# Final Report: Estimation of differential vulnerability and fall age ratios of American black ducks

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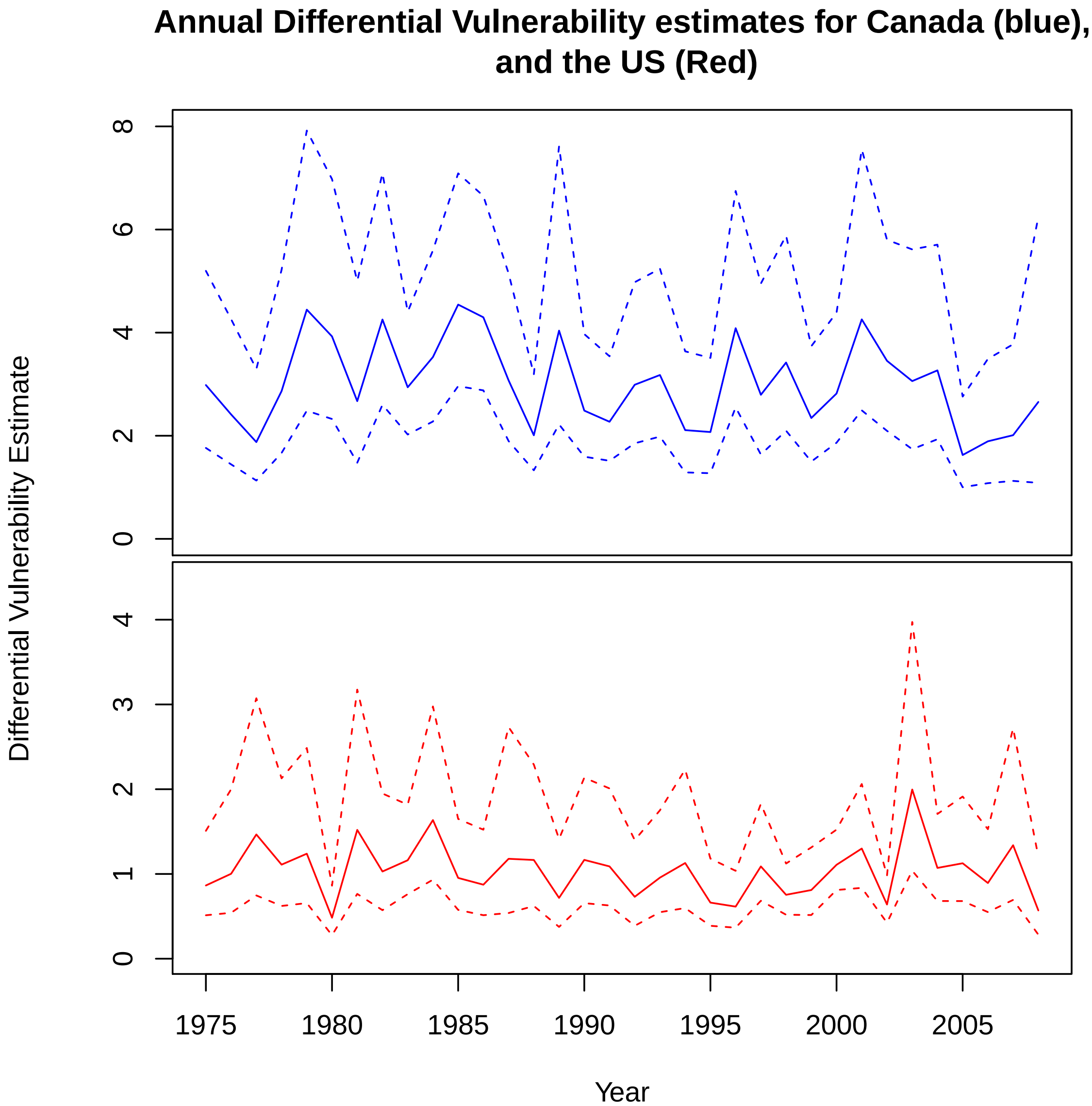
## 1 Revisions since 8/17/2010

For simplicity this report will serve as an addendum to the August 17, 2010 report. In the last report vulnerability and age ratios analysis were conducted a number of different ways since we didn't have an idea about how age ratio estimates might be affected by different assumptions of vulnerability. After discussions among the working group members this report represents a final set of analyses with regard to vulnerability and age-ratio estimation. Notable revisions to methods are:

