

Ecography

ECOG-05003

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Supplementary material

Appendix 1

Table A1. Sample sizes for transmitter deployments on five species of sea ducks in eastern North America, 2002-2017.

Species	Total deployed	Locations individual ⁻¹ (mean)	Total retained	Males	Females
Black scoter	113	532	89	42	47
Surf scoter	207	427	139	75	64
White-winged scoter	96	315	83	21	62
Common eider (<i>dresseri</i>)	91	396	76	15	61
Long-tailed duck	165	187	89	30	59
Total	672	338	476	183	293

Table A2. Biophysical covariates used to assess habitat selection and movement phenology in sea ducks.

Covariate	Dataset	Type	Units	Source	Degrees	Resolution km (²)	Temporal
Terrestrial habitats							
Precipitation	Worldclim (Prec)	Continuous	cm	Worldclim2 (Fick and Hijmans 2017)	8.3×10^{-2}	10 (100)	1970-2000
Maximum temperature	Worldclim (t_{\max})	Continuous	°C	Worldclim2 (Fick and Hijmans 2017)	8.3×10^{-2}	10 (100)	1970-2000
Minimum temperature	Worldclim (t_{\min})	Continuous	°C	Worldclim2 (Fick and Hijmans 2017)	8.3×10^{-2}	10 (100)	1970-2000
Distance to coast	World Vector Shoreline (Intermediate)	Continuous	m	Global Self-consistent Hierarchical High-Resolution Geography Database, NOAA (Wessel et al. 1996)	na	1 (1)	na
Distance to lake	North American Rivers and Lakes	Continuous	m	North American Data Atlas, U.S. Geological Survey	1×10^{-6}	0.1 (0.01)	na
Distance to large lake ($> 300 \text{ km}^2$)	North American Rivers and Lakes	Continuous	m	North American Data Atlas, U.S. Geological Survey	1×10^{-6}	0.1 (0.01)	na
Elevation	2-minute Gridded Global Relief Data, (ETOPO2) v2	Continuous	m	National Geophysical Data Center 2006	3.3×10^{-2}	3.5 (12)	na
Slope	2-minute Gridded Global Relief Data, (ETOPO2) v2	Continuous	°	National Geophysical Data Center 2006	3.3×10^{-2}	3.5 (12)	na
Land cover type	Landsat	Categorical	na	U.S. Geological Survey; North American Environmental Atlas	3.3×10^{-2}	3.5 (12)	2010
Aquatic habitats							
Net primary production	Vertically Generated Production Model	Continuous	$\text{mgC m}^{-2} \text{ day}^{-1}$	Ocean Productivity, Oregon State University (O'Malley 2012)	8.3×10^{-2}	10 (100)	2002-2019
Sea surface temperature	MODIS Aqua 11 μm Day/Night Sea Surface Temperature Data	Continuous	°C	NASA 2014	8.3×10^{-2}	10 (100)	2002-2019
Salinity	Remote Sensing Systems SMAP Ocean Surface Salinities	Continuous	g kg^{-1}	Meissner et al. 2019	8.3×10^{-2}	10 (100)	2002-2019
Distance to coast	World Vector Shoreline (Intermediate)	Continuous	m	Global Self-consistent Hierarchical High-Resolution Geography Database, NOAA (Wessel et al. 1996)	na	1 (1)	na
Depth (bathymetry)	2-minute Gridded Global Relief Data, (ETOPO2) v2	Continuous	m	National Geophysical Data Center 2006	3.3×10^{-2}	3.5 (12)	na
Slope	2-minute Gridded Global Relief Data, (ETOPO2) v2	Continuous		National Geophysical Data Center 2006	3.3×10^{-2}	3.5 (12)	na
Tidal current velocity	U.S. Mean Tidal Current (Atlantic USA)	Continuous	m s^{-1}	U.S. Department of Energy (Atlantic USA)	1×10^{-1}	0.1 (0.01)	na
Aquatic vegetation	Composite	Binary	na	NOAA Office for Coastal Management (Atlantic USA) North American Environmental Atlas (Canada)	1×10^{-6}	0.1 (0.01)	na
Bottom substrate	Composite layer	Categorical	na	U.S. Geological Survey (Atlantic USA: CONMAP); Great Lakes Aquatic Habitat Framework (Great Lakes); Fisheries and Oceans Canada (Gulf of St. Lawrence: Loring and Nota 1973)	3.3×10^{-2}	3.5 (12)	na

Table A3. Model selection tables for zero-inflated binomial models of occurrence and species counts of sea ducks during a) breeding, b) wintering, c) spring staging, and d) fall staging and molt, 2002-2017.

