SUGGESTIONS FOR A NEW APPROACH FOR USE IN ASSESSING INDICATED BREEDING PAIR POPULATIONS OF DUCKS DURING SPRING IN NORTH AMERICA

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ABSTRACT

Waterfowl biologists have been concerned with various elements of duck count methodologies and data treatments for several decades. We present a brief review of past efforts to assess spring duck breeding populations and then we propose a new conceptual approach that should help to improve spring breeding duck population assessments in Canada and the U.S.

Keywords

Duck count methods, spring breeding pairs, wetland attributes

JUSTIFICATION AND CONCEPT DISCUSSION

Alison (1978) provided numerous excerpts of records of waterfowl-related activities including hunting that spanned 21 known civilizations and which occurred periodically in the past 6,000 years of recorded history. Likewise, the archaeological evidence for South Dakota, and very probably for the other waterfowl breeding ground regions, shows that the history of waterfowl presence and duck hunting extends back for thousands of years in North America (Parris and Higgins 2010). Even though the interaction of humans with waterfowl has a long history in North America (Weed and Dearborn 1903), the history of structured attempts to census waterfowl populations is relatively brief, and especially for duck censuses done at larger landscape scales (e.g., physiographic units or regional scales).

The purpose of this paper is not to provide an exhaustive review and synthesis of the duck census accounts and protocols that exist in North American literature, but rather to give a brief description of some past efforts to assess duck
populations and to bring some consideration to a new approach to duck population assessments.

Very likely, most of the earliest attempts to estimate the status of waterfowl populations were simply based on general observations made mostly by untrained people and were categorized in general terms such as “lots more ducks this year than last year” or “there’s so many ducks this year that they darken the skies in all directions” or “there’s too few ducks to hunt this fall”. For sure, many of today’s statisticians would refer to such observations as anecdotal and unreliable, but in contrast how sound were the data on which decisions were made in the establishment of the 1918 Migratory Bird Treaty Act or the “Duck Stamp Act”, both of which are still in effect today and both of which were founded in response to general-observational derived concerns relative to significant declines in duck populations and their habitats.

In 1929, at the 16th American Game Conference, committee chairman Aldo Leopold stated “There is pressing need to know more about the status, not only of the migratory game crop as a whole, but of each constituent species.” “Game yields can be greatly increased, and the costs and risks of management decreased, by more research.” Key words in these statements by Leopold are status, migratory game crop, and game yield for each constituent (duck) species. The above quotes of Leopold were taken from page 6 in Hawkins et al. (1984).

In similar fashion, a report entitled “The 1935 International Wild Duck Census” occurred in relation to the effects of the 1930s drought which was reported in a publication entitled “The Duck Decline in the Northwest: A Report on the Prairie Duck-Breeding Region”. Both reports were published by a Foundation: More Game Birds in America, the progenitor of Ducks Unlimited of today, respectively in 1935 and 1933. The information in the 1933 report was gathered during a trip through the primary prairie duck breeding area of North America during approximately the first half of July in 1933. The information in the 1935 report was gathered during August in 1935 with the cooperation of thousands of individuals and organizations. The 1935 census yielded 42.7 million ducks (page 5) but the 1935 continental population (page 79) was estimated at 65 million ducks (also reported in Hawkins et al. [1984, pg. 17]) which was much below what they believed to be a satisfactory number for the overall welfare of the continental population. In comparison, the 1993 fall flight population of ducks in North America was estimated to be 59 million and the fall-flight index of total ducks has ranged from 55 to 88 million since 1970 (Caithamer et al. 1993). Since 2001 the USFWS has not issued a total fall-flight duck population forecast and the last time they completed a total duck production (broods) survey was 2003.

Besides providing the results of the 1935 wild duck census, the authors (unknown) also provided a fairly detailed set of descriptive guidelines on how to organize and implement large-scale duck counts from the air or via ground or water transportation means in Chapters 3 and 10 in the 1935 report, all of which, in all probability, were the basis for all of the duck census protocols that have been developed since 1935 by various state, federal and private organizations. In general, the period from circa 1930 to 1970 was the time when considerable efforts were made to standardize duck counting methodologies, to define what
duck group elements represented a breeding-pair unit during the nesting season, and how to tabulate the duck count data from a structured waterfowl census (See Dzubin 1969, Hammond 1969 and others in the Saskatoon Wetlands Seminar publication and Cowardin and Blohm 1992). During the same time period that guidelines were being developed toward standardizing duck surveys on small to state-sized census units, guidelines and sampling protocols were being developed for multi-regional scale duck surveys in the U.S. and Canada (see Henny et al. 1972, USFWS 1976, Hawkins et al. 1984).

