# ESTIMATING POPULATION ABUNDANCE AND MAPPING DISTRIBUTION OF WINTERING SEA DUCKS IN COASTAL WATERS OF THE MID-ATLANTIC

Mark D. Koneff[1], J. Andrew Royle[2], Douglas J. Forsell[3], James S. Wortham[1], G. Scott Boomer[1], and Matthew C. Perry[2]

[1]USFWS, Division of Migratory Bird Management, Laurel, MD; Mark_Koneff @fws.gov
[2]USGS, Patuxent Wildlife Research Center Laurel, MD
[3]FWS, Annapolis, MD, USA.

Survey design for wintering scoters (*Melanitta sp.*) and other sea ducks that occur in offshore waters is challenging because these species have large ranges, are subject to distributional shifts among years and within a season, and can occur in aggregations. Interest in winter sea duck population abundance surveys has grown in recent years. This interest stems from concern over the population status of some sea ducks, limitations of extant breeding waterfowl survey programs in North America and logistical challenges and costs of conducting surveys in northern breeding regions, high winter area philopatry in some species and potential conservation implications, and increasing concern over offshore development and other threats to sea duck wintering habitats. The efficiency and practicality of statistically-rigorous monitoring strategies for mobile, aggregated wintering sea duck populations have not been sufficiently investigated. This study evaluated a 2-phase adaptive stratified strip transect sampling plan to estimate wintering population size of scoters, long-tailed ducks *(Clangua hyemalis)*, and other sea ducks and provide information on distribution. The sampling plan results in an optimal allocation of a fixed sampling effort among offshore strata in the U.S. mid-Atlantic coast region. Phase 1 transect selection probabilities were based on historic distribution and abundance data, while Phase 2 selection probabilities were based on observations made during Phase 1 flights. Distance sampling methods were used to estimate detection rates. Environmental variables thought to affect detection rates were recorded during the survey and post-stratification and covariate modeling were investigated to reduce the effect of heterogeneity on detection estimation. We assessed cost-precision tradeoffs under a number of fixed-cost sampling scenarios using Monte Carlo simulation. We discuss advantages and limitations of this sampling design for estimating wintering sea duck abundance and mapping distribution and suggest improvements for future surveys.