Appendix E. GIS Methods for Ecological Function Scoring.

The following tables provide specific information detailing how GIS was used in developing the ecological functions scores. Table E1 is intended for use with Table 5A in the main body of this report; Table E2 for use with Table 5B.

Table E1. GIS Methods for Marine Shoreline Ecological Function Scoring.

Functions	GIS Methods
Physical Conditions	
Natural sediment transport patterns	The number of jetties and/or groins in each reach was quantified based on the datasets *MarinaJettyBreakwater_Snapped* and *Groin_Snapped* (both Friends of the San Juans 2009), respectively. Each of these two datasets was intersected with reach areas and in-water reach boundaries[1]. Regarding quantifying the number of jetties, *MarinaJettyBreakwater_Snapped* indicated that a combination of breakwater, marina, and/or jetty existed in reaches 11, 29, 41, 44, 60, 90, 114, 132, 155, and 186; however, because it could not be determined from the data if a jetty was part of a particular combination, none of these combination features were counted as a jetty.
Shoreline sediment input alterations – Feeder bluffs	The percentage of feeder bluffs armored in each reach was based on feeder bluffs (shoreform attribute codes FB and FBE) in the dataset *SJCshoreformFinal_PIAT_Nov2011* (Pulling It All Together project 2011). To calculate the total length of feeder bluffs in each reach, *SJCshoreformFinal_PIAT_Nov2011* was intersected with reach areas and in-water reach boundaries[1]. Next, the total length of armored feeder bluffs per reach was calculated by intersecting *SJCshoreformFinal_PIAT_Nov2011* with the dataset *ArmorLineShorezone* (Friends of the San Juans 2009). Prior to intersecting, these two datasets were better aligned using the integrate function (tolerance of 2 feet). The resulting data was intersected with reach areas and in-water reach boundaries[1]. Finally, geometric feature lengths were used to calculate the percentage of feeder bluffs armored by reach.
Shoreline sediment input alterations – Pocket beaches	The percentage of pocket beaches armored in each reach was based on pocket beaches in the dataset *SJCshoreformFinal_PIAT_Nov2011* (Pulling It All Together project 2011). First, the total length of pocket beaches in each reach was calculated by intersecting *SJCshoreformFinal_PIAT_Nov2011* with reach areas and in-water reach boundaries[1]. Next, the total length of armored pocket beaches in each reach were calculated by intersecting *SJCshoreformFinal_PIAT_Nov2011* with the dataset *ArmorLineShorezone* (Friends of the San Juans 2009). Prior to intersecting, these two datasets were better aligned using the integrate function (tolerance of 2 feet). The resulting data was intersected with reach areas and in-water reach boundaries[1]. Finally, geometric feature lengths were used to calculate the percentage of pocket beaches armored by reach.
Shoreline sediment input alterations – Barrier beaches	The percentage of barrier beaches armored in each reach was based on barrier beaches in the dataset *SJgeomorph_FishProb* (Beamer et al 2012). First, the total length of barrier beaches in each reach was calculated by intersecting *SJgeomorph_FishProb* with reach areas and in-water reach boundaries[1]. Next, the total length of armored barrier beaches in each reach was calculated by intersecting the dataset *SJgeomorph_FishProb* with the dataset *ArmorLineShorezone* (Friends of the San Juans 2009). Prior to intersecting, the two datasets were better aligned using the integrate function (tolerance of 2 feet). The resulting data was intersected reach areas and in-water reach

Functions	GIS Methods
	boundaries[1]. Finally geometric feature lengths were used to calculate the percentage of barrier beaches armored by reach.
Natural current patterns	The number of outfalls in each reach was quantified based on the number of cross culverts, storm drain outfalls, and tidegates found in the datasets *Culverts* (for cross culverts and storm drain outfalls) and *Catch_Basins* (for tidegates) (both datasets San Juan County 2008). To calculate the number of culvert and storm drain outfalls per reach, *Culverts* was intersected with reach areas and in-water reach boundaries[1]. The number of tidegates in each reach was calculated outside of GIS due to the limited number of occurrences.
Wave/current attenuation	The percentage of shoreline armoring was based on the dataset *ArmorLine* (Friends of the San Juans 2009). First, the total length of shoreline armoring in each reach was calculated by intersecting *ArmorLine* with reach areas and in-water reach boundaries[1]. Next, the total length of shoreline in each reach was calculated by intersecting the dataset *NOAA_Shorelines* (National Oceanic and Atmospheric Administration 2006) with a reaches dataset. Finally, geometric feature lengths were used to calculate the percentage of shoreline armoring in each reach.
Nutrient and toxics removal	Water quality categories were based on the dataset *305b_list* (Washington Department of Ecology 2008). To assign water quality categories by reach, this dataset was first intersected with a reaches dataset. Water quality polygons associated with streams were assigned to reaches based on the intersected data. Water quality polygons associated with marine waters were associated with reaches in a non-GIS based review. The poorest stream and marine water quality categories were identified for each reach. In reaches where both marine and stream water quality polygons occurred, the poorest water quality categories were averaged (and rounded up if necessary) for purposes of determining the water quality category scored.
Shade	The percentage of shading in each reach was calculated based on the C-CAP land cover dataset *WA_2006.img* (National Oceanic and Atmospheric Administration 2006). This raster dataset was converted to a vector dataset, and then intersected with a reaches dataset extending only 30 feet landward of the shoreline. The areas of shoreline in each reach covered by deciduous forest, evergreen forest, mixed forest, palustrine forested wetland, palustrine shrub/scrub wetland, or scrub/shrub land cover classes were calculated and totaled (other land cover classes in the dataset were excluded).Geometric feature areas by vegetation type were used to calculate the percentage of each reach shaded.
Habitat Conditions	
Total vegetation	Vegetation percentages were calculated based on the C-CAP land cover dataset *WA_2006.img* (National Oceanic and Atmospheric Administration 2006). This raster dataset was converted to a vector dataset, and then intersected with a reaches dataset. The areas of shoreline in each reach covered by deciduous forest, estuarine aquatic bed, estuarine emergent wetland, evergreen forest, mixed forest, palustrine aquatic bed, palustrine emergent wetland, palustrine forested wetland, palustrine shrub/scrub wetland, or scrub/shrub land cover classes were calculated and totaled (other land cover classes in the dataset were excluded). Geometric feature areas by vegetation type were used to calculate the percentage of total vegetation in each reach.
Estuary habitat	Acreage of estuary habitat was calculated based on the C-CAP land cover dataset *WA_2006.img* (National Oceanic and Atmospheric Administration 2006). This raster dataset was converted to a vector dataset, and then intersected with a reaches dataset. The area of each reach covered by estuarine emergent wetland was calculated and totaled.

