Modeling dependencies in multivariate seabird distributions: linking graphical models to social network analysis

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Summary. Graphical modeling of seabird distributions.

1. Introduction

2. Methods

3. Data

species: Herring gull ($n = 3978$), greater shearwater ($n = 3732$), northern gannet ($n = 3451$), great black-backed gull ($n = 3319$), Wilson's storm-petrel ($n = 2746$), common loon ($n = 1900$), northern fulmar ($n = 1688$), red-throated loon ($n = 1400$), Cory's shearwater ($n = 1138$), Leach's storm-petrel ($n = 1005$), unidentified gull ($n = 984$), common tern ($n = 982$), black-legged kittiwake ($n = 971$), dovekie ($n = 962$), razorbill ($n = 908$), sooty shearwater ($n = 871$), laughing gull ($nl = 856$), long-tailed duck ($n = 851$), unidentified loon ($n = 754$), Bonaparte's gull ($n = 708$), unidentified scoter ($n = 703$), surf scoter ($n = 678$), black scoter ($n = 669$), unidentified tern ($n = 619$), unidentified alcid ($n = 555$), unidentified large gull ($n = 553$), unidentified bird ($n = 543$), ring-billed gull ($n = 530$), common eider ($n = 528$), white-winged scoter ($n = 522$), atlantic puffin ($n = 403$), red phalarope ($n = 394$), unidentified storm-petrel ($n = 379$), manx shearwater ($n = 374$), unidentified shearwater ($n = 364$), double-crested cormorant ($n = 354$), unidentified large alcid (razorbill or murre) ($n = 330$), unidentified small gull ($n = 313$), ubbg ($n = 299$), unidentified phalarope ($n = 292$), pomarine jaeger ($n = 287$), red-breasted merganser ($n = 220$), red-necked phalarope ($n = 207$), royal tern ($n = 207$), dark scoter ($n = 199$), unidentified small tern ($n = 184$), south polar skua ($n = 169$), bufflehead ($n = 159$), parasitic jaeger ($n = 154$), common murre ($n = 153$), unidentified diving/sea duck ($n = 121$), Forster's tern ($n = 119$), great skua ($n = 117$), unidentified merganser ($n = 117$), roseate tern ($n = 115$),

brown pelican ($n = 92$), unidentified large tern ($n = 91$), unidentified skua ($n = 89$), unidentified shorebird ($n = 87$), Audubon's shearwater ($n = 86$), thick-billed murre ($n = 83$), common goldeneye ($n = 82$), unidentified jaeger ($n = 78$), black guillemot ($n = 75$), unidentified murre ($n = 73$), horned grebe ($n = 65$), unidentified grebe ($n = 63$), least tern ($n = 61$), unidentified scaup ($n = 52$), red-necked grebe ($n = 49$), American black duck ($n = 47$), unidentified goldeneye ($n = 34$), band-rumped storm-petrel ($n = 23$) and, finally, black-capped petrel ($n = 3$).

While some marine bird species such as various types of gulls have been sighted at numerous locations, other species occurred only very rarely. At the same time, as we defined a minimum of at least 50 marine birds per species as inclusion criteria, this limited number of locations equivalently implies that certain marine bird species appeared in groupings rather than as isolated birds or occurred only in a geographically strictly-limited habitat. An example of such only rarely observed species are black-capped petrels whose 50 counted sighting have only been recorded at $n = 3$ different locations. This reflects our expectations, as black-capped petrels have been classified as endangered species by the IUCN Red List of Threatened Species. Discovering the relevant subset of species whose spatial occurrence is linked to the spatial pattern of any endangered species by means of a SDGM might provide new insights into multivariate interdependencies. This new insights might provide important knowledge for the conservation of endangered species and might assist to understand such phenomena from a global perspective on different natural environments.

4. Results