Technological and computerized analytical advances that evolved from circa 1970 to the present have enabled waterfowl researchers and managers to work with larger data sets from larger geographic areas in a more timely manner to aid their decision processes. Paramount among these advances are the capabilities to capture, file, archive, and electronically transfer and/or manipulate the data sets electronically. Some recent examples incorporating various kinds of digital and remotely-sensed data sets for purposes of waterfowl management are Cowardin et al. (1995) and Reynolds et al. (2006). Waterfowl management agencies, particularly the U.S. Fish and Wildlife Service, have been involved in assessments of duck and wetland conditions in the U.S. and Canada since the 1950s (Martin et al. 1979; Reynolds 1987) primarily for use in establishing annual duck hunting regulations that are published annually.

Annually assessing the status of the continental duck populations, the suitability of their habitats for production of young, and the expected fall flight is not a simple task. It entails hundreds of personnel and the cooperation and coordination of dozens of agencies and organizations. For the most part, the collective information and data summaries from such surveys have been funneled through various information transfer channels in four Flyways for decades, eventually culminating in the regulation setting process relative to the onset of fall duck hunting.

Unfortunately in some respects, most, but not all, of the earlier-established, smaller but intensively-monitored duck study research units, were discontinued circa the 1970s-1980s as duck population and habitat monitoring efforts shifted toward larger-scale monitoring operations that are based on numerous sampling processes enabling rigorous statistical treatment of the resultant data sets. However, even though the same habitats and the same population of ducks are being sampled by more than one affiliate, the summary data results are not always in close agreement. For example, data summaries relative to the population of wetlands (a static sample unit) are in fairly close agreement when compared between the annual monitoring efforts whereas data summaries relative to spring breeding-pair populations of ducks (a highly mobile sample unit) may differ annually by as much as 2-fold (R. Reynolds, pers. comm. in 2009, Bismarck, ND) for the same basic geographic area.

Disparity among duck survey results, even when conducted in the same region or time period, is not a new phenomenon. For example, Cowardin and Blohm (1992) expressed that all systems for the estimation of breeding-population sizes of ducks are subject to errors of biological interpretation such as determining whether an observed pair of ducks represents a resident or a migrant pair and whether observed social groups such as lone males represent breeding pairs.
Likewise, they qualified that data sets such as the National Wetlands Inventory (Wilen 1990), even small ones, may contain errors of omission that when used in data expansion processes, will cause underestimation of breeding-population sizes and/or recruitment rates.

Further confounding duck counts is the fact that all duck species do not settle and begin nesting at the same time. For example, an early count which might be best for mallards (Anas platyrhynchos) and pintails (A. acuta) may be the worst possible count time for lesser scaup (Aythya affinis) and ruddy ducks (Oxyura jamaicensis) relative to their late nesting chronologies. This census problem was addressed during a lesser scaup study in South Dakota which identified how the timing of the USFWS breeding pair count overestimated the number of nesting pairs by 11-fold (Naugle et al. 2000:180). Very likely, a large proportion of the scaup that were/are counted in South Dakota were/are recounted again in North Dakota and perhaps a third time in Manitoba or other points northward because the USFWS duck surveys also progress from southern to northern transects as the season progresses. The best estimate of the number of nesting (breeding pairs) scaup is further confounded by the fact that few of the yearling cohort of each year’s scaup population engage in nesting efforts; most do not do so until they are 2-years-olds, and a few perhaps not until their third year (Trauger 1971). Very likely, a similar phenomenon occurs during surveys of other duck species, particularly during springs that are deemed early or late, or during seasons of extremely wet or dry wetland conditions. For example, in abnormally dry springs, breeding pairs are prone to overfly the prairies to wetter conditions farther north in Canada or Alaska (Crissey 1969: 162). In brief, even though data from the USFWS surveys are viewed mainly as index estimates or trend data only, there is opportunity for adjustments in survey protocols and timing which would yield better summary data products (For example see: Diem and Lu 1960, Bennett 1967, Martinson and Kaczynski 1967, Dzubin 1969:224, Sauder et al. 1971, Ringelman and Flake 1980, Rumble and Flake 1982, Blohm 1989, Smith 1995, Austin et al. 2000, Giudice 2001, Pagano and Arnold 2009 A and B).

