POPULATION DYNAMICS OF BREEDING WOODCOCK IN THE CANAAN VALLEY, WEST VIRGINIA

JAMES M. CLARK, Environmental Protection Office Naval Air Station, Patuxent River, MD 20670

Abstract: Data collected from woodcock banded in Canaan Valley, West Virginia from 1964 to 1970 were analyzed to determine population dynamics of resident (breeding) woodcock. Immatures comprised over 60% of the banded sample, with immature males comprising 42% ($P<0.05$). Immatures appeared more susceptible to capture. Overall sex ratio for the banded sample revealed more males than females, but more females were found in the adult class. Greater survival of immature females causes ratios favoring females in the adult class. Additionally, adult females have a higher survival rate than adult males. Exceptionally high recovery rates were attributed to concentrated hunting pressure and band collecting. Immatures were 1.7 times more susceptible to gunning than adults. High variances and confidence limits were computed for population and survival estimates, which suggested great variation in collection of data. Survival and recovery estimates between age classes of each sex did not differ ($P>0.05$). Analysis of pooled data for each sex indicated that female recovery rates varied from year to year, but survival rates remained constant over time. Because of extremely small sample sizes and variation of these data, caution should be used in interpreting these results.

Proc. Ann. Conf. S.E. Assoc. Fish & Wildl. Agencies 33: 288-295

The proportion of gamebirds banded in an area to those later recovered provides an index of harvest rates. Harvest rates can be used as a basis for determining age composition of the pre-season population and production rates, and to evaluate hunting regulation changes to see if more restrictive or liberal regulations are effective in changing kill rates. Distribution of harvest and harvest rates are measured because birds taken by hunters comprise the chief source of banding recoveries (Geis 1972).

Using recent population models, I analyzed data gathered for woodcock banded in Canaan Valley (1965-1972) to yield vital survival statistics which characterize a heavily hunted resident (summer) population. This paper discusses results of these analyses and the feasibility of using recent population models on a relatively small sample.

I would like to extend my appreciation to L. Klatt, Biometrician for the West Virginia Department of Natural Resources (DNR), and J. Nichols and T. Dwyer of the Migratory Bird and Habitat Research Laboratory for assisting with the analyses.

METHODS

Tables of shot recoveries and recaptures were prepared by computer at the DNR Operational Center, Elkins, WV. Estimations of survival and recovery rates were completed at the Migratory Bird and Habitat Research Laboratory, Laurel, M.D. Population data wre analyzed using the Fortran IV program to estimate time-specific survival and recovery rates from banding and recovery data (Seber-Robson-Youngs Model (S-R-Y)), and to estimate age-specific survival and recovery rates from banding and recovery data (Robson-Brownie Model (R-B)) (Anderson et al. 1974). Chi-Square was used to test significance.

The resident banding period was set from April 15 to September 20 (summer). An adjusted banding period was necessary for some population models which assume banding occurred for only 3 months. Banding period was adjusted to 16 June-15 September for S-R-Y and R-B models.

The S-R-Y model allows both survival and recovery rates to vary from year to year, but assumes these parameters are independent of the bird's age or capture status. This

model is not applicable to birds banded young which have lower survival rates and higher recovery rates the first year (Anderson et al. 1974).

The R-B model allows recovery rates to vary annually but assumes survival is constant. These parameters are assumed to be independent of the age of the bird or its capture history. Both R-B and S-R-Y models assume that the banding and hunting season do not overlap, only shot recoveries are used and the banding period does not exceed 3 months.

RESULTS

Number of Woodcock Banded

From 1965 to 1970, 1140 woodcock were banded. Immatures comprised 62% and males 58% of the summer sample (Table 1). Except for 1966, more immature males were captured than any other age and sex classes.

TABLE 1. Summary of woodcock banded, Canaan Valley, West Virginia, 1965-1970 (April 15-September 20).

	Immature		Adult			
Year	Male	Female	Male	Female	Unknown	Total
1965	29(48)[a]	14(23)	8(13)	9(15)	-	60
1966	32(24)	15(11)	41(31)	41(31)	3(2)	132
1967	117(44)	57(21)	41(15)	50(19)	3(1)	268
1968	120(44)	58(21)	33(12)	62(23)	2(1)	275
1969	62(34)	40(22)	34(18)	47(26)	1(1)	184
1970	119(54)	45(20)	21(10)	31(14)	5(2)	221
Total	479(42)	229(20)	178(16)	240(21)	14(1)	1140

[a]Percentage

All summary of total woodcock captured is presented in Table 2. Immatures appeared to be more susceptible to capture with immatures males most vulnerable ($P<0.05$), but no difference was detected between total males and females ($P>0.05$).

