The identification of Barrow's Goldeneye *Bucephala islandica* and Common Goldeneye *B. clangula americana* ducklings

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The Common and Barrow's Goldeneyes *Bucephala clangula* and *B. islandica* are congeneric with the Bufflehead *B. albeola*. Goldeneye ducklings can be distinguished by larger size (Palmer 1976), an unlobed white cheek-patch that is smoothly oval just above the ear (Nelson unpubl. data), and contrastingly patterned 'bluish' or 'greenish' feet.

Compared to the almost identically plumaged goldeneye ducklings, the downy Bufflehead is smaller over all (Palmer 1976), has a squarish white cheek-patch lobed well above the ear (Nelson unpubl. data), and has neutral gray feet (Erskine 1972, Palmer 1976). As well, the Bufflehead has a smaller nail area relative to bill size (Linsdale 1933) and it lacks the striking eye-colour changes documented in ducklings of both goldeneye species (Nelson 1983).

The more difficult problem is to separate Barrow's Goldeneye from the Common. Traditionally, tracheal differences distinguish between adult males of the two goldeneye species (e.g. Gilpin 1878, Kortright 1942, Bellrose 1976, 1980). These differences apply also to first-winter Common Goldeneye males (Taverner 1919), but not to downy or feathered but flightless Common Goldeneye males (contrary to Munro 1939). Tracheal enlargements are entirely absent in male Barrow's Goldeneyes of all ages, but adult hybrid males described by Snyder (1953) from the east and by Jackson (1959) from the west had tracheas, bills, and plumages intermediate between *B. islandica* and *B. c. americana*.

Seven suspected hybrid museum specimens (*B. islandica* X *B. c. americana*) (5 age A, 2 age B) were excluded from Table 2. All seven were from eastern British Columbia (Creston (3), Parson (2), Golden (1), Rawlings Lake (1)) where, according to Palmer (1976) and Bellrose (1976, 1980), the breeding ranges of the two goldeneye species overlap. All were identified as Barrow's Goldeneye. The appearance of the suspected hybrids was like that of Barrow's Goldeneye (see Fig. 1), but their measurements, if somewhat intermediate, were more like those of the Common Goldeneye when tested with Nelson's ratio (n = 7, range = 2.7-3.6, mean = 3.242, S.D. = 0.323, S.E. = 0.131; see *B.c. americana* in Table 2).

The objectives of this paper are threefold: to present techniques that will distinguish between Barrow's and Common Goldeneyes, to recognize hybrid goldeneyes, and to establish new goldeneye nesting records. This paper is intended for field workers in waterfowl management and for curators and managers of live and prepared collections.

Methods

Bill measurements of live and prepared goldeneye specimens of both species were taken in centimetres following the method of Baldwin, Oberholser, and Worley (1931), except that a steel caliper was used instead of the dividers recommended. Tracheas were dissected according to the method described by Johnsgard (1961), and all birds were sexed using the method of Hochbaum (1942). Daily sketches of live birds were done at random, and later made into ink drawings using measurements taken on the days indicated in Figure 1.