Predictors	AIC	Δ AIC	WAIC	Deviance explained
a. Breeding				
Precipitation + Maximum temperature + Minimum temperature + Distance to coast + Distance to lake + Distance to large lake + Elevation + Landcover + Latitude \times Longitude	13212.9	0.69		90.4%
Precipitation + Maximum temperature + Minimum temperature + Distance to coast + Distance to lake + Distance to large lake + Elevation + Slope + Landcover + Latitude \times Longitude	13214.5	1.6	0.30	90.6%
Precipitation + Maximum temperature + Distance to coast + Distance to lake + Distance to large lake + Elevation + Landcover + Latitude \times Longitude	13221.9	9.0	0.01	90.3%
b. Winter				
Net primary production + Sea surface temperature + Salinity + Distance to nearest shoreline + Depth + Slope + Latitude \times Longitude	5558.0	0.74		78.5%
Net primary production + Sea surface temperature + Distance to nearest shoreline + Depth + Slope + Latitude \times Longitude	5560.1	2.1	0.26	78.6%
c. Pre-breeding (spring)				
Net primary production + Sea surface temperature + Salinity + Distance to nearest shoreline + Depth + Slope + Latitude \times Longitude	8751.2	0.95		76.2%
Net primary production + Sea surface temperature + Salinity + Distance to nearest shoreline + Depth + Latitude \times Longitude	8757.1	5.9	0.05	76.1%
d. Post-breeding (fall)				
Net primary production + Sea surface temperature + Salinity + Distance to nearest shoreline + Depth + Latitude \times Longitude	9666.1	0.51		79.7%
Net primary production + Sea surface temperature + Distance to nearest shoreline + Depth + Slope + Latitude \times Longitude	9666.2	0.1	0.49	79.7%
Net primary production + Sea surface temperature + Distance to nearest shoreline + Depth + Latitude \times Longitude	9720.8	54.7	0	79.0%

Figure A4. Deployment locations, years, and sample sizes (a) and eastern North American ranges (b-f) for sea ducks tracked in eastern North America, 2002-2017 (BLSC= black scoter, COEI = *dresseri* common eider, LTDU = long-tailed duck, SUSC= surf scoter, WWSC = white-winged scoter)

