Metlakatla Port-Pairs Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 37.62 + 0.003 \cdot MS - 3.09 \cdot FP_{Passengers} + 0.29 \cdot PM + 0.68 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 279.68 - 0.09 \cdot MS - 39.31 \cdot FP_{CarDeck} + 3.39 \cdot PM - 0.09 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 14. Metlakatla-Ketchikan and Ketchikan-Metlakatla Port-Pairs Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	37.62	0.00	279.68	0.00
Continuous	MS	Monthly Sailings	0.003	0.91	-0.09	0.43
Continuous	FP	Fare Price	-3.09	0.00	-39.31	0.00
Indicator Variable	PM	Peak Months	0.29	0.83	3.39	0.51
Indicator Variable	WM	Winter Months	0.68	0.60	-0.09	0.99
Observations			66		66	
R-Squared			0.33		0.55	

Notes: This model is based on a separate data set from all other regression models in the study, because tickets are priced for round-trip service. Since there are only two ports within the data set, the independent variable parameters to control for available amenities are unnecessary and not included.

*Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 13. PWS for Whittier-Valdez and Valdez-Whitter Port-Pairs Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 24.15 - 1.21 \cdot MS - 16.88 \cdot FP_{Passengers} + 13.74 \cdot FEB + 11.94 \cdot MAR + 7.20 \cdot APR + 44.14 \cdot MAY + 88.82 \cdot JUN + 117.80 \cdot JUL + 110.34 \cdot AUG + 56.21 \cdot SEP + 9.91 \cdot OCT + 1.39 \cdot NOV - 2.01 \cdot DEC + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 205.06 - 7.67 \cdot MS - 1027.48 \cdot FP_{CarDeck} + 32.49 \cdot FEB + 41.11 \cdot MAR + 56.89 \cdot APR + 266.12 \cdot MAY + 538.19 \cdot JUN + 662.59 \cdot JUL + 616.64 \cdot AUG + 332.75 \cdot SEP + 58.84 \cdot OCT + 4.34 \cdot NOV - 15.09 \cdot DEC + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 15. PWS for Whittier-Valdez and Valdez-Whitter Port-Pairs Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	24.15	0.00	205.06	0.00
Continuous	MS	Monthly Sailings	-1.21	0.00	-7.67	0.00
Continuous	FP	Fare Price	-16.88	0.00	-1027.48	0.05
Indicator Variable	FEB	February	13.74	0.00	32.49	0.20
Indicator Variable	MAR	March	11.94	0.00	41.11	0.09
Indicator Variable	APR	April	7.20	0.08	56.89	0.02
Indicator Variable	MAY	May	44.14	0.00	266.12	0.00
Indicator Variable	JUN	June	88.82	0.00	538.19	0.00
Indicator Variable	JUL	July	117.80	0.00	662.59	0.00
Indicator Variable	AUG	August	110.34	0.00	616.64	0.00
Indicator Variable	SEP	September	56.21	0.00	332.75	0.00
Indicator Variable	OCT	October	9.91	0.02	58.84	0.02
Indicator Variable	NOV	November	1.39	0.75	4.34	0.87
Indicator Variable	DEC	December	-2.01	0.66	-15.09	0.57
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Is Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
	Observations			226		226
	R-Squared			0.87		0.88

Equation 14. Lynn Canal for Haines-Skagway and Skagway-Haines Port-Pairs Regression Model Equations

$$Y_{Passengers\ per\ Sailing} = 20.63 - 0.64 \cdot MS - 2.81 \cdot FP_{Passengers} + 1.41 \cdot FEB + 3.44 \cdot MAR + 9.81 \cdot APR + 24.65 \cdot MAY + 45.12 \cdot JUN + 61.37 \cdot JUL + 56.14 \cdot AUG + 34.61 \cdot SEP + 12.27 \cdot OCT + 4.43 \cdot NOV + 0.45 \cdot DEC + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 165.95 - 5.95 \cdot MS - 121.92 \cdot FP_{CarDeck} + 1.45 \cdot FEB + 32.10 \cdot MAR + 105.89 \cdot APR + 230.11 \cdot MAY + 429.27 \cdot JUN + 557.05 \cdot JUL + 516.70 \cdot AUG + 308.27 \cdot SEP + 113.15 \cdot OCT + 35.29 \cdot NOV + 3.47 \cdot DEC + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 16. Lynn Canal for Haines-Skagway and Skagway-Haines Port-Pairs Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	20.63	0.00	165.95	0.00
Continuous	MS	Monthly Sailings	-0.64	0.00	-5.96	0.00
Continuous	FP	Fare Price	-2.81	0.00	-121.92	0.28
Indicator Variable	FEB	February	1.41	0.40	1.45	0.94
Indicator Variable	MAR	March	3.44	0.04	32.10	0.08
Indicator Variable	APR	April	9.81	0.00	105.89	0.00
Indicator Variable	MAY	May	24.65	0.00	230.11	0.00
Indicator Variable	JUN	June	45.12	0.00	429.27	0.00
Indicator Variable	JUL	July	61.37	0.00	557.05	0.00
Indicator Variable	AUG	August	56.14	0.00	516.70	0.00
Indicator Variable	SEP	September	34.61	0.00	308.27	0.00
Indicator Variable	OCT	October	12.27	0.00	113.15	0.00
Indicator Variable	NOV	November	4.43	0.01	35.29	0.05
Indicator Variable	DEC	December	0.45	0.79	3.47	0.85
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=2	Has Road Head?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=3	Is Metro Area?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=4	Has Jet Airport?	0.00	(Omitted)	0.00	(Omitted)
Indicator Variable	i=5	Is Regional Hub?	0.00	(Omitted)	0.00	(Omitted)
Observations			252		252	
R-Squared			0.91		0.88	