Another potential bias that accrues in duck count data summaries is related to basin size or fragmentation. Duck pair densities per unit area of habitat (pairs/acre of water) or (pairs/mi$^2$) have been published for more than 50 years, and in nearly all publications, duck pair density per unit area of wetland decreases as basin size increases (e.g., see graph by Jerome H. Stoudt 1949:147) even though numerically there were more pairs on larger water areas (see Stoudt 1949:147; Table 4). Unfortunately, the importance of this relationship has been overlooked or neglected through the past several decades, and in fact, it may be responsible for many apparent discrepancies among current study results and in past and recent duck population estimates. We believe this is further exacerbated by duck population expansion or modeling exercises based on pair data estimates collected on count data from fragmented segments of individual wetland basins.

Other factors affecting the quality of duck data sets include, but are not limited to, capabilities of duck species identification (Pagano and Arnold 2009A), visibility limitations due to emergent vegetation or environmental conditions (Pagano and Arnold 2009B) for which the actual count data for specific species
are manipulated with index adjustment factors (e.g., in the 1970s each indicated pair of American wigeon \((A. americana)\) or green-winged teal \((A. crecca)\) was multiplied by a factor of 15x resulting in 2 pairs being indexed as 30 pairs (Higgins et al. 1992: 64). However, throughout the prairie pothole region of the U.S. and Canada, historical reports rarely, if ever, provide any evidence of breeding pair densities of either of these two species greater than 2 pairs per mi\(^2\), and very often only 1 pair/mi\(^2\) or less.

**Suggestions Relative to Future Duck Surveys**—As stated previously, our intent is not to criticize any specific study per se, but to point out that there is potential for modifications and/or improvements in operational procedures, protocols and technologies that would or could improve our ability to produce more accurate estimates of the North American duck populations in a timely-manner. These modifications might originate as simply as the adoption of past suggestions that now have more merit of consideration or they might originate from the addition of new data or analytical techniques.

Most biologists would agree that an ideal duck count would be one where the total census area could be covered instantly, similar to a single photo coverage. However, in reality, even when suitable help is available and weather conditions are favorable, most larger study areas take at least one full day of effort for a total census and more often several days or weeks of effort are necessary to complete a total duck and wetlands survey. Ducks are very mobile and often flush to another wetland with most types of minimal disturbance or by random chance due to feeding, nesting or other behavior needs. Therefore, it is all but impossible to prevent multiple counting (roll-up) of some birds at different times during any single census. Averaging two or more counts in the same season helps to minimize roll-up effects. Perhaps at some future date, instant or remotely-sensed photography might be an option, but at present, duck counts are still done while walking, riding or flying.

The following is an unrefined conceptual approach that, in our opinion, has the potential as a better means of estimating the numerical populations of duck breeding populations and/or duckling production on an annual basis, and it also has possible application to other wetland wildlife and plant species.

First, ducks must be treated in similar fashion to any other farm crop, except their fields are wetland basins, and most importantly, the basins must have enough water to be suitable for a duck. John Lynch in a reference memo pertaining to “Waterfowl Crop-Forecasting” (see page 7 in the 1969 Saskatoon Wetlands Seminar publication stated “The best possible stock of potential breeders [ducks] ain’t going to pay off if there ain’t enough water. Our seed won’t germinate if the land ain’t ready.” In the same context, the success of any year is dependent on the number and size of the fields (in our case wetlands) and the number of bushels (ducklings) that each field yields. But unlike plants, ducks are not rooted to one place within one field (wetland) and each wet basin may be occupied or unoccupied by ducks and broods at any specific time for any number of reasons.

Fortunately, determining if a wet basin is occupied or not by ducks is a fairly easy task, and results from several basins are usually expressed as “percent
occupancy” or “the number of wet basins per pair” (see Dzubin 1969:138-160) either of which provide a probability value relative to duck pairs or broods using a sample of wet basins. Furthermore, such wet basin % occupancy values can be partitioned according to wetland basin size, wetland basin water condition, wetland basin classification or the ratio of emergent cover to open water. These data (Table 1) can also be partitioned spatially within landscapes or land use types, physiographic zones, or temporally (e.g., daily, weekly, monthly, seasonally, etc.) by duck species and/or brood size and age classes (Tables 2 and 3 and Figs. 1 and 2).