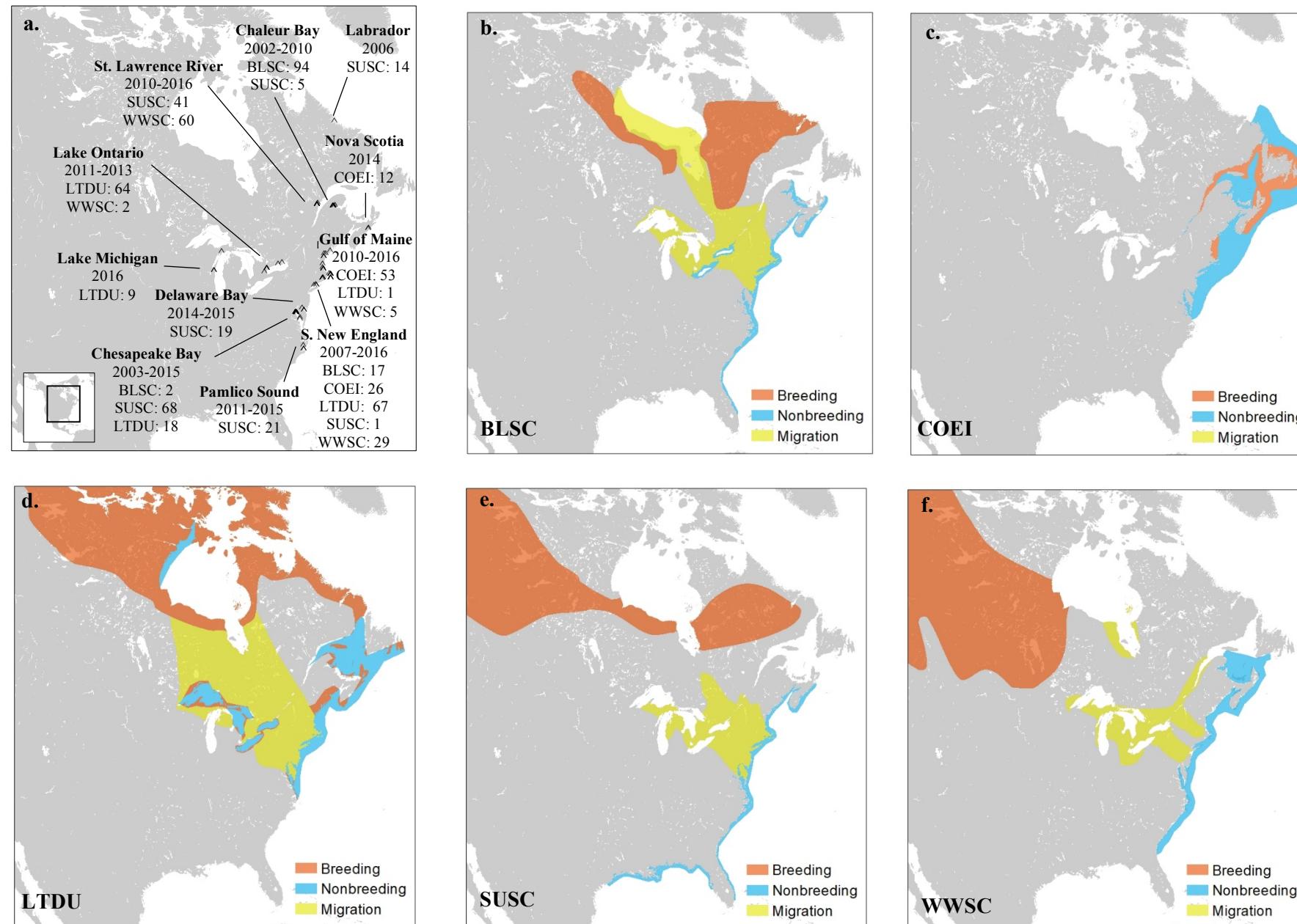


Figure A5. State-space modeled locations of sea ducks tracked in eastern North America, 2002-2017 (COEI = *dresseri* common eider, WWSC = white-winged scoter, SUSC= surf scoter, LTDU = long-tailed duck, BLSC= black scoter)

