Sea Duck Joint Venture
Annual Project Summary for Endorsed Projects
FY 2008 – (October 1, 2007 to Sept 30, 2008)
Reporting Deadline: September 29, 2008

Project Title:

Distribution of Sea Ducks in Southeast Alaska: Geographic Patterns and Relationships to Coastal Habitats. SDJV Project # 86. Year 2 of 2 years.

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Project Description:

Aerial surveys flown by the U.S. Fish and Wildlife Service (FWS) indicate that Southeast Alaska (Figure 1) provides winter habitat for at least 10 species of sea ducks totaling >300,000 individuals, making the region one of the most important sea duck wintering areas in the Pacific Flyway. In summer the region provides molting habitat for large numbers of scoters and mergansers. Despite this, relatively little is known about the coastal habitat requirements of many of the sea ducks that occur in this region.

This study utilizes existing aerial survey data collected by the FWS between 1996 and 2002 to examine sea duck distributions and relationships with coastal habitat attributes. The aerial surveys were comprehensive, covering the majority of the Southeast AK coastline. Species extracted from the survey for analysis were: harlequin duck, black scoter, surf scoter, white-winged scoter, long-tailed duck, bufflehead, common goldeneye, Barrow's goldeneye, common merganser, and red-breasted merganser. These could not all by identified to species during the survey, therefore some species were grouped (e.g., common and Barrow's goldeneye). Sea duck observations and habitat attributes have been summarized using a geographic information system (GIS). Analysis of summary data includes species diversity indices and generalized linear modeling to identify important habitat attributes. Results will be provided for summer and winter habitat use by species group.

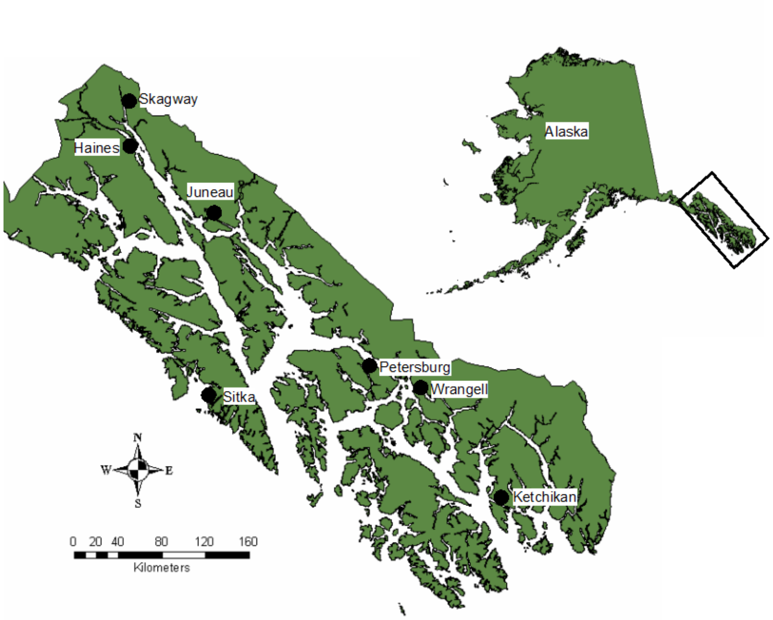

Figure 1: Study Location – Southeast Alaska

Objectives:

1. Document and map regional patterns of species diversity among sea ducks that occur in Southeast Alaska.

2. Compare regional distributions of scoters, harlequin ducks, goldeneye, bufflehead, long-tailed ducks, and mergansers in Southeast Alaska.

3. For each species or species group of sea ducks, assess consistency in distributions across years, and similarities between summer and winter distributions.

4. For each species or species group, develop and test models describing seasonal relationships between characteristics of shoreline or nearshore environments and numbers of sea ducks.

This project contributes to the identification of important coastal sea duck habitats, a SDJV priority. The characterization of winter habitats in particular was identified by the SDJV strategic plan (2001) as a moderate to high research need for most species of sea ducks that occur in Southeast Alaska.