Thus, because all ducks are wetland obligate species and because wetland basins are a more static unit to sample in time and space, we contend that the development and use of a new approach of assessing duck nesting populations (breeding pairs) and annual brood production based on the assignment of % occupancy values/species/wetland basin attributes all of which are collected in relation to the on-set of nesting and/or the size and age class of broods per wetland, will yield a more robust and less variable duck population data set which should enhance our management capabilities of the North American duck population.

### Table 1. An example list of wetland basin attributes.

<table>
<thead>
<tr>
<th>Duck Species</th>
<th>Wetland Class/Type*</th>
<th>Basin Size</th>
<th>H₂O Condition</th>
<th>Emergents</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Tiny</td>
<td></td>
<td>Dry (zero)</td>
<td>None</td>
</tr>
<tr>
<td>II</td>
<td>Small</td>
<td></td>
<td>Nearly Dry</td>
<td>None</td>
</tr>
<tr>
<td>III</td>
<td>Medium</td>
<td>¼ Full</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>IV</td>
<td>Large</td>
<td>½ Full</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>V</td>
<td>Extra Large</td>
<td>¾ Full</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Stock Ponds</td>
<td></td>
<td>Full</td>
<td></td>
<td>Choked</td>
</tr>
<tr>
<td>Dugouts</td>
<td></td>
<td>Over Full</td>
<td></td>
<td>Full</td>
</tr>
</tbody>
</table>

*Wetland classification according to Stewart and Kantrud (1971).

### Table 2. Summary data example for blue-winged teal (Anas discors) counted in Figs. 1 and 2 assuming a wetland basin population of 2,000 basins for each of the five wetland water condition categories, totaling 10,000 seasonal basins regardless of wet or dry condition.

<table>
<thead>
<tr>
<th>Basin Water Condition Category</th>
<th>Pairs/Basin (% Occupancy)</th>
<th>Pairs/2,000 Basins</th>
<th>Broods/Basin (% Occupancy)</th>
<th>Broods/2,000 Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full (N=2,000)</td>
<td>2/1 (200%)</td>
<td>4,000</td>
<td>1/5 (20%)</td>
<td>400</td>
</tr>
<tr>
<td>¾ Full (N=2,000)</td>
<td>1/4 (25%)</td>
<td>500</td>
<td>1/20 (5%)</td>
<td>100</td>
</tr>
<tr>
<td>½ Full (N=2,000)</td>
<td>1/10 (10%)</td>
<td>200</td>
<td>1/100 (1%)</td>
<td>20</td>
</tr>
<tr>
<td>¼ Full (N=2,000)</td>
<td>1/25 (4%)</td>
<td>80</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>Dry (N=2,000)</td>
<td>0 (0%)</td>
<td>0</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>Totals (N=10,000)</td>
<td></td>
<td>4,780</td>
<td>520</td>
<td></td>
</tr>
</tbody>
</table>
Summary Suggestions—1. Counts need to include entire basins for ducks regardless of their size; i.e., no partial wetland basin counting to induce bias in population estimates (Stoudt 1949:147).

2. Breeding pair counts need to be conducted more in sync with the chronology of spring migration for all 12 duck species (±); i.e., this means at least two survey periods per year, perhaps three. For example, in 1995, Holland (1997) showed that the earlier FWS survey in South Dakota indicated 17 times more scaup breeding pairs than his later survey (110,900 vs. 6,500) that same spring. If we assume a similar annual error factor for the past 20 years, the total accumulated error for South Dakota would be a little over 2 million scaup. Considering similar error rates for roll-over counting in North Dakota and perhaps the southern tiers of Alberta, Saskatchewan, Manitoba, and the Northwest Territory.

<table>
<thead>
<tr>
<th>Basin Water Condition Category</th>
<th>Pairs/Basin (%) Occupancy</th>
<th>Pairs/2,000 Basins</th>
<th>Broods/Basin (%) Occupancy</th>
<th>Broods/2,000 Basins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full (N=2,000)</td>
<td>1/100 (1%)</td>
<td>20</td>
<td>1/2,000 (1%)</td>
<td>1</td>
</tr>
<tr>
<td>¾ Full (N=2,000)</td>
<td>1/200 (.5%)</td>
<td>10</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>½ Full (N=2,000)</td>
<td>0 (0%)</td>
<td>0</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>¼ Full (N=2,000)</td>
<td>0 (0%)</td>
<td>0</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>Dry (N=2,000)</td>
<td>0 (0%)</td>
<td>0</td>
<td>0 (0%)</td>
<td>0</td>
</tr>
<tr>
<td>Totals (N=10,000)</td>
<td></td>
<td>30</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 3. Summary data example for ruddy ducks counted in Figs. 1 and 2 assuming a wetland basin population of 2,000 basins for each of the five wetland water condition categories, totaling 10,000 seasonal basins regardless of wet or dry condition.**