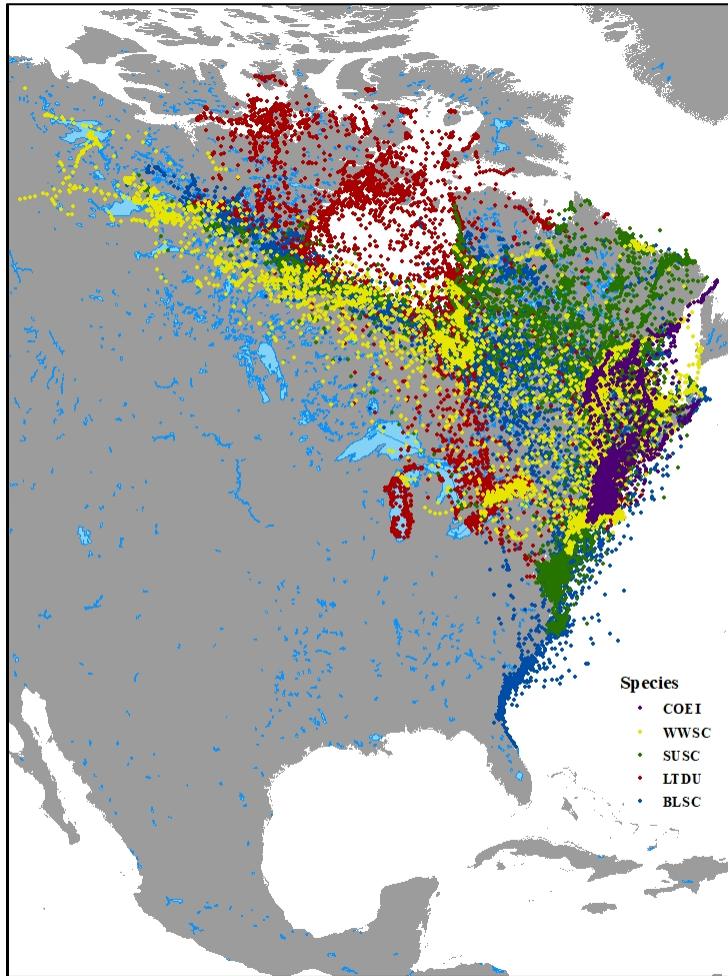
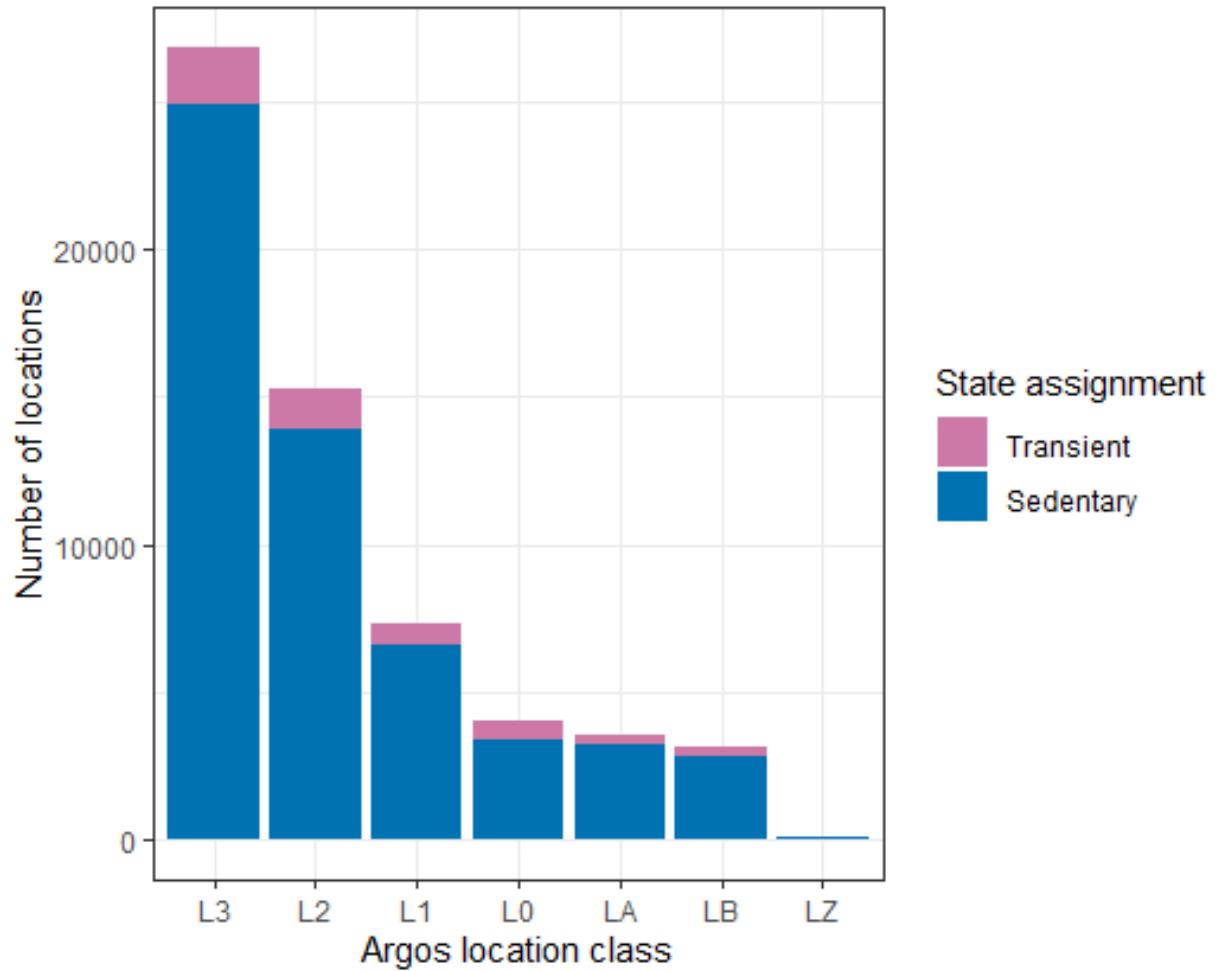


Figure A6. Number of state-space modeled daily locations assigned to transient or resident behavioral states vs. Argos location class of most accurate fix for that day.



References

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