Results*:*

Analysis of Winter Habitat Associations

We modeled the relationship between the presence of six groups of sea ducks in winter and selected shoreline habitat variables using logistic regression. Duck observations and habitat variables were summarized into randomly selected 0.5 mile plots using GIS. The shoreline habitat variables that were strongly correlated with each other were removed, leaving 6 variables that were used for each species group: a shoreline exposure ranking, the distance to the outer exposed coast, the distance to the nearest large stream (5km or longer), the number of islets, the percentage of shoreline by length that was rocky (as opposed to sandy or muddy) and the intertidal width. We used Akaike's Information Criterion to identify the most parsimonious models. We evaluated the models using a second set of plots from the aerial duck observation dataset, and calculated receiver operating characteristic curves (ROC) as an indication of classification accuracy. The area under the ROC curve (AUC) provides a single measure of accuracy that is threshold independent. An AUC value of 1.0 indicates a perfect prediction, while 0.5 indicates random predictions. For our model evaluation, we considered AUC values of 0.90-1 as excellent, 0.80-0.90 as good, 0.70-0.80 as fair, 0.60-0.70 as poor, and 0.50-0.60 as inadequate.

Spatial Autocorrelation

Moran's I correlograms indicated the presence of spatial autocorrelation in all duck observation data, and habitat data. To account for spatial autocorrelation in our models, we included an autocovariate term that was based on the presence of ducks in neighboring plots. This reduced the degree of spatial autocorrelation in all species groups.

Habitat Association Models

For five of the six species groups, inclusion of the habitat variables improved model fit (Table 1). The exception was the long tailed ducks, where only the autocovariate term was strongly supported. There was some model uncertainty in each species group, with between 3 and 10 models having a delta AIC<2. Because of model uncertainty, we report model-averaged parameter estimates.

Harlequin Duck

Five models had a delta AIC <2, and the model weights were spread between 0.18 and 0.06 (Table 1), suggesting that no single model was best. The parameters rock, intertidal width, and the autocovariate term, appeared in each of these 5 top models, while the parameter islets appeared in 4 out of 5 models and Exposure in 2 of the top 5 models. Rock, intertidal width and the autocovariate term all had parameter weights close to 1 (Table 2), while islets was weighted 0.75 and exposure was weighted 0.45. Percent rock was positively related to harlequin duck presence, and the parameter estimate was ≥ 2SE. The odds ratio indicated that the odds of harlequin ducks being present increased by 1.8 for every increase in percent rock. Intertidal width was negatively related to harlequin duck presence, and the parameter estimate was ≥ 2SE. The odds ratio indicated that the odds of harlequin ducks being present decreased by 1.005 for every meter of increase in shoreline width. The presence of islets was positively related to harlequin duck presence, however the parameter estimate was ≤ 2SE. The odds ratio indicated that the odds of harlequin duck presence increased by 1.013 for every additional islet.

Exposure was positively related to harlequin duck presence, however the parameter estimate was ≤ 2SE. The odds ratio indicated that the odds of harlequin duck presence increased by 1.004 for every unit increase in exposure rank. The best harlequin duck model had a fair discriminatory level with an ROC value of 0.76.

Mergansers

Four models had a delta AIC <2, and the best model had an AIC weight of 0.33 which was 1.83 times greater than the next model (Table 1). The parameters distance to streams, exposure, rock and the autocovariate term were present in each of the top 4 models.

Distance to streams, exposure, and rock each had parameter weights > 0.9 (Table 2). Intertidal width was weighted 0.89, and the autocovariate term was weighted 0.85. Distance to streams was negatively related to merganser presence, meaning that presence was more likely when streams were closer. The parameter estimate was ≥ 2SE. The odds of merganser presence increased by 1.009 for every kilometer closer the plot was to a large stream. Exposure was negatively related to merganser presence, and the parameter estimate was ≥ 2SE. The odds of merganser presence increased by 1.058 for every unit decrease in exposure ranking. Percent rock was positively related to merganser presence, and the parameter estimate was ≥ 2SE. The odds of merganser presence increased by 1.48 for every percentage increase in rock. Intertidal width was negatively related to merganser presence, and the parameter estimate was ≥ 2SE. The odds of merganser presence increased by only 1.002 for every unit decrease in meters of intertidal width. The best merganser model had a poor discriminatory level with an AUC value of 0.63.