**Blue-winged teal / Seasonal Basin**

- Pairs / Basin  
  - 2 / 1  
  - 1 / 4  
  - 1 / 10  
  - 1 / 25  
  - 0 / 1/4  

- Broods / Basin  
  - 1 / 5  
  - 1 / 20  
  - 1 / 100  
  - 0 / 1/4  
  - 0 / 1/4  

**Figure 1. An example of breeding pair and brood ratio of occurrence of blue-winged teal on a population of 10,000 seasonal basins, either wet or dry, that ranged from ¼ - ½ acre in size and which had variable degrees of basin inundation at the time of the census.**

**Ruddy Duck / Seasonal Basin**

- Pairs / Basin  
  - 1 / 100  
  - 1 / 200  
  - 0 / 1/2  
  - 0 / 1/4  
  - 0 / 1/4  

- Broods / Basin  
  - 1 / 2000  
  - 0 / 3/4  
  - 0 / 1/2  
  - 0 / 1/4  
  - 0 / 1/4  

**Figure 2. An example of breeding pair and brood ratio of occurrence of ruddy ducks on a population of 10,000 seasonal basins, either wet or dry, that ranged from ¼ - ½ acre in size and which had variable degrees of basin inundation at the time of the census.**
adds up to an accumulative sum of millions of scaup breeding pairs that do not really exist.

3. Count adjustment factors for some species (e.g., visibility multipliers as used for wigeon, etc., Higgins et al. 1992:64) need to be re-evaluated and perhaps even eliminated, so if we error, it will be directed towards more conservative instead of liberal regulation setting.

4. Consideration should be given to setting hunting regulations for the U.S. one year following the survey year (e.g., the 2007 survey data would be used to set the 2008 season regulations) in a similar manner to that currently being implemented in Canada. Using the delayed approach would remove the urgency to summarize and model data in a rush to meet time schedules for the Flyway Technical and Council meetings, Federal Register, Public Hearings, etc. It would also enable the use of late summer, fall and winter precipitation and wetland conditions relative to the next spring’s pond counts and would also enable use of brood count data (actual yield estimates).

5. Consideration should be given to the use of a new census methodology approach that connects the breeding pair and brood count data to wetland occupancy rates of individual wetland basins and also to some specific basin attributes (e.g., basin size, basin classification, basin emergent vegetation coverage, and especially to the basin water condition: see Table 1 and Figures 1 and 2). For example, Trauger and Stoudt (1979) stated, “Pond occupancy rates indicate that the decline in waterfowl [ducks] is occurring more rapidly than losses of wetland habitat. There is an increasing number of ponds without ducks, suggesting that the available breeding habitat is underutilized.”

6. Better information is needed relative to criteria that best represents a breeding pair of ducks for each species (e.g., see Brashier et al. 2002), and/or the percentage of each species spring population that could be expected to nest each year (e.g., see Trauger 1971).

7. To ensure intergenerational (historic background) connectiveness through time relative to duck counting criteria, methods and protocols, a single-source comprehensive literature synthesis should be compiled and published in a similar fashion to earlier publications such as Flyways (Hawkins et al. 1984), or like reviews by Bowden (1973), Blohm (1989), and Smith (1995). Copies of historically significant works such as the “Saskatoon Wetlands Seminar”, “The 1935 International Duck Census”, etc., should be reproduced to ensure greater availability for future generations of waterfowl management personnel.

8. And lastly, we urge the responsible agencies to give full consideration to the reimplementation of the annual late summer production (brood) surveys and the annual fall-flight forecast for all duck species combined as well as for each individual species separately. Such data summaries would facilitate duck population audits and performance accountability of duck management efforts by various agencies. They would also provide simplified information for use by various waterfowl hunters and other interested parties. And, in retrospect, many older waterfowl biologists, if asked if they had to choose between conducting only a breeding pair survey or a brood survey, would have opted for brood surveys; however, most would have also expressed the need and value of conducting both types of surveys as their first choice.
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LITERATURE CITED