The overall sex ratio for the banded sample revealed more males than females, but a slight preponderance of females occurred in the adult class (Table 3). Conversely, the immature sex ratio favored males.

Recoveries

A total of 252 recoveries from 1140 banded woodcock were retrieved from 1965-70 (Table 4). Only 30 recoveries occurred outside West Virginia. Recoveries in Canaan Valley accounted for 94% of total recoveries (237). These exceptionally high recovery rates can be attributed to concentrated hunting pressure and "band" collecting in Canaan Valley.

Direct recovery rates were 21% for immatures and 15% for adults (Table 5). Band recoveries were pooled for adult males and females and for immature males and females since no difference was found in distribution of recoveries according to age ($P>0.05$). Immature rates exceeded adult rates each year which suggested young birds were more vulnerable to gunning than adults. Assuming Canaan Valley migrants of both age classes

TABLE 2. Total captures of woodcock by Method, Canaan Valley, West Virginia, 1965-1970 (April 15 - September 20). Includes captures and recaptures.

Method	Immature		Adult		Unk.	Total
	Male	Female	Male	Female		
Trap	81	50	22	37	6	196
Mistnet	36	15	67	40	1	159
Nightlight (Foot)	355	145	158	161	7	826
Nightlight (Truck)	482	229	244	301	10	1266
Total	954	439	491	439	24	2447

TABLE 3. Age and sex ratios of woodcock banded, Canaan Valley, West Virginia (April 15 - September 20).

Year	Males / Females	Immatures / Adult Females	Immature Females / Adult Females	Immature Males / Immature Females	Immatures / Adults	Adult Males / Adult Females
1965	1.61	4.78	1.56	2.07	2.53	.89
1966	1.33	1.15	.37	2.13	.57	1.00
1967	1.47	3.48	1.14	2.05	1.91	.82
1968	1.28	2.87	.94	2.07	1.87	.53
1969	1.10	2.17	.85	1.55	1.26	.72
1970	1.84	5.29	1.45	2.64	3.15	.68
Mean	1.40	2.95	.95	2.00	1.69	.75

were exposed to similar hunting pressure and band reporting rates, relative recovery rates indicate immatures were 1.7 times more likely to be shot than adults.

Survival and Recovery Rates Estimated by Robson-Brownie

Analysis of the adult and immature data was performed separately for each sex. Immature and adult females were found to have the same survival and recovery rates ($P>0.05$) (Table 6), thus female data were pooled for analysis by the S-R-Y model. Survival rates were lower for males than females (Table 7), although recovery rates were still extremely high. Immature and adult males were also found to have similar survival and recovery rates ($P>0.05$), thus male data were pooled for analysis by S-R-Y model.

Survival and Recovery Rates Estimated by Seber-Robson-Youngs

The S-R-Y program progresses from a general model which makes very simple, but restrictive assumptions. Three models were used on these data. Estimated recovery and survival rates are presented in Tables 8 and 9. Direct recovery rates for females were found to vary over time ($P<0.05$). A test between models suggested female recovery rates varied from year to year, but that annual survival rates remained constant. Statistical testing between models suggested male recovery and survival rates remained constant over time ($P<0.05$). The inability to detect annual differences in recovery or survival rates is not surprising considering the large confidence intervals associated with the estimates.

TABLE 4. Recovery records (birds recovered after banding season) for woodcock banded in Canaan Valley, West Virginia, 1965-1970 (April 15 - September 20). Includes woodcock recovered inside and outside of valley.

Immature Male		Year Recovered					
Year banded	No. banded	65	66	67	68	69	70
65	29	4	0	0	09	0	1
66	32		9	0	2	0	0
67	117			25	4	0	0
68	120				30	2	1
69	62					17	0
70	119						21

Immature Female		Year Recovered					
Year banded	No. banded	65	66	67	68	69	70
65	14	3	0	0	1	0	0
66	15		3	0	1	0	0
67	57			5	2	1	0
68	58				16	2	0
69	40					0	1
70	45						7

Adult Male		Year Recovered					
Year banded	No. banded	65	66	67	68	69	70
65	8	0	0	1	0	0	0
66	41		3	1	1	0	0
67	4$			9	1	0	0
69	33				5	0	2
69	34					9	1
70	21						4