Bufflehead

Three models had a delta AIC < 2, and the best model with an AIC weight of 0.48 was 2.3 times greater than the next model with and AIC weight of 0.21 (Table 1). The parameters distance to streams, exposure, islets, intertidal width, and the autocovariate term were found in each of the top models. Distance to streams, exposure islets, intertidal width, and the autocovariate term had parameter weights close to 1 (Table 2). Distance to streams was negatively associated with bufflehead presence, meaning that presence was more likely when streams were closer. The parameter estimate for this variable was ≥ 2SE. The odds of bufflehead presence increased by 1.02 for every kilometer closer the plot was to a large stream. Exposure was negatively associated with bufflehead presence, and the parameter estimate was ≥ 2SE. The odds of bufflehead presence increased by 1.051 for every unit decrease in the exposure ranking. Islets was positively related to bufflehead presence, and the parameter estimate was ≥ 2SE. The odds of bufflehead presence increased by 1.04 for every increase in number of islets. Intertidal width was positively related to bufflehead presence, and the parameter estimate was ≥ 2SE. The odds of bufflehead presence increased by 1.008 for every meter increase in intertidal width. The best bufflehead model had a good discriminatory level with an AUC value of 0.80.

Goldeneye

Seven models had a delta AIC <2, and the best model with an AIC weight of 0.163 was only 1.05 times better than the next model with an AIC weight of 0.156 (Table 1). The parameters distance to streams, exposure and the autocovariate term appeared in each of the top models. Distance to streams, exposure, and the autocovariate term had parameter weights >0.90 (Table 2). Distance to streams was negatively associated with goldeneye presence, meaning that presence was more likely when streams were closer. The parameter estimate for this variable was ≥ 2SE. The odds of goldeneye presence increased by 1.02 for every kilometer closer the plot was to a large stream. Exposure was negatively related with goldeneye presence, and the parameter estimate was ≥ 2SE. The odds of goldeneye presence increased by 1.062 for every unit decrease in the exposure ranking. The best goldeneye model had a poor discriminatory ability with an AUC value of 0.67.

Long Tailed Duck

Ten models has a delta AIC>2, and the AIC weights of the models were all fairly close, ranging from 0.076 for the best model, to 0.028 for the tenth best model (Table 1). The best model was only 1.1 times better than the next model. Only the autocovariate term appeared in each of the top 10 models, and it was the only parameter in the top model. Only the autocovariate term had a parameter weight >0.90 (Table 2). The remaining parameter weights were < 0.50. The odds of long tailed duck presence changed only very slightly with changes in the habitat parameters. The largest relationship was for percent rock, where the odds of long tailed duck presence increased by 1.14 for every percentage decrease in rock, but this value is still small when compared with the other species groups. The best long-tailed duck model had a fair discriminatory ability with an AUC value of 0.77 when the autocovariate term was included.

Scoters

Five models had a delta AIC>2, and the best model had an AIC weight of 0.21 which was 2.1 times better than the next model with an AIC weight of 0.091 (Table 1). The parameters exposure, islets, and the autocovariate term occurred in each of the top 5 models. The parameters exposure and the autocovariate term had parameter weights >0.90, while islets had a parameter weight of 0.84 (Table 2). The remaining parameter weights were <0.35. Exposure was negatively related to scoter presence, and the parameter estimate was ≥ 2SE. The odds of scoter presence increased by 1.029 for every increase in exposure ranking. Islets were positively related to scoter presence, however the parameter estimate was ≤ 2SE. The odds of scoter presence increased by 1.02 for every increase in the number of islets. The best scoter model had a fair level of discriminatory ability with an AUC value of 0.71.