- Analyses begin in 1975, which was the year the group felt that Parts Collection Surveys in the US and Canada were considered operational, and aging and sexing techniques had become standardized.
- All models are now fit with the assumption that harvest rates are unconditional, that is, harvest in the US is not conditional on survival through the Canadian hunting season. After reviewing previous analyses, age ratio estimates were impacted very little with changes to the underlying harvest process. Whether vulnerability is constant, or variable had a greater impact on age ratio estimates than how one views the harvest process.
- Analyses are limited to male data. Males have a greater representation in the banding and parts collection survey which should result in estimates of greater precision. Current AHM models also use age ratios estimated from male based data (I think).
- The final set has been reduced to 2 models. The first model includes only bandings from Canadian provinces, while the second mode incorporate US bandings from Maine. Maine is considered to be part of the core breeding range, equivalent to Canadian provinces, despite differing regulations.
- Also tasked were to compare estimates of age ratios with those from Conroy (2010 report) pyMc model. However, after a few discussions with Conroy this comparison was not really possible. Black duck reproduction in the AHM model is modeled as a log-linear model that estimates age ratios as a function of covariates for black duck density, mallards, and a time trend since 1990. While the pyMC model does utilize wing data; it is used to estimate the the parameters of the log linear model and not that age-ratio per se. Thus the age ratio in the model is more of a prediction and not a direct estimation.

## 2 Differential Vulnerability

The current model set assumes that vulnerability is year and recovery region (US,Canada) specific. The figure below indicates the vulnerability in the US has been relatively stable since 1975 (US Mean=1.139, Canada Mean=2.949). However, the same cannot be said for vulnerability in Canada. In addition to this there remain a fair amount of uncertainty in estimates from both countries.




In earlier discussions we questioned whether the observed pattern of differential vulnerability estimates is solely a result of sample error, in that vulnerability was unchanging, or whether vulnerability itself may vary from year to year. Since, black duck regulations are unlikely to change in the near future, one obvious way to address the issue would be to ramp up banding efforts. This will reduce uncertainty around recovery rate estimates. Theoretically with enough banding, sampling error should approach zero, and any remaining variation is process related. On the other hand, if vulnerability is truly varying then A.) There are different factors driving recovery rates of adults and juveniles, or B.) factors that influence recovery rates may differentially impact the recovery rates of adults and juveniles.

## 3 Age Ratios

Given that Maine is the last state to band large numbers of black ducks annually, we anticipated that this information would improve age ratio estimates over a model that only included Canadian data. Results from analyses suggest otherwise. After reviewing the raw data, the model results are expected. On average Maine bands between 50–450 black ducks per year, averaging around 200/year. While this seems like a fairly good number, only a handful of these bands are recovered during the first hunting season after banding. So, in actuality there is very little contribution to the overall estimation. However, for other non-biological reasons, it may be worthwhile to retain the model that includes data from Maine.

