

Aussi disponible en français

No. 96, April 1979



Toward population goals for Canvasback
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Abstract

Analysis of recent migratory game bird hunting regulations and estimated kill in Canada, particularly in the Prairie Provinces, suggests that a restricted daily bag and possession limit has no effect on the kill of Canvasback. Data on breeding habitat as a possible influence on hunting kill during the years tested were examined but not significantly correlated although some associations were evident. The implications of historic data on breeding habitat, a limited environment and consequent supply of Canvasback suggest that recent populations are near the maximum that can be expected. Increasing demand for Canvasback would have to be met by social incentive such as further regulatory rationing outside Canada.

Introduction

In late 1976 bilateral discussions were held between representatives of the governments of Canada and the United States as part of regular reviews of international migratory bird management. Canadian Wildlife Service (CWS) officials agreed to review the management activities for Canvasback (*Aythya valisineria*) in Canada. The US Department of Interior has been petitioned by a segment of their interested public to review the status of Canvasback and to adopt promptly all measures "necessary and appropriate to conserve" the species and its habitat (Anon. 1975). During the 1960s the United States Fish and Wildlife Service (USFWS) management policies were directed toward conservation of Canvasback which led to changes in legislation. As a result, by the mid 1970s the USFWS was faced with public complaints about reduced hunting opportunities. Canadian management policies during that period, while sympathetic, had not changed significantly and had not been visibly indicative of mutual concern. Indeed Canadian policies could be construed at face value as lethargic, if not retrograde, by the public mainly in the United States. There was thus a need for a quick analytical look at Canadian migratory bird management particularly for Canvasback and a public statement of defects in Canadian policy, if any, with a consequent indication of future directions to be taken in Canada.

Methods

Data on locations in which selected diving duck species were reported shot in the Prairie Provinces from 1968 through 1975 were provided by the Population and Surveys Section, Migratory Birds Branch, CWS, Ottawa. Those data referred to Lesser Scaup (*Aythya affinis*), Redhead (*Aythya americana*), Canvasback, Common Goldeneye (*Bucephala clangula*) and

Greater Scaup (*Aythya marila*). In addition, data on breeding population, habitat, sex and age of shot samples available in current CWS Progress Notes, USFWS Administrative Reports and the 1977 Waterfowl Status Report and Fall Flight Forecast were examined for the years 1969 through 1977.

Data for the five species were requested as relative importance of each was known only generally and the need to group data into larger aggregates for analysis was unknown. Data on Common Goldeneye and Greater Scaup were examined but not analysed extensively because of their more restricted representation in the harvest in the Prairie Provinces, and nationally both in Canada and the United States. Data on other diving duck species such as Ruddy Duck (*Oxyura jamaicensis*) and Hooded Merganser (*Lophodytes cucullatus*) were not provided for the Prairie Provinces as their relative importance in waterfowl harvest generally was believed insignificant. Data on harvest of Canvasback in the Prairie Provinces were then compared to other species and environmental variables in multivariate analyses.

Table 1
Bag limits* for ducks and Canvasback in Manitoba, Saskatchewan and Alberta, 1967-1976†

Year	Manitoba		Saskatchewan		Alberta	
	Canvas-back	Ducks	Canvas-back	Ducks	Canvas-back	Ducks
1967	2	8(10)‡	2	8	8	8(10)‡
1968	2	5(7)‡	2	5(7)‡	8	8(10)‡
1969	1	7(9)‡	1	7(9)‡	8	8
1970	1	8(10)‡	1	10	8	8
1971	1	8(10)‡	1	10	8	8
1972	1	8(10)‡	1	10	8	8
1973	1	6(8)‡	1	8	8	8
1974	1	6	1	8	8	8
1975	1	6	1	8	8	8
1976	1	8	1	8	8	8

*During the period in all provinces cited, possession limits have been twice the daily bag limit shown.
†Taken from the Office Consolidation of the Migratory Birds Convention Act for the years cited.
‡After the second week in October, two additional Lesser Scaup were allowed.