Table 1: Model Selection Results by Species Group

Model, by Species		Delta AIC	Weight	Parameters	Deviance
Harlequin Duck					
	Width + Islets + Rock + HAutocov	0.00	0.183	5	3518.6
	Width + Exp + Islets + Rock + HAutocov	0.66	0.132	6	3517.2
	Width + Exp + Islets + Rock + DtoStream + HAutocov	1.05	0.109	7	3515.6
	Width + Islets + Rock + DtoStream + HAutocov	1.11	0.105	6	3517.7
	Width + Rock + HAutocov	1.98	0.068	4	3522.6
Mergansers					
	Exp + Islets + Rock + DtoStream + MAutocov	0.00	0.332	7	4632.2
	Width + Exp + Islets + Rock + DtoExp + DtoStream + MAutocov	1.22	0.181	8	4631.4
	Width + Exp + Rock + DtoStream + MAutocov	1.63	0.147	6	4635.9
	Width + Exp + Rock + DtoExp + DtoStream +	1.76	0.138	7	4634.0

MAutocov				
Bufflehead				
Width + Exp + Islets + DtoStream + BAutocov	0.00	0.488	6	3104.2
Width + Exp + Islets + DtoExp + DtoStream + BAutocov	1.68	0.211	7	3103.9
Width + Exp + Islets + Rock + DtoStream + BAutocov	1.74	0.204	7	3103.9
Goldeneyes				
Exp + DtoStream + GAutocov	0.00	0.164	4	4639.5
Exp + Rock + DtoStream + GAutocov	0.09	0.156	5	4637.6
Width + Exp + DtoStream + GAutocov	0.86	0.106	5	4638.4
Width + Exp + Rock + DtoStream + GAutocov	1.13	0.093	6	4636.7
Exp + Islets + Rock + DtoStream + GAutocov	1.82	0.066	6	4637.3
Exp + Islets + DtoStream + GAutocov	1.92	0.063	5	4639.5
Exp + DtoExp + DtoStream + GAutocov	1.97	0.061	5	4639.5
Long Tailed Duck				
LAtuocov	0.00	0.076	2	1301.2
Rock + LAutocov	0.18	0.069	3	1299.3
Exposure + LAutocov	0.94	0.047	3	1300.1
Width + Rock + LAutocov	1.10	0.044	4	1298.2
Width + LAutocov	1.33	0.039	3	1300.5
Islets + Rock + LAutocov	1.33	0.039	4	1298.5
Islets + LAutocov	1.58	0.035	3	1300.7
DtoExp + LAutocov	1.90	0.029	3	1301.1
DtoStream + LAutocov	1.92	0.029	3	1301.1
Width + Exp + LAutocov	1.94	0.029	4	1299.1
Scoters				
Exp + Islets + SAutocov	0.00	0.206	4	3536.5
Exp + Islets + DtoStream + SAutocov	1.49	0.098	5	3535.9
Width + Exp + Islets + SAutocov	1.53	0.096	5	3536.0
Exp + Islets + DtoExp + SAutocov	1.89	0.080	5	3536.3
Exp + Islets + Rock + SAutocov	1.99	0.076	5	3536.4

Table 2: Model Averaged Parameter Weights and Estimates by Species Group

	Harlequin Ducks				Mergansers				Buffleheads			
covariate	W	E	se	OR	W	E	se	OR	W	E	se	OR
Intercept		-2.595	0.010			-0.754	0.152			-1.714	0.155	
Autocov	**0.977**	**4.248**	0.179	70.00	**0.857**	**3.521**	0.175	33.83	**1.000**	**4.844**	0.273	127.027
Exp	0.445	0.004	0.006	1.004	**1.000**	**-0.056**	0.006	1.058	**1.000**	**-0.05**	0.007	1.051
DtoExp	0.285	-0.000	0.000	1.000	0.391	-0.001	0.001	1.000	0.302	0.000	0.001	1.000
DtoStream	0.356	-0.002	0.003	1.002	**0.911**	**-0.010**	0.005	1.010	**0.992**	**-0.020**	0.006	1.020
Islets	**0.749**	0.013	0.010	1.013	0.636	0.009	0.009	1.009	**0.999**	**0.038**	0.009	1.039
Rock	**0.997**	**0.589**	0.151	1.802	**0.953**	**0.391**	0.148	1.479	0.296	-0.029	0.080	1.029
Width	**0.971**	**-0.004**	0.002	1.004	**0.892**	**-0.002**	0.001	1.002	**1.000**	**0.008**	0.001	1.008

