

A COMPARISON OF TWO WATERFOWL BROOD SURVEY TECHNIQUES¹

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Aerial surveys, brood beat outs, road surveys, and brood observations have been used to estimate numbers of waterfowl broods (M. E. Anderson, unpubl. reps., South Dakota Dep. Game, Fish, and Parks Fed. Aid Proj. W-17-R-7 and 8, 1953, 1955; Bennett 1967). M. C. Hammond (unpubl. rep., U.S. Bur. Sport Fish and Wildl., 1970) summarized several brood survey techniques and suggested that combining 2 or more techniques might be desirable for increased accuracy in some detailed waterfowl studies. The objective of this study was to compare 2

techniques, flush counts and hidden observation counts, for censusing duck broods on livestock watering ponds (stock ponds).

METHODS

Waterfowl brood counts were conducted on 34 stock ponds in Jones and Lyman counties, south central South Dakota during the first 2 weeks of July and August 1977 and 1978. Surveys involved 2 techniques: observation of ponds by hidden observers (observation counts), and flushing of broods to open water by walking the shoreline and emergent cover (flush counts). Dogs were not used. Ponds ranged from 0.71 to 2.70 ha of surface water and were a minimum of 2.5 km apart. Age-class of broods (Gollop and Marshall 1954), brood size, and species were recorded.

Observation counts began at sunrise and 2.5 hours before sunset and lasted

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approximately 2.5 hours. Morning and evening observation periods coincided with periods of greatest diurnal activity and visibility of waterfowl broods (Diem and Lu 1960, Ringelman and Flake 1980). Spotting scopes and binoculars were used to assure maximum visibility of a stock pond and minimum disturbance to broods. Observation counts were discontinued when temperatures exceeded 32 C or wind velocity was greater than 24 km/hour. These conditions are known to affect brood visibility and activity (Ringelman and Flake 1980).

Brood surveys were conducted by 2 crews of 2 persons each. During observation counts, each member of a crew observed a separate pond; thus, 4 ponds were surveyed by observation each morning and evening. Immediately following morning observation counts, stock ponds observed that morning and the previous evening by 1 crew were flush-surveyed by members of the other crew. Shorelines and adjacent uplands were walked and stands of emergents were waded in a zigzag manner to flush broods. Members of the crew walked in opposite directions from a starting point around the pond. To reduce potential observer bias in the counting effort, information from observation counts was not shared between crews until after the flush count.

Estimates of total broods on each pond were obtained by the Petersen Index (Seber 1973:59). On ponds in which no broods were seen with 1 of the survey techniques, the number of broods seen on that pond during the other count was assumed to be the total number of broods present. Broods seen more than once were counted only once. Individual broods were distinguishable by a combination of age-class, species, and number of ducklings. Distraction display by hens was considered evidence of a brood; in al-

Table 1. Comparison of observation and flush survey results of waterfowl broods on stock ponds in South Dakota.

Sample date	No. broods		No. ponds	<i>a</i> level for paired <i>t</i> test
	Obs. ^a	Flush		
1977				
Jul	64	63	32	0.905
Aug	59	58	30	0.897
1978				
Jul	175	191	34	0.180
Aug	101	121	32	0.047

^a Obs. = Observation survey technique.

most all such instances the observers were able to locate at least part of the brood by searching the area from which the hen was flushed.

Paired *t* tests, chi-square combination of tests of significance (Steel and Torrie 1960:350), and Tukey's single degree of freedom test for non-additivity (Steel and Torrie 1960:229) were used to evaluate the number of broods tallied by the 2 counts (flush and observation) and total broods. The chi-square test allows for the combining of tests of significance based on the probabilities of significance of the original tests. Stock ponds on which no broods of a particular species were found with either survey technique were excluded from the analysis for that species. Visibility correction factors were calculated for each species for both methods by taking the inverse of the ratio of broods seen on that survey to the number of broods estimated to be on the pond from both surveys.

RESULTS

Species observed included blue-winged teal (*Anas discors*), mallard (*A. platyrhynchos*), pintail (*A. acuta*), gadwall (*A. strepera*), northern shoveler (*A. clypeata*), and American wigeon (*A. americana*). Green-winged teal (*A. crecca carolinensis*), redhead (*Aythya americana*), lesser scaup (*A. affinis*), and rud-

Table 2. Comparison of the accuracy of flush and observation techniques in surveying waterfowl broods on stock ponds in South Dakota.

Sample date	Total no. broods on stock ponds ^a	Percent of total broods		^a level for test of difference from total	
		Obs.	Flush	Obs.	Flush
1977					
Jul	99	64.6	63.6	<0.016	<0.004
Aug	80	73.8	72.5	0.001	<0.002
1978					
Jul	254	68.9	75.2	<0.001	<0.001
Aug	149	67.8	81.2	<0.001	<0.001

^a Estimated total number of broods obtained by the Petersen Index.

dy duck (*Oxyura jamaicensis*) broods were rarely observed.