Results

In Manitoba and Saskatchewan bag limits for Canvasback have been restricted since the late 1960s (Table 1), whereas in Alberta they have been the same for all ducks within each year since 1969. For this study I grouped estimated retrieved kills of Canvasback and other ducks for each province into two periods, 1970-72 and 1973-75, because similar regulatory treatments between periods could be compared within

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Table 2
Estimated retrieved kill of Canvasback and total ducks in Manitoba, Saskatchewan and Alberta, 1970-1975

Year	Manitoba		Saskatchewan		Alberta	
	Total ducks	Canvasback	Total ducks	Canvasback	Total ducks	Canvasback
1970	518 095	5690	930 506	7503	904 665	6921
1971	332 231	4646	690 155	4516	847 956	5618
1972	355 773	4224	616 457	5446	801 981	3465
1973	251 931	3579	471 870	2608	831 633	5694
1974	249 590	5355	699 661	8054	1 014 272	4814
1975	299 221	7981	807 295	9062	850 709	4181

and among provinces. Two-way analysis of variance on total estimated retrieved kill of ducks in the Prairie Provinces indicated acceptance of the hypothesis of equal kill between periods ($F_{1,12} = 1.333$). There was no significant interaction, or variance associated with a province and a period ($F_{2,12} = 1.002$). When provinces were compared alone the hypothesis of equal kill was rejected ($F_{2,15} = 26.208$). Tukey's "w" test (Steel and Torrie 1960:110) indicated that the kill in Manitoba was not equal to that in Saskatchewan or Alberta although the kill in those two provinces were equal over the total period. For Canvasback, however, hypotheses of equal kill among provinces ($F_{2,12} = 0.535$), between 1970-72 and 1973-75 seasons ($F_{1,12} = 0.154$) and no interaction of a province with a time period ($F_{2,12} = 0.186$) were accepted. Although the estimated retrieved kill of all ducks in Saskatchewan or Alberta was significantly higher than in Manitoba and there were no additional restrictions on bag or possession limits of Canvasback in Alberta, the estimated retrieved kill of Canvasback must be considered equal among Prairie Provinces during 1970 through 1975 (Table 2). In other words, additional restrictions on bag or possession limits of Canvasback during that time had no effect in the Prairie Provinces.

Table 3
Estimated retrieved kill* of Redhead and Canvasback in Manitoba, Saskatchewan and Alberta, 1969-1976†

Year	Manitoba		Saskatchewan		Alberta	
	Redhead	Canvasback	Redhead	Canvasback	Redhead	Canvasback
1969	16 176	4670	8 533	5024	7 449	5109
1970	14 814	5690	12 782	7403	9 591	6921
1971	8 048	4646	6 902	4516	15 736	5618
1972	7 612	4224	8 836	5446	9 307	3465
1973	4 429	3579	5 304	2608	8 598	5694
1974	8 128	5355	10 475	8054	10 806	4814
1975	8 825	7981	9 684	9062	8 546	4181
1976	11 745	5232	9 123	7144	6 642	3837

*If figures reported for a given year varied when compared in subsequent years the last reported number was used, in most occurrences the variance was slight.
†CWS Progress Notes Nos. 37 and 71 and unpublished computer output for 1976.

I next examined the effect of changing bag limits from season to season. Visual inspection of the data (Table 3) for estimated harvest for each province indicated no clear trend. Analysis of variance among provinces from 1969-1976 ($F_{7,23} = 1.839$; $F_{2,23} = 1.673$) and regression analysis (Fig. 1; $r^2 = 0.020$) confirmed a no linear trend hypothesis in each province. A similar analysis with data on Redhead, which I have considered here only because it is a look-alike species and is managed in concert with Canvasback, led to the same conclusions (Fig. 2; $F_{1,12} = 2.210$; $F_{2,12} = 0.063$; $F_{2,12} = 0.173$; $F_{7,23} = 1.067$; $F_{2,23} = 0.227$; $r^2 = 0.086$) about equal kill over time with differing regulations among provinces. Conscious interventions with or "management" of those species, i.e. changing hunting regulations, did not have a clear effect on the kill in the Prairie Provinces. Factors such as weather, opening date of season, availability of the species, hunter preference, reception and perception of information available to the hunter are confounded in these analyses but few data are available about their effect on kill and some factors are not manageable in any event. If important at all, they may only be compensatory in their effect on total kill of Canvasback in the Prairie Provinces.

Table 4
Relative geographic distribution of diving duck kill* in Manitoba and other Prairies Provinces, 1968-1975

Species	Location in Man.†										Man. sub-total		Other Prairies		Total	
	98-50		95-50		100-50		97-50		Other Man.		Man. sub-total		Other Prairies		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Redhead	128	19	17	2	52	8	69	10	416	61	682	45	847	55	1529	26
Canvasback	115	35	4	1	32	10	27	8	151	46	329	37	566	63	895	15
Greater Scaup	8	12	12	18	3	5	5	8	37	57	65	81	15	19	80	1
Lesser Scaup	271	16	109	13	226	14	178	11	769	47	1653	64	919	36	2572	44
Common Goldeneye	40	6	245	34	15	2	45	6	375	52	720	89	93	11	813	14
Total	562	16	487	14	328	10	324	9	1748	51	3449	59	2440	41	5889	100

*Cumulative number of identified wings returned by hunters reporting to the National Species Survey not including Ruddy Ducks, mergansers or sea ducks.