Adult Females		Year Recovered					
Year banded	No. banded	65	66	67	68	69	70
65	9	1	0	0	0	0	0
66	41		8	1	2	0	0
67	50			4	0	1	0
68	62				14	1	1
69	47					11	0
70	31						1

DISCUSSION

Whether considering total captures or only the banded sample, twice as many immature males were captured than any other age and sex class. Several reasons could account for this apparent overabundance of immature males. They may be more susceptible because of inexperience or a spatial preference to areas where capture techniques were concentrated. The seclusion and decreased activity of breeding adults during the summer may favor a higher immature to adult capture ratio. Adult males, particularly, may be less inclined to make crepuscular forays after 2-3 months of intensive breeding activity. This may also explain the discrepancy found between total numbers of either sex in the adult class. This suggests that the age-sex composition of the banded sample is not indicative of the overall population structure. High percentages of immature males in banded samples have been found in other studies (Clark 1971, Krohn et al. 1977).

TABLE 5. Direct and relative recovery rates of immature and adult woodcock banded April 15 - September 20. Canaan Valley, West Virginia.

Year	Direct recovery rates		Relative recovery rate
	Immature	Adult	
1965	16.3(7)[a]	5.9(1)	2.8
1966	25.5(12)	13.4(11)	1.9
1967	17.2(30)	14.3(13)	1.2
1968	25.8(46)	20.0(19)	1.3
1969	25.5(26)	24.7(20)	1.0
1970	17.1(28)	9.6(5)	1.8
Mean	21.2 (149)[b]	14.7(69)	1.7

[a]Shot recoveries.
[b]Total shot recoveries.

TABLE 6. Estimates of survival and recovery rates for female woodcock in Canaan Valley, West Virginia (Robson-Brownie, H_1).

Adult Females				
Year	Survival	Standard Error	Recovery	Standard Error
1966	72.0	59.7	16.0	7.3
1967	14.7	10.2	5.2	3.0
1968	21.8	12.4	19.4	5.4
1969	21.1	29.7	22.5	6.1
1970	-	-	2.3	2.5

Immature Females				
Year	Survival	Standard Error	Recovery	Standard Error
1966	75.0	80.2	25.0	12.5
1967	20.6	12.6	9.1	3.9
1968	15.4	11.4	25.5	6.1
1969	39.5	-	14.0	5.3

Spatial arrangement of different age and sex classes on roosting fields may also contribute to the difference in capture ratios. Owen and Morgan (1975) found that adults walked (rather than flew) more than immatures from diurnal to nocturnal cover; subsequently, adults would be less susceptible to mistnetting. Adults may stay closer to the edge of fields. Unless mistnets are located at field edges and nightlighting activities include searching borders of roosting fields, adults could be overlooked. Adults captured during spring on singing grounds may become trap-shy and avoid traps during summer.

TABLE 7. Estimates of survival and recovery rates for female in woodcock in Canaan Valley, West Virginia (Robson-Brownie, H_1).

Adult Males				
Year	Survival	Standard Error	Recovery	Standard Error
1966	-	-	4.8	4.7
1967	15.7	12.2	21.5	6.6
1968	14.1	11.1	22.7	8.4
1969	38.8	26.0	20.8	7.0
1970	-	-	20.0	8.9
Immature Males				
Year	Survival	Standard Error	Recovery	Standard Error
1966	14.8	15.0	33.3	9.6
1967	11.2	6.8	21.4	3.8
1968	5.7	4.3	24.8	4.1
1969	-[a]	-	27.4	5.7
1970	-	-	17.1	3.6

[a]Data insufficient to compute survival and standard error.

The age ratio of the banded sample average 1.69 immatures per adult, which is relatively consistent with results of other studies (Martin et al. 1965, Krohn et al. 1977). Age ratios in the harvest appear to be higher because of greater vulnerability of immatures to gunning and greater non-hunting mortality of adults between time of banding and the next hunting season.

The immature sex ratio favored males, but the adult ratio favored females. This suggests that immature males are more vulnerable to capture, and thus, may be more susceptible to hunting and other mortality. Greater survival of immature females may cause ratios favoring females in the adult class. Additionally, adult females appear to have a greater survival rate than adult males. Since woodcock are promiscuous, an unbalance sex ratio favoring females should not reduce productivity.

Exceptionally high recovery rates for all age and sex classes can be attributed to: (1) banded birds were readily available to hunters, (2) hunting pressure was high during the period these woodcock were available, and (3) a concerted effort was made to obain hunting data. The rates show males were more susceptible during their first year with a depressed rate for males surviving their first year. Annual band recovery rates differed significantly by age of birds banded. These findings suggest that there are age differences in vulnerability to shooting and that annual harvest rates may vary among age groups. Krohn et al. (1974) found that recovery rates of woodcock in Maine did not differ significantly between age and sex, implying no difference in vulnerability to shooting was detected.