Comparisons of flush and observation counts (all species) indicated no difference in effectiveness between the 2 techniques on 3 of 4 sample dates (Table 1). Although flush counts exceeded observations for both sample dates in 1978, only the difference from the August count was significant ($\alpha = 0.047$). When data from both sample dates in 1978 were combined, chi-square analysis showed that

more broods ($\alpha = 0.049$) were seen with the flush technique than with the observation technique. Chi-square analysis of combined data from both sample dates in 1977 showed no difference ($\alpha = 0.98$) between the 2 techniques, indicating that the year was a factor in the difference in the results.

The total number of broods on stock ponds was greater ($\alpha = 0.016$) than tallied by either observation or flush counts alone for all survey dates (Table 2). Per-

Table 3. Comparisons of observation and flush counts for waterfowl broods of commonly sighted species on stock ponds in South Dakota.

Species	Date	No. broods			No. ponds	α level for paired t tests ^b		
		O	F	T ^a		O - F	O - T	F - T
Blue-winged teal	Jul 1977	25	33	40	23	0.04	<0.01	0.05
	Aug 1977	27	21	35	25	0.13 ^c	0.01	<0.01
	Jul 1978	62	78	88	30	0.02	<0.01	<0.01
	Aug 1978	34	39	48	28	0.18 ^c	<0.01	<0.01
Mallard	Jul 1977	20	15	20	17	0.17 ^c	0.03	0.01
	Aug 1977	8	17	20	16	0.01	<0.01	0.04
	Jul 1978	38	36	55	27	0.25 ^c	<0.01	<0.01
	Aug 1978	13	18	21	16	0.09 ^c	<0.01	0.09 ^c
Gadwall	Jul 1977	3	5	6	5	0.24 ^c	0.19 ^c	0.10 ^c
	Aug 1977	10	7	10	8	0.04	0.50 ^c	0.04
	Jul 1978	19	22	29	18	0.17 ^c	0.01	0.01
	Aug 1978	25	29	34	17	0.33 ^c	0.01	0.01
Pintail	Jul 1977	9	4	13	10	0.05	0.04	0.01
	Aug 1977	3	2	3	3	0.10 ^c	0.19 ^c	0.01
	Jul 1978	7	15	17	10	0.09 ^c	0.04	0.08 ^c
	Aug 1978	4	1	5	5	0.21 ^c	0.50 ^c	0.21 ^c

^a O = observation technique, F = flush technique, and T = estimated total based on the Petersen Index.

^b O - F = observation minus flush, O - T = observation minus total, and F - T = flush minus total for paired t tests.

^c Indicates no difference in paired t test ($\alpha \leq 0.05$).

Table 4. Comparisons of observation and flush counts for waterfowl broods by age-class on stock ponds in South Dakota.

Age-class	Date	No. broods			No. ponds	α level for paired <i>t</i> tests ^b		
		O	F	T ^a		O-F	O-T	F-T
Class I	Jul 1977	44	30	54	30	0.03	<0.01	0.01
	Aug 1977	8	3	8	6	<0.01	0.50 ^c	<0.01
	Jul 1978	75	67	106	30	0.10 ^c	<0.01	<0.01
	Aug 1978	17	15	21	13	0.31 ^c	0.02	0.03
Class II	Jul 1977	14	19	26	20	0.16 ^c	<0.01	<0.01
	Aug 1977	21	30	41	25	0.04	<0.01	<0.01
	Jul 1978	66	92	117	31	<0.01	<0.01	<0.01
	Aug 1978	37	48	60	26	0.11 ^c	<0.01	<0.01
Class III	Jul 1977	3	5	7	6	0.18 ^c	0.01	0.09 ^c
	Aug 1977	25	17	32	21	0.05	<0.01	<0.01
	Jul 1978	18	21	30	17	0.50 ^c	<0.01	0.01
	Aug 1978	45	52	68	28	0.13 ^c	<0.01	<0.01

^a O = observation technique, F = flush technique, and T = estimated total based on the Petersen Index.^b O-F = observation minus flush, O-T = observation minus total, and F-T = flush minus total for paired *t* tests.^c Indicates no difference in paired *t* test ($\alpha < 0.05$).

centages of total number of broods seen on the observation and flush counts were determined for the 4 sample dates (Table 2). Differences between flush counts and observation counts were consistent ($\alpha \leq 0.22$) over all ponds for all but the August 1978 sample date ($\alpha = 0.03$) (Tukey's 1 df test), indicating no interaction between ponds and survey technique for those sample dates.

Comparisons of flush and observation survey techniques by species (Table 3) indicated flush counts from July sample dates (both 1977 and 1978) for blue-winged teal accounted for more ($\alpha = 0.04$) broods than observation counts, whereas August counts for blue-winged teal showed no difference between the 2 techniques. Both techniques were equal for counting mallard and gadwall broods, except in August 1977 when flush counts were better for censusing mallard broods and observations were better for gadwall broods. Data on pintails were inconclusive, as sample sizes were small for both years.