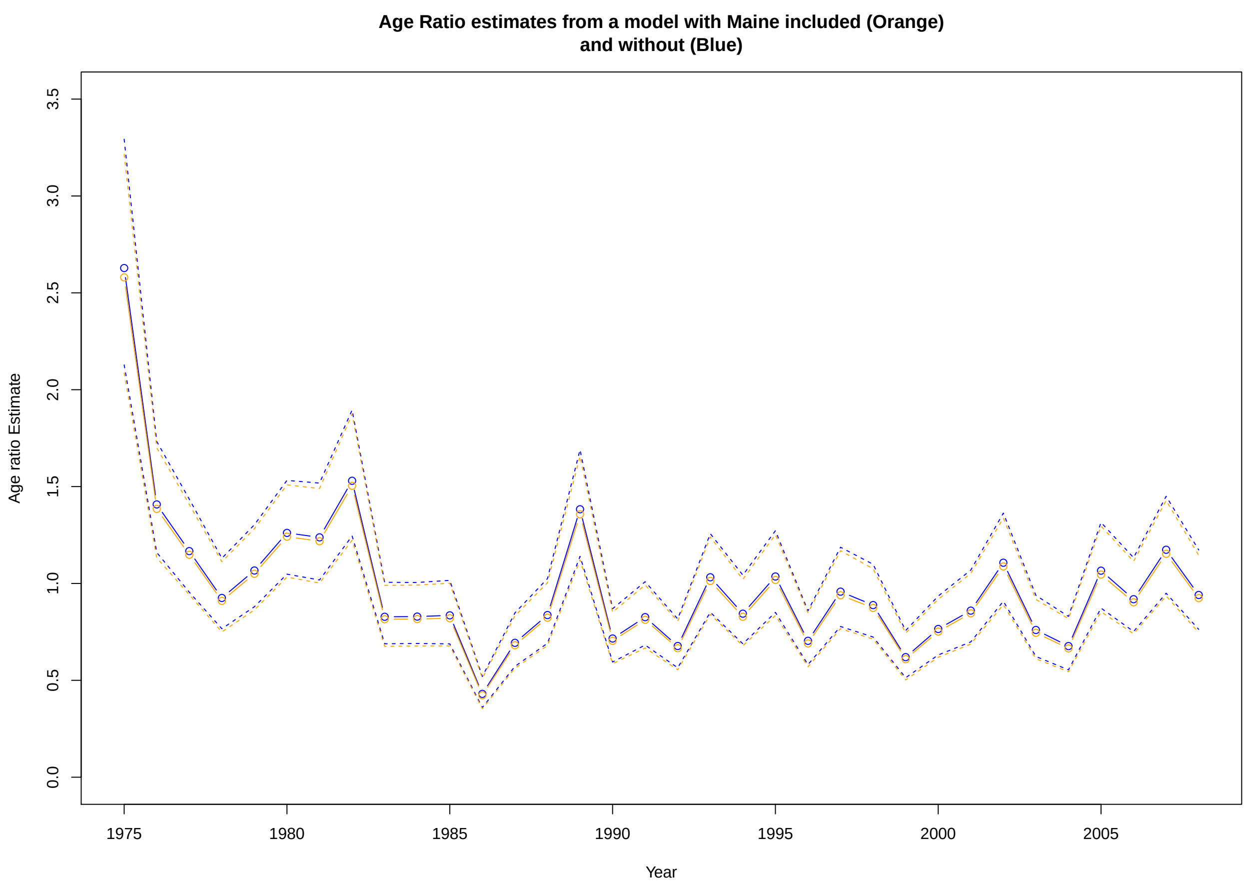


Table 1: Median black duck age ratio estimates and 95% Bayesian credible intervals from 1975–2008.

| Year | Median | 95% Credible Interval |
|---|---|---|
| 1975 | 2.6280 | 2.1280 – 3.2930 |
| 1976 | 1.4080 | 1.1600 – 1.7330 |
| 1977 | 1.1670 | 0.9549 – 1.4350 |
| 1978 | 0.9252 | 0.7663 – 1.1300 |
| 1979 | 1.0670 | 0.8799 – 1.3030 |
| 1980 | 1.2610 | 1.0480 – 1.5320 |
| 1891 | 1.2380 | 1.0180 – 1.5180 |
| 1982 | 1.5300 | 1.2450 – 1.8950 |
| 1983 | 0.8281 | 0.6887 – 1.0060 |
| 1984 | 0.8290 | 0.6901 – 1.0050 |
| 1985 | 0.8355 | 0.6883 – 1.0160 |
| 1986 | 0.4302 | 0.3595 – 0.5196 |
| 1987 | 0.6936 | 0.5718 – 0.8479 |
| 1988 | 0.8369 | 0.6913 – 1.0250 |
| 1989 | 1.3830 | 1.1400 – 1.6900 |
| 1990 | 0.7160 | 0.5946 – 0.8695 |
| 1991 | 0.8261 | 0.6822 – 1.0090 |
| 1992 | 0.6772 | 0.5647 – 0.8169 |
| 1993 | 1.0320 | 0.8515 – 1.2570 |
| 1994 | 0.8441 | 0.6885 – 1.0430 |
| 1995 | 1.0360 | 0.8507 – 1.2720 |
| 1996 | 0.7039 | 0.5810 – 0.8588 |
| 1997 | 0.9577 | 0.7779 – 1.1870 |
| 1998 | 0.8884 | 0.7236 – 1.0990 |
| 1999 | 0.6198 | 0.5134 – 0.7569 |
| 2000 | 0.7650 | 0.6309 – 0.9349 |
| 2001 | 0.8598 | 0.6983 – 1.0690 |
| 2002 | 1.1070 | 0.9081 – 1.3630 |
| 2003 | 0.7600 | 0.6232 – 0.9383 |
| 2004 | 0.6768 | 0.5540 – 0.8299 |
| 2005 | 1.0660 | 0.8729 – 1.3150 |
| 2006 | 0.9188 | 0.7519 – 1.1330 |
| 2007 | 1.1740 | 0.9495 – 1.4500 |
| 2008 | 0.9406 | 0.7630 – 1.1730 |