Results and Discussion

Some goldeneyes can be distinguished by vis-

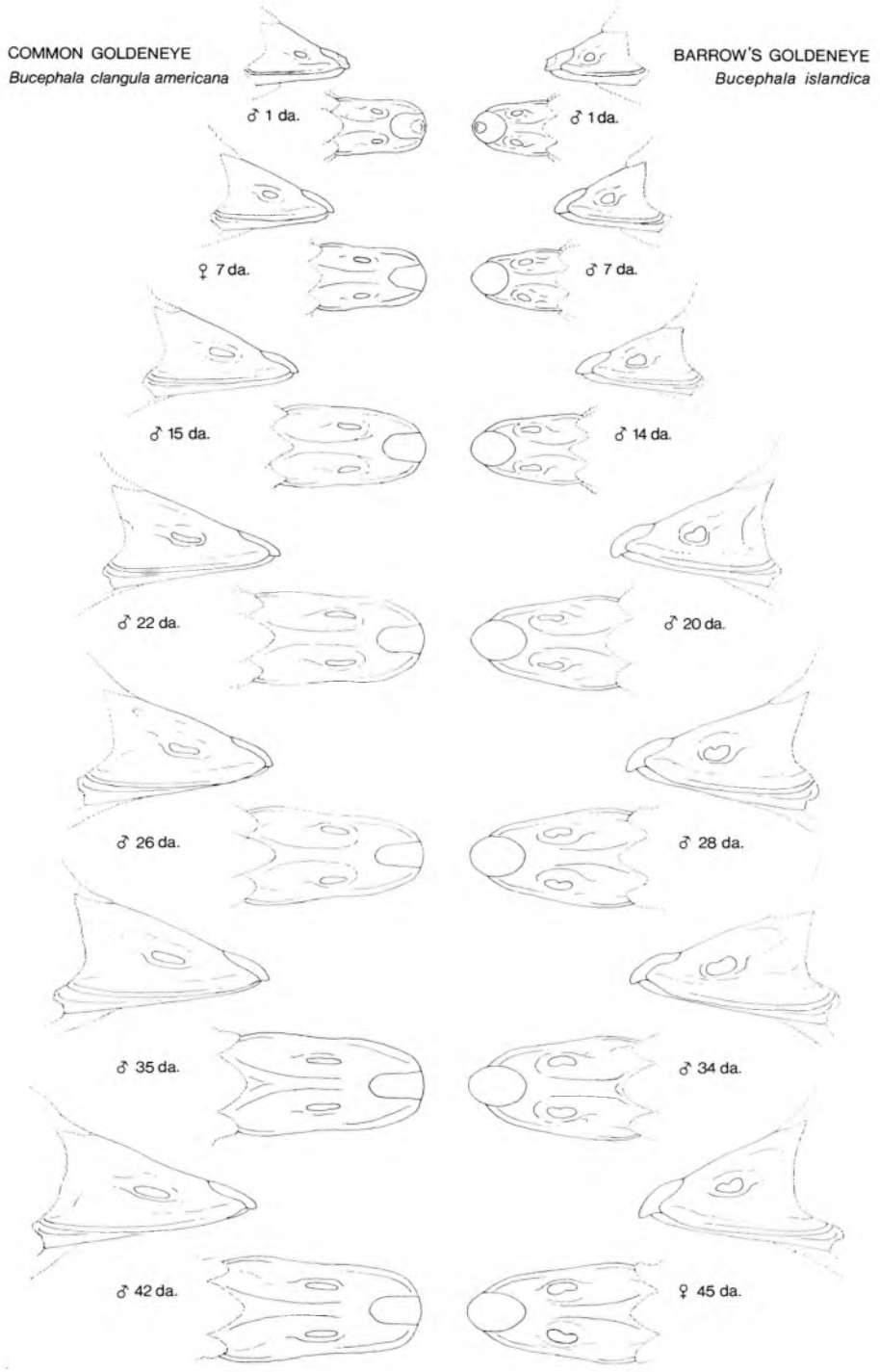

Figure 1. Measured drawings of bills of known-age live goldeneye.