Equation 15. Cross Gulf for Service to Chenega Bay, Ouzinkie, Port Lions, and Seldovia Equations

$$Y_{Passengers\ per\ Sailing} = 73.99 + 0.57 \cdot MS - 38.40 \cdot FP_{Passengers} + 4.74 \cdot PM - 5.29 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = 432.03 + 26.87 \cdot MS - 942.54 \cdot FP_{CarDeck} - 14.10 \cdot PM + 17.35 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 17. Cross Gulf for Service to Chenega Bay, Ouzinkie, Port Lions, and Seldovia Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	73.99	0.00	432.03	0.00
Continuous	MS	Monthly Sailings	0.57	0.46	26.87	0.00
Continuous	FP	Fare Price	-38.40	0.00	-942.54	0.00
Indicator Variable	PM	Peak Months	4.74	0.00	-14.10	0.11
Indicator Variable	WM	Winter Months	-5.29	0.00	17.35	0.27
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	9.87	0.00	107.59	0.00
Indicator Variable	i=2	Has Road Head?	0.88	0.87	47.05	0.45
Indicator Variable	i=3	Access Metro Area?	7.62	0.16	52.54	0.40
Indicator Variable	i=4	Has Jet Airport?	-58.48	0.00	-429.51	0.00
Indicator Variable	i=5	Is Regional Hub?	-10.40	0.17	-54.62	0.53
Observations			1,209		1,209	
R-Squared			0.63		0.44	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.

Equation 16. Cross Gulf for Service to Chenega Bay, Ouzinkie, Port Lions, and Seldovia, When To or From is Not Bellingham Equations

$$Y_{Passengers\ per\ Sailing} = 14.23 + 0.28 \cdot MS - 39.02 \cdot FP_{Passengers} + 3.44 \cdot PM - 3.80 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

$$Y_{Car\ Deck\ per\ Sailing} = -50.39 + 28.09 \cdot MS - 952.85 \cdot FP_{CarDeck} - 18.15 \cdot PM + 28.64 \cdot WM + \sum_{i=1}^{5} \beta_i \cdot Parameter_i$$

Table 18. Cross Gulf for Service to Chenega Bay, Ouzinkie, Port Lions, and Seldovia, When To or From is Not Bellingham Regression Models and Baseline Values

			Passengers per Sailing		Car Deck (feet) per Sailing	
Variable Type	Abbreviation	Variable Name	Coefficient (β)	P-Value	Coefficient (β)	P-Value
Key Variables						
N/A	N/A	Constant	14.23	0.12	-50.39	0.68
Continuous	MS	Monthly Sailings	0.28	0.71	28.09	0.01
Continuous	FP	Fare Price	-39.02	0.00	-952.85	0.00
Indicator Variable	PM	Peak Months	3.44	0.00	-18.15	0.07
Indicator Variable	WM	Winter Months	-3.80	0.01	28.64	0.10
Parameters for Model Specification						
Indicator Variable	i=1	Has a Hospital?	11.15	0.00	140.99	0.00
Indicator Variable	i=2	Has Road Head?	0.17	0.97	44.62	0.47
Indicator Variable	i=3	Access Metro Area?	10.21	0.03	92.88	0.13
Indicator Variable	i=4	Has Jet Airport?	0.59	0.93	34.51	0.68
Indicator Variable	i=5	Is Regional Hub?	-9.66	0.13	-70.34	0.41
Observations			936		936	
R-Squared			0.29		0.22	

*Note: Peak Months and Winter Months variables are used as indicator variables within the regression, but percentage values are used as the input within the revenue model equations.