†Refers to degrees west longitude and north latitude of southeast corner of block.

Table 5
Indices to harvest of Redhead and Canvasback in Canada and the United States, 1969-1976 hunting seasons*

Year	Canada												US total				Total	
	Prairie Provinces				Total				US total				Total					
	Redhead	%	Canvasback	%	Redhead	%	Canvasback	%	Redhead	%	Canvasback	%	Redhead	Canvasback				
1969	32 158	12	14 803	10	49 846	19	22 073	14	215 300	81	131 600	86	265 146	153 673				
1970	37 187	13	20 114	12	60 129	22	29 304	17	215 400	78	143 500	83	275 529	172 804				
1971	30 686	11	14 780	9	47 754	18	23 901	14	220 500	82	141 700	86	268 254	165 601				
1972	25 755	25	13 135	46	51 855	51	24 471	85	52 600	49	4 400	15	104 455	28 871				
1973	18 331	18	11 881	18	30 670	29	20 055	31	73 700	71	44 900	69	104 370	64 955				
1974	29 409	20	18 233	17	49 011	34	31 728	30	94 651	66	73 494	70	143 662	105 222				
1975	27 055	13	21 224	15	52 224	25	42 497	30	158 009	75	99 125	70	210 233	141 622				
1976	27 560	13	16 213	10	59 768	27	37 054	22	160 471	73	129 180	78	220 239	166 234				

*Canadian Wildlife Service, Progress Notes 37 and 71 and unpublished computer output for 1976 USFWS Administrative Reports.

I next considered the effect of geographic location of kill. About 20% of all Canvasback reported killed in the Prairie Provinces are taken in Manitoba, and about half of that total are killed in an area south of Riding Mountain National Park and around Lake Manitoba (Fig. 3). Yet Manitoba accounts for some 60% of all diving ducks reported killed in the Prairie Provinces (Table 4). There appears to be some relationship, perhaps because of hunter preference, availability or some other factor, between diving duck kill and southern Manitoba.

In the United States, counties with previously high kill of Canvasback have recently been closed to Canvasback hunting. Complete closure of legal hunting throughout the United States can reduce the reported total kill of Canvasback but not eliminate it (Table 5). The seasons were closed throughout the United States from 1960 through 1963 and in 1972. In other years since 1960 bag and possession limits for Canvasback were more restricted than for other ducks. The apparent capacity of harvesting Canvasbacks in the United States is such that the total harvest has recently increased (Fig. 4) even with area (county) closures and reduced bag limits elsewhere.

Table 6
Indices to breeding Redhead and Canvasback*, May and July ponds† in southern Alberta, Saskatchewan and Manitoba, 1968-1977‡

Year	May ponds	July ponds	Redhead	Canvasback
1969	2963	1658	759	530
1970	4389	2613	834	601
1971	3865	2017	693	441
1972	3435	1313	489	429
1973	1888	1736	754	696
1974	5601	2753	613	493
1975	4586	2410	974	706
1976	3811	2152	946	686
1977	2022	1391	688	702

*Adjusted for visibility bias.

†All indices in thousands.

‡Waterfowl status report and fall flight forecast 25 July 1977 USFWS (litho).

If total harvest is to be maintained, restored to apparent former levels, or increased, sooner or later habitat constraints will become limiting. Breeding habitat occupancy is one of the expected major constraints to population growth when reduction in mortality results in greater survival of a breeding population. The hypothesis that breeding population is a function of available ponds in the spring (May ponds) and in the previous summer (July ponds) and of US and Canadian harvest during the previous hunting season was tested by multiple regression of logarithmic transformations of the data (Tables 5 and 6) and rejected ($r^2 = 0.395$, $F_{4,3} = 1.268$).

Those factors seem to be major life cycle components of any game ducks. The correlation coefficient associated with each combination of factors in the regression is given in Table 7.