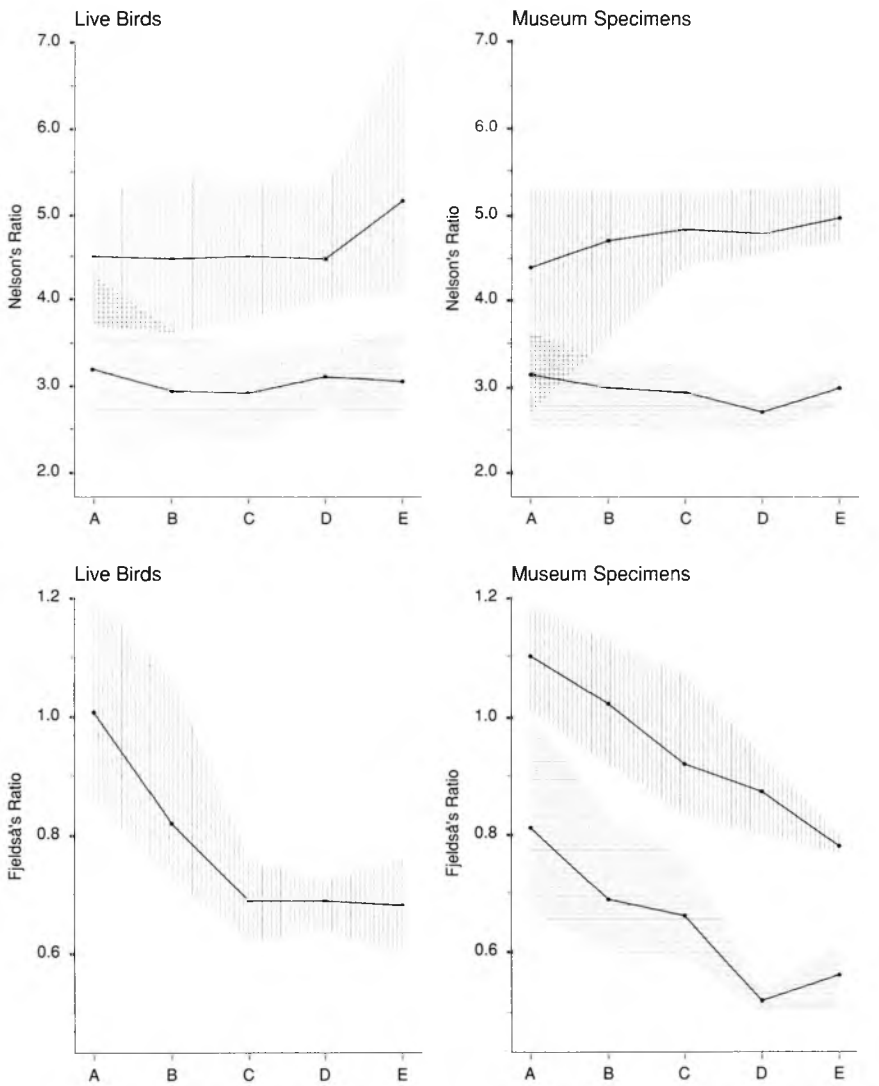

Figure 2. Two ratios that can be plotted using bill measurements of goldeneye. Vertical hatching = range for *B. islandica*; horizontal hatching = range for *B. c. americana*.

ual chartacters alone. For example, Barrow's Goldeneye has a bill that tapers to a smooth, rounded point, the nail of the bill is nearly as wide as the bill itself, and the nostril is large, round, and raised. The Common Goldeneye has a shovel-shaped, less tapered bill, the nail is narrow and is flanked on both sides by the bill, and the nostril is a flattened oval (see Fig. 1).

Other goldeneyes can be distinguished by one of two mathematical ratios: Fjeldså's (1977:77) ratio or Nelson's ratio, used herein for the first time. Fjeldså's ratio, which is Width of Nail divided by Distance between Anterior Corners of Nostrils (WN/DACN), was virtually infallible for live, newly-hatched goldeneyes ("0.9-1.0" for Barrow's Goldeneye, "0.6-0.7" for the Common) having one or both

Table 1. Mathematical ratios obtained from live goldeneye (graphically represented by Fig. 2). Samples of live, known-age birds lumped to match estimated ages of museum specimens: age A = days 1-5, age B = days 6-10, age C = days 11-15, age D = days 16-20, age E = day 21 and older.

Species Origin Parameter Age	Sample	Range	Mean	S.D.	S.E.
B. islandica					
British Columbia					
Nelson's ratio: (LN x WN)/WBPN					
A	106	3.70-5.19	4.51	0.296	0.029
B	86	3.62-5.51	4.49	0.354	0.038
C	53	3.78-5.35	4.50	0.325	0.045
D	30	4.01-5.31	4.48	0.290	0.053
E	183	4.06-6.93	5.16	0.552	0.041
Fjeldså's (1977) ratio: WN/DACN					
A	42	0.86-1.20	1.01	0.081	0.012
B	39	0.73-1.07	0.82	0.083	0.013
C	17	0.62-0.76	0.69	0.048	0.012
D	9	0.64-0.72	0.69	0.028	0.010
E	79	0.60-0.76	0.68	0.038	0.004
B.c. americana (1968, 1976, 1981)					
Manitoba					
Nelson's ratio: (LN x WN)/WBPN					
A	65	2.10-4.30	3.19	0.464	0.58
B	34	2.42-3.66	2.96	0.363	0.062
C	36	2.37-3.44	2.92	0.330	0.055
D	10	2.75-3.47	3.13	0.220	0.069
E	73	2.61-3.65	3.06	0.215	0.025
Fjeldså's (1977) ratio:					
(Data not available.)					

Table 2. Mathematical ratios obtained from museum specimens of goldeneye (graphically represented by Fig. 2). Ages estimated as in Table 1.