Functions	GIS Methods
Birds	Bird species presence based on the dataset *ws_occurpoint_dr* (for bald eagle, black oystercatcher, osprey, peregrine falcon, purple martin, and wild turkey), *ws_occurpolygon_dr* (for additional bald eagle and purple martin), and *sbirdcat_sv* (alcids; alcids and cormorants; cormorants; and other seabirds) (all Washington Department of Fish and Wildlife 2010). These datasets were intersected with reach areas and in-water reach boundaries[1].
Haul-outs	Haul out presence or absence was based on the dataset *haulouts* (Washington Department of Fish and Wildlife 2010). This dataset was intersected with reach areas and in-water reach boundaries[1].
Eelgrass	Eelgrass presence or absence based on dataset *OuterLineOfEelgrass* (Friends of the San Juans 2009). This dataset was intersected with reach areas and in-water reach boundaries[1].
Floating kelp	Floating kelp presence or absence based on the dataset *Bullkelp* (Friends of the San Juans 2009). This dataset was intersected with reach areas and in-water reach boundaries[1].
Understory Kelp	Understory kelp presence or absence based on the attribute NFLOATKELP in the dataset *nkelplin* (Washington Department of Natural Resources 2006). This dataset was intersected with reach areas and in-water reach boundaries[1].
Forage fish priority spawning habitat	Spawning by priority species was determined based on the datasets *doc_sand_lance_spawning*, *doc_smelt_spawn*, and *rocksole* (all Washington Department of Fish and Wildlife 2010). These datasets were intersected with reach areas and in-water reach boundaries[1].
Herring spawning habitat	Herring spawning habitat presence or absence based on the dataset *DocHerringSpawningGround2012* (Washington Department of Natural Resources 2012). This dataset was intersected with reach areas and in-water reach boundaries[1].
Shellfish	Shellfish species presence was based on the dataset *shellfish_summary* (Washington Department of Fish and Wildlife 2010). This dataset was intersected with reach areas and in-water reach boundaries[1].

[1] The dataset depicting reach areas and in-water reach boundaries was created by extending reach areas waterward 660 feet using Euclidean allocation. In-water boundaries were then clipped to 500 feet waterward of shoreline.

Table E2. GIS Methods for Lacustrine Shoreline Ecological Function Scoring.

Functions	GIS Methods
Physical Conditions	
Shoreline modifications	GIS not used in analysis.
Natural current patterns	GIS methods same as for marine shorelines.
Nutrient and toxics removal	GIS not used in analysis. Water quality polygons were associated with reaches outside of GIS due to the limited number of occurrences.
Shade	GIS methods same as for marine shorelines.
Habitat Conditions	
Total vegetation	GIS methods same as for marine shorelines.
Wetland habitat	The percentage of wetland habitat in each reach was based on the datasets *All_tidal_wetlands* and *Merge_wetlands_ted_mindy* (both Adamus Resource

Functions	GIS Methods
	Assessment, Inc. and EarthDesign, Inc. in collaboration with San Juan County 2010). These two datasets were merged, and then intersected with a reaches dataset. Geometric feature areas were used to calculate the percentage of wetlands in each reach.
Birds	GIS methods same as for marine shorelines.
Salmonids	Ecological function scores for salmonid presence priority spawning habitat were based on the Washington Department of Fish and Wildlife dataset *fishdist_sv* (2010). This dataset was intersected with reach areas and in-water reach boundaries[1].

[1] The dataset depicting reach areas and in-water reach boundaries was created by extending reach areas waterward 660 feet using Euclidean allocation. In-water boundaries were then clipped to 500 feet waterward of shoreline.