Comparisons by age-class (Table 4) showed that the observation technique

was better for counting class I broods in 1977 ($\alpha \leq 0.03$); in 1978 both techniques were equal. Flush counts accounted for more Class II broods ($\alpha \leq 0.04$) on the August 1977 and July 1978 sample dates; more class II broods also were seen on the flush counts on other sample dates, but the differences were not significant. There was no difference between the 2 techniques for class III broods except in the August 1977 census period; observation counts from this survey were greater ($\alpha = 0.05$) than flush counts. Evaluations of single surveys against totals by age-class showed significant differences for all cases when the sample size was adequate.

Visibility correction factors were calculated for each species (Table 5). For observation counts, gadwall broods were the most visible, followed by blue-winged teal, mallard, and pintail broods. Blue-winged teal were the most visible on flush counts, followed by gadwall, mallard, and pintail broods. When averaged for both techniques over 1977 and 1978, blue-winged teal and gadwall broods were the most visible, followed by mallard and

Table 5. Accuracy of flush and observation counts relative to estimated total number of duck broods on stock ponds in South Dakota.

Species	Percentage of totals ^a			Visibility correction factor ^b		
	Obs.	Flush	Average	Obs.	Flush	Average
Mallard	68.1	74.1	71.1	1.47	1.35	1.41
Blue-winged teal	70.1	81.0	75.5	1.43	1.23	1.32
Pintail	62.2	59.5	60.9	1.61	1.68	1.65
Gadwall	72.2	79.7	76.0	1.39	1.25	1.32
Total broods ^c	68.6	74.4	76.1	1.46	1.34	1.40

^aPercentages of total were averaged for all 4 sample dates.^bCorrection factor = inverse of the fraction of each species or total broods that were seen on each census technique.^cTotal broods includes all species seen on surveys.

pintail broods. The correction factor for all broods for observation counts was 1.46; for flush counts, 1.34. The average for both techniques was 1.40.

DISCUSSION

The larger number of broods seen on flush counts as compared to observation counts in 1978 may have been related to the heavy growth of yellow sweetclover (*Melilotus officinalis*) in 1978. Visual obstruction readings (VOR) (Robel et al. 1970) increased from 1.28 ± 0.17 ($\bar{x} \pm \text{SE}$) in 1977 to 2.38 ± 0.31 in 1978 on land surrounding the study ponds (Rumble 1979) primarily because of the sweetclover. Inactive broods loafing in or near dense upland vegetation may have been missed on observation counts. On flush counts, broods seen on the shoreline or upland usually moved to open water; in addition, location of broods on the shoreline or adjacent upland was often facilitated by the presence of a broody hen.

Hammond (1970) indicated that the visibility correction on ground surveys of dabbling duck broods was approximately equal to the reciprocal of the percentage of open water. Thus, percentage of dabbling broods visible could be estimated by the percent open water on the surveyed pond. Percent open water averaged 83.1 on the study ponds, and the data indicated that

64-81% of the estimated total broods on stock ponds were observed on a single observation or flush survey. If only broods that were seen were tallied as totals vs. estimating totals by the Petersen Index, the percent of the total seen on a single survey more closely approximated the percent open water (72-85%). Habitat conditions affected the accuracy of the flush and observation techniques, but these changes were for the most part consistent over ponds within a sample date as indicated by Tukey's 1 df test for non-additivity.

Results are presented by species for observation and flush count techniques. Managers interested in surveying blue-winged teal broods could use either technique when conditions in pastures were normal, as they were in 1977. However, in years or areas where upland vegetative cover is tall and dense, as sweetclover was in 1978, the flush technique is recommended. More young mallard broods were seen on the observation counts than on flush counts. This difference, however, was not significant. In August, when mallard broods are older, flush counts are recommended.

Results from age-class analyses were not conclusive. Class I ducklings may be more effectively censused by observation counts than the older age-classes. Rin-

gelman and Flake (1980) reported that there were more apparent age-related differences in brood behavior than species differences.

Hammond (1970) reported that gadwall broods were the most visible on census-ing efforts followed by mallard, blue-winged teal, and pintail broods. In order of brood visibility, the results of this study are in agreement with Hammond (1970) except for blue-winged teal, which were equally visible with gadwall. Blue-winged teal and gadwall tended to move towards open water and remain there during surveys whereas mallards and pintails were more likely to seek vegetative cover.

Flush counts of waterfowl broods on stock ponds were equal to or more effective than hidden observation counts and can be conducted more rapidly. Stock ponds with extensive emergent cover are best surveyed with hidden observation counts; such ponds may require 2 or more observation counts to get a reasonable estimate of numbers of broods. When possible, ponds being approached for flush counts should be observed from a concealed vantage point for several minutes to allow initial sighting of active broods before approaching the pond edge. For detailed brood studies, morning or evening observation counts combined with separate flush counts will improve the accuracy of brood counts.

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