Table 7
Correlation coefficients between factors affecting life cycles of game ducks

	log previous July ponds	log previous season Canadian harvest	log previous season US harvest	log breeding Canvasback
log May ponds	+0.35	-0.29	+0.44	-0.41
log previous July ponds	xx	+0.64	+0.68	-0.07
log previous season Can. harvest	xx	xx	+0.28	+0.51
log previous season US harvest	xx	xx	xx	-0.35

The data show some synchrony (Fig. 4) and the correlation matrix implies, from strongest association of July ponds with Canadian and US harvest, that different conclusions might be drawn with larger samples. Analysis using previous Prairie Province harvest data instead of previous total Canadian harvest data weakened the F-ratio in total, strengthened the correlation with July ponds and US harvest and weakened the correlation with May ponds and breeding Canvasback. Those effects imply that the Prairie Province harvest is more likely related to fledged young available (raised in Prairie Province July ponds) and will follow the US harvest more closely than the total Canadian harvest. The Prairie Province harvest, however, has less effect on breeding Canvasback recorded on May ponds the next year than does the total Canadian harvest. Canadian prairie hunters seem to shoot more Canvasback if they are around but that harvest has little effect on the number that come back the next spring. Comparable data on Canadian harvest of Canvasback are not

available earlier than 1969. Different implications or confident conclusions about habitat for example, must await more data, one replicate of which appears only once per year. An alternative would be to design experiments with hunting regimes, including complete closure of hunting Canvasback for specified time periods, with commensurate measurement of effects on breeding population survival and concomitant fall flight.

Discussion

Results show that the kill of Canvasbacks and Redheads in the Prairie Provinces is relatively low compared to that in United States and stable over years. Despite variable and some apparently liberal hunting regulations, the relative annual harvest is unaffected by Canadian regulations imposed during the period analysed, although an expected change did occur in harvest of other ducks with restrictions on hunting.

By definition, there are top-ranking geographic locations for harvest of Canvasback within the Prairie Provinces. The proportion of Canvasback taken in total in those areas is so small, however, that additional restrictions are not believed warranted if indeed the present restrictions should continue. Additional legal restrictions would of necessity complicate hunting further and add to management cost. A major increase in survival of Canvasback cannot readily be associated with new management regimes in those localities.

Analysis of factors associated with hunting mortality, subsequent breeding populations of Canvasback and their habitat did not reveal any conclusive relationships from 1969 through 1976. Geis and Crissey (1969) concluded that restrictive hunting regulations in the United States reduced annual mortality. Anderson and Burnham (1976:12) have shown defects in many analyses of banding recoveries to estimate survival, for lack of arithmetic rigour. The conclusions of Geis and Crissey (op. cit.) were questioned on those grounds. The gross effect of reduced US kill with restrictive US regulations was not questioned by Anderson and Burnham. The data analysed here confirm the effect of restrictive hunting regimes. Lower breeding populations followed higher US harvest. In this analysis, however, increase in recorded breeding Canvasbacks was associated with an increase in Canadian harvest, indicating a spurious correlation or an effect confounded by unequal size of Canadian and US harvest as no biological evidence such as highly selective kill of males in eastern Canada is readily available to warrant inference of increased breeders with increased Canadian harvest.

No relation could be detected between recorded breeding population and recorded habitat available for broods the previous summer. Indeed there seemed to be a relationship between more spring breeding habitat recorded (May ponds) and fewer breeding Canvasback, which implies a sampling or observation problem rather than a biological event. An alternative hypothesis would be a degree of saturation of habitat suitable to breeding Canvasback not previously considered likely on a broad scale.

Sugden (1978) compiled data on breeding habitat for Canvasback at eight widely scattered locations in the Prairie Provinces collected for at least two years during the period

1951 through 1955. His analysis indicates that the number of breeding Canvasback will increase as the number of May ponds increases. The equation $y = 0.087x - 0.564$ had a regression coefficient 0.99 when y equals the number of Canvasback pairs per unit area and x equals the number of May ponds per unit area. The equation implies about 18 May ponds per breeding pair of Canvasback recorded, which is about triple the mean of data (5.9) used for continental management of breeding Canvasback (Table 6).

The implications are that (1) the generally observed unequal sex ratio among indicated breeding pairs of Canvasbacks or other factors may have a profound effect on the accuracy of continental data used for management of the species and (2) on a continental basis, mean occupancy of available spring habitat would not be expected to be lower than one pair of Canvasback per 18 ponds. The Sugden equation would thus be a conservative estimate of the expected number of breeding Canvasback associated with all May ponds recorded in the Prairie Provinces. As the mean number of recorded May ponds since 1955 has been 