Species Origin Parameter Age	Sample	Range	Mean	S.D.	S.E.
B. islandica					
British Columbia; Alaska					
Nelson's ratio:(LN x WN)/WBPN					
A	12	2.70-5.29	4.40	0.700	0.200
B	1	—	4.70	—	—
C	4	4.42-5.26	4.83	0.416	0.208
D	1	—	4.78	—	—
E	3	4.69-5.33	4.96	0.406	0.234
Fjeldså's (1977) ratio: WN/DACN					
A	11	1.01-1.19	1.10	0.002	0.001
B	1	—	1.02	—	—
C	4	0.83-1.07	0.92	0.130	0.065
D	1	—	0.87	—	—
E	2	0.77-0.80	0.78	0.030	0.021
B. c. americana					
Alberta, British Columbia, Manitoba, Ontario, Québec					
Nelson's ratio: (LN x WN)/WBPN					
A	25	2.53-3.65	3.14	0.307	0.061
B	6	2.52-3.27	2.98	0.300	0.122
C	5	2.46-3.30	2.95	0.385	0.172
D	4	2.46-2.85	2.70	0.360	0.180
E	3	2.79-3.31	2.98	0.350	0.200
Fjeldså's (1977) ratio: WN/DACN					
A	25	0.67-1.01	0.81	0.087	0.017
B	6	0.60-0.83	0.69	0.094	0.038
C	5	0.59-0.76	0.66	0.074	0.033
D	4	0.50-0.54	0.52	0.024	0.012
E	3	0.50-0.61	0.56	0.068	0.039

Table 3. Mathematical ratios obtained from live goldeneye of known sex. Ages estimated as in Table 1

Species Origin Parameter Age	Sample	Range	Mean	S.D.	S.E.
B. islandica (1976, 1983) Females					
British Columbia					
Nelson's ratio: (LN x WN)/WBPN					
A	45	3.77-4.97	4.40	0.299	0.045
B	28	4.14-5.23	4.45	0.406	0.077
C	21	4.05-4.75	4.35	0.238	0.052
D	12	4.26-5.15	4.57	0.360	0.104
E	42	4.42-6.26	5.24	0.547	0.084
B. islandica (1976, 1983) Males					
British Columbia					
Nelson's ratio: (LN x WN)/WBPN					
A	49	4.23-5.03	4.63	0.216	0.031
B	25	4.37-4.93	4.68	0.206	0.041
C	19	4.23-5.25	4.66	0.347	0.079
D	11	4.25-5.10	4.59	0.305	0.092
E	60	4.37-6.53	5.31	0.572	0.074
B. c. americana (1968, 1976, 1983) Females					
Manitoba					
Nelson's ratio: (LN x WN)/ WBPN					
A	37	2.51-3.63	3.25	0.299	0.049
B	8	2.92-3.37	3.15	0.193	0.068
C	8	2.96-3.31	3.16	0.168	0.060
D	4	2.93-3.22	3.08	0.150	0.038
E	30	2.67-3.23	2.98	0.209	0.038
B. c. americana (1968, 1976, 1983) Males					
Manitoba					
Nelson's ratio: (LN x WN)/WBPN					
A	44	2.33-3.76	3.32	0.440	0.066
B	13	3.19-3.64	3.32	0.183	0.051
C	13	2.74-3.19	3.16	0.250	0.069
D	7	2.89-3.45	3.20	0.258	0.098
E	46	2.77-3.57	3.13	0.230	0.034

egg-teeth. Fjeldså's ratio, in which neither ranges nor means overlap (see Fig. 2), proved somewhat less reliable for older birds because the ratios of both goldeneye species decreased in parallel fashion with age, producing no constant ratio in live or prepared specimens of either species. On the other hand, Nelson's ratio, which is Length of Nail times Width of Nail, the product divided by the Width of Bill at Posterior of Nail ((LN x WN)/WBPN) was nearly constant (more than 4.0 for Barrow's ducklings, less than 4.0 for Common) and distinguished almost invariably between Barrow's and Common goldeneye ducklings regardless of age or sex. Nelson's ratio proved equally useful for both live and prepared specimens, and differed significantly between Barrow's and Common Goldeneye ducklings by multiple comparison of means and standard errors ($P<0.05$). See Tables 1-3 and Figure 2; note that ranges of some young birds' bills overlap, but means do not.

In conclusion, Fjeldså's (1977) ratio may be used with confidence for newly hatched, live and prepared goldeneyes of either species, but Nelson's ratio should be used to distinguish between slightly older goldeneyes of both species, live or prepared.

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