Models used provided estimates of total annual survival rates and made no assumptions about competing morality risks. Therefore, "non-overlapping" mortality type assumptions (only hunting losses occur in 1 period, while only "natural" mortality occurs during the rest of the year) do not apply to these data. Additionally, no models were available to determine if hunting mortality is additive or compensatory.

TABLE 8. Estimates of recovery rates from woodcock banded as adults and immatures (Seber-Robson-Youngs, Model 1).

Males

Year	Recovery Rate	Standard Error	Direct Recovery Rate	Standard Error
1966	20.0	6.0	20.0	6.0
1967	21.4	3.3	21.9	3.3
1968	24.1	3.7	23.7	3.7
1969	24.5	4.4	27.2	4.6
1970	17.6	3.3	17.6	3.3

Females

Year	Recovery Rate	Standard Error	Direct Recovery Rate	Standard Error
1966	18.9	6.4	18.9	6.4
1967	7.3	2.5	8.1	2.7
1968	23.3	4.1	23.2	4.2
1969	23.2	4.6	23.8	4.7
1970	8.6	3.3	9.7	3.5

TABLE 9. Estmates of average annual survival rates of woodcock (adults and immatures) in Canaan Valley, West Virginia, 1966-1969 Youngs, Model 1).

Year	Survival Rests (percent) Male	Standard Error	Females	Standard Error
1966	8.7	8.7	62.4	38.4
1967	13.8	5.9	17.3	7.8
1968	9.0	4.7	19.2	8.6
1969	20.7	11.0	16.9	13.4
Mean	13.1	3.8[a]	28.9	10.0

[a]Standard error of arithmetic mean.

Survival rates (from all models) averaged 38.8% for females and 31.5% for males. Estimated survival rates for immature males were lower than for all other age-sex classes. Estimated survival for adult males, adult females, and immature females closely coincided. From these data a greater proportion of adult females should be present in the population because of greater survival of immature females.

Analysis of pooled data for males and females showed that female recovery rates varied from year to year, with annual survival rates remaining constant. For males, recovery and survival rates were found to remain constant over time.

Limitations of Recovery and Survival Estimates

Estimators developed from the theory of maximum likelihood have many good statistical properties, but assume at least 200-300 annual bandings for each age and sex class. Our annual bandings fell well short of this requirement.

Methods and intensity of collecting varied from year to year causing possible bias. High coefficients of variation were found in the S-R-Y model, which suggested the data were highly variable. Because of large confidence intervals associated with the estimates, variations in either survival or recovery rates could not be detected. Although bird-banding is time consuming and expensive, insufficient attention has been given to planning the study, assessing the assumptions, and analyzing the data thoroughly (Anderson 1972). Data gathering and analysis should be preceded by proper planning and evaluation of the necessary assumptons.

LITERATURE CITED

Anderson, D.R. 1972. Bibliography on methods of analyzing bird banding data. U.S. Fish and Wildl. Ser. Spec. Sci. Rep.Wildl. No. 156. 13 pp.

_____, D.R., F.R. Fiehrer, and C.F. Kimball. 1974. A computer program for estimating survival and recovery rates. J. Wildl. Manage. 38(2):369-370.

Clark, E.R. 1971. Woodcock status report. 1970. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. 140. 38 pp.

Geis, A.D. 1972. Role of banding data in migratory bird population studies. Pages 213-228 *in* Population ecology of migratory birds. U.S. Fish and Wildl. Serv., Wildl. Res. Rep. 2. 278 pp.

Krohn, W.B., F.W. Martin, and K.P. Burnham. 1974. Band-recovery, distribution, and survival estimates of Maine woodcock. *In* Fifth American woodcock workshop, Athens, GA. n.p.

_____, J.C. Rieffenberger, and F. Ferrigno. 1977. Fall migration of woodcock at Cape May, New Jersey. J. Wildl. Manage. 41(1):121-131.

Martin, F.W., A.D. Geis, and W.H. Stickel. 1965. Results of woodcock wing collections, 1959-1962. J. Wildl. Manage. 39(1):179-182.

Owen, R.B. Jr., and J.W. Morgan. 1975. Summer behavior of adult radio-equipped woodcock in central Maine. J. Wildl. Manage. 39(1): 179-182.