	Goldeneyes				Long Tailed Ducks				Scoters			
covariate	W	E	se	OR	W	E	se	OR	W	E	Se	OR
Intercept		-0.388	0.153			-3.653	0.203			-2.132	0.144	
Autocov	**0.907**	**3.452**	0.177	31.57	**0.979**	**8.342**	0.488	4197	**0.996**	**5.169**	0.219	175.6
Exp	**1.000**	**-0.060**	0.006	1.062	0.342	0.003	0.007	1.000	**1.000**	**-0.029**	0.006	1.029
DtoExp	0.273	0.000	0.000	1.000	0.277	0.000	0.001	1.000	0.292	0.000	0.001	1.000
DtoStream	**1.000**	**-0.022**	0.005	1.022	0.257	0.000	0.002	1.000	0.328	0.001	0.002	1.001
Islets	0.287	0.001	0.003	1.001	0.342	0.005	0.010	1.005	**0.839**	0.018	0.011	1.018
Rock	0.486	-0.090	0.127	1.095	0.462	-0.152	0.226	1.164	0.274	0.007	0.050	1.007
Width	0.383	0.000	0.001	1.000	0.371	-0.001	0.001	1.000	0.314	0.000	0.001	1.000

W = parameter weight, E = weighted parameter estimate, se = standard error of the weighted parameter estimate, and OR = Odds Ratio. Items in bold are parameter weights > 0.50, or parameter estimates ≥ 2*SE

Diversity Calculations

An initial calculation of sea duck diversity based on winter surveys has been prepared using species groups in 0.5 mile plots. The Simpson's diversity index was calculated for each plot. The resulting diversity values were converted into an inverse distance weighted raster surface to examine spatial patterns (Figure 2). Further work on this objective will explore alternative methods of creating raster surfaces, explore the effects of different sampling plot sizes, and may relate the diversity index to habitat attributes using a generalized linear model.

