**Predicting canvasback population size for harvest regulation**

The largest North American diving duck, the canvasback *Aythya valisineria*, is also one of the least abundant. Aquatic plants make up a large portion of the canvasback diet, which is unusual for a diving duck. This diet, their large size, and rarity make the canvasback (“King Can”) highly prized by hunters.



Canvasback hunting regulations are set annually with the goal of ensuring an estimated continental breeding population size of 500,000 birds in the spring. In the summer of year t, population size for the following spring (year t+1) is predicted under four fall harvest scenarios\* from a simple model that uses estimated (1) population size and (2) number of breeding ponds in the Canadian prairies in the current spring (year t). Canadian ponds serve as an index for habitat conditions and are correlated with recruitment into the population (new t+1 breeding birds).

*What is the problem?*

1. The current model does not do a good job predicting canvasback population size (Figure 1A). The model substantially over predicted following the two highest abundance years, and under predicted following the lowest abundance year (Figure 1B), likely due to the failure to account for sampling error (“regression to the mean”). The model is conservative, as t+1 predictions are close to the estimates for year t (Figure 1C); this property is biologically reasonable for a long-lived species, but does not reflect the annual variation in the estimates, which can show large jumps (Figure 1D). Large annual changes could be due to a number of factors, including the timing of the survey relative to breeding or shifts in the birds’ distribution. As a result of the model’s conservative behavior, the predicted time series tends to lag the estimates (Figure 1D), with predictions also somewhat more extreme than the estimates (likely because population size has increased along with improved habitat conditions, i.e., more ponds).
2. The annual regulations cycle has recently changed, so that harvest season will now be set one year in advance, i.e., year t data must be used to predict year t+2 population size and set the year t+1 harvest regulations. (So, e.g., fall 2015 hunting regulations were set using spring 2015 estimates and 2016 predictions, but fall 2016+ regulations will be set using 2015+ estimates and, non-existent, 2017+ predictions.)



Figure 1. (A) Spring breeding population size predicted from the previous spring’s population size and Canadian pond numbers versus population size estimated from the annual survey. (B) Year t+1 prediction error (predicted−estimated t+1 breeding population size) versus year t estimated breeding population. (C) Spring breeding population size predicted from the previous spring’s population size and Canadian pond numbers versus the previous spring’s estimated population size. (D) Time series of estimates (black) and predictions (red).

\*The four possible hunting seasons are: (1) a closed season (no legal hunting of canvasback), (2) a restricted season, (3) a liberal season with a “one-bird bag,” i.e., one bird allow per hunter per day, and (4) a liberal season with a “two-bird bag.” Restricted seasons allow fewer total hunting days than liberal seasons, and only a one bird bag.

*Project goal*

The USFWS needs a new approach to set canvasback regulations. Can this be achieved with the current monitoring data? Can we understand the sources of variation in the annual estimates and use them to provide scientific support for setting and adjusting the harvest strategy?

Explore the canvasback, pond and harvest data provided and, considering the needs of the USFWS, make some recommendations for how the Service might approach modify their approach to scientifically informed management of canvasback harvest.

*The estimates and the model*

The size of the continental breeding population of canvasbacks is estimated annually using data collected from the Waterfowl Breeding Population and Habitat survey, which is one of the largest and longest running wildlife surveys in the world. The ‘traditional survey area” consists of 50 strata surveyed by eight aerial crews (see the survey map provided). Observer counts are adjusted using crew-specific visibility correction factors (VCFs), which are either constants (three crew areas) or calculated annually based on a double sampling design (selected survey segments are surveyed by crews on the ground). Breeding ponds are also counted by the crews that survey the 26 Canadian and U.S. prairie and parkland strata, resulting in annual total pond estimates for these strata; models employed to set harvest strategies use the estimates from 15 of the Canadian strata (strata 26-40).

The data files provided includes canvasback (canvasback\_estimates.csv) and pond estimates (pond\_estimates.csv) by stratum. The total canvasback population size is the sum of the stratum estimates (note that there are a handful of missing strata in a few years). The Canadian pond totals used in the harvest model is the sum of the pond estimates for strata 26-40 (although strata 75-6 are in Canada, these strata are not included in the model).

Annual estimates of harvest and population age-ratios (immatures:adults) are included in another file (canvasback\_harvest.csv), which also indicates the harvest strategy associated with the harvest estimate (c = closed; r = restricted; m = moderate; l = liberal; l2 = liberal, 2-bird bag; there are also a number of intermediate seasons, in the years before establishment of the strategy [1975-94]: rc and mr ).

The file entitled Final\_Canvasback\_Harvest\_Strategy\_2004.pdf explains the model used for prediction and to set the annual harvest regulations.

The raw canvasback and pond data that were used to produce the estimates are not included, but are available.