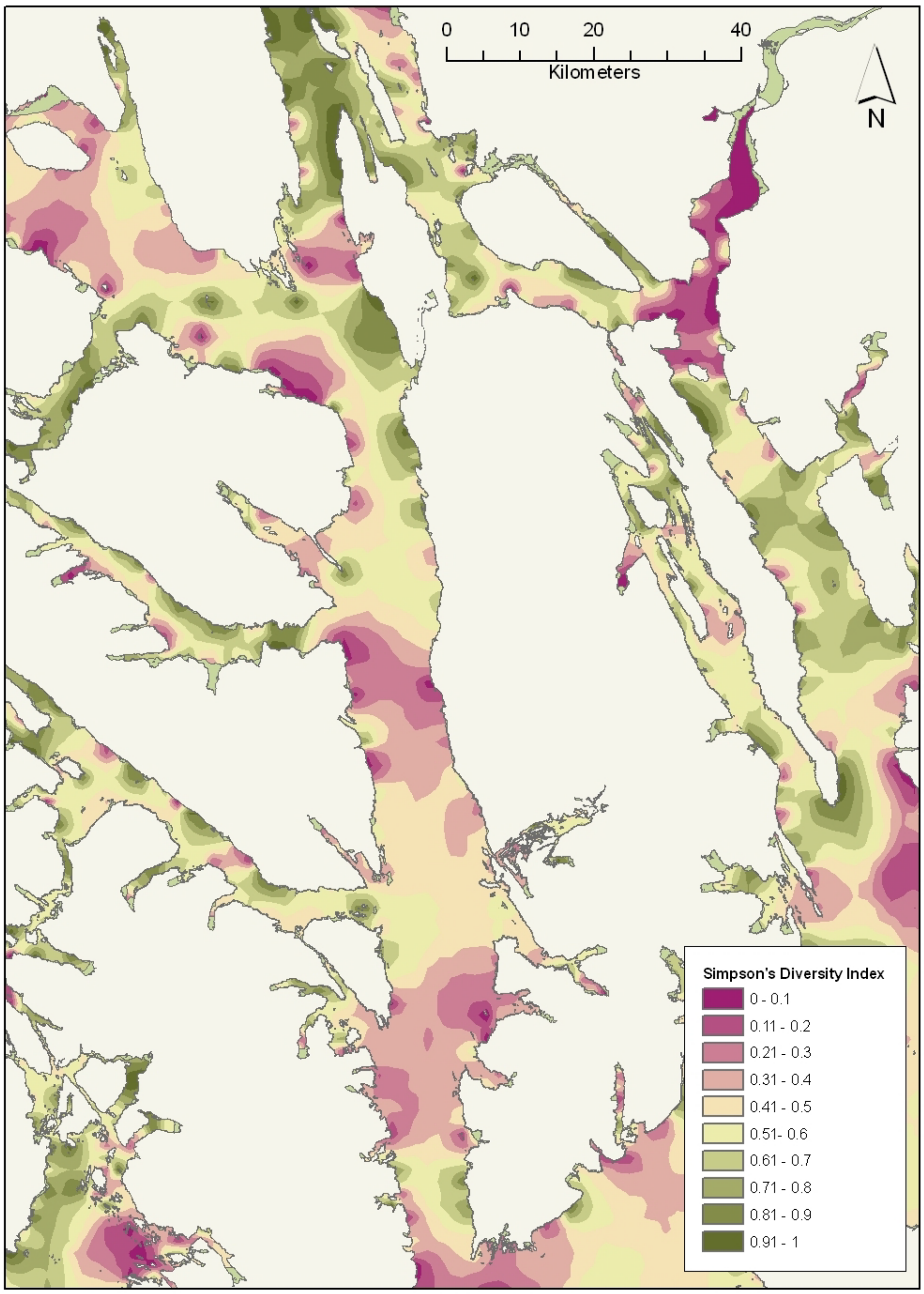

Figure 2. Sample species diversity calculation using an inverse distance weighted surface.

Project Status:

Analysis of the winter habitat associations has been completed, and a manuscript is nearing completion. A similar analysis of summer habitat associations is planned and will follow the same methodology as the winter analysis. The summer analysis and paper should be completed quickly, as the largest hurdle in completing the habitat association models was developing the methodology; there is a large diversity of statistical procedures in use for modeling of this type, and understanding the advantages and disadvantages of each was a time consuming exercise.

The methodology for the diversity analysis is being developed, and an initial analysis has been completed. Alternate methods will be explored to examine the effects of plot size and extrapolation technique. The only remaining step to complete the regional analysis is a trend analysis of the residuals from the summer and winter habitat models.

Completion of the remaining objectives is planned for the fall/early winter of 2008/2009, using the funding that is remaining from this project from partners.

Project Funding Sources (US$)

SDJV (USFWS) Contribution	Other U.S. federal contributions	U.S. non-federal contributions	Canadian federal contributions	Canadian non-federal contributions	Source of funding (agency or organization)
13,200					SDJV
	18,500				USGS
	9,000				USFWS
				12,000	SFU

Total Expenditures by Category (SDJV plus all partner contributions; US$). Complete only if project was funded by SDJV in FY08; total dollar amounts should match those in previous table.

ACTIVITY	BREEDING	MOLTING	MIGRATION	WINTERING	TOTAL
Banding (include only if this was a major element of study)					
Surveys (include only if this was a major element of study)					
Research				**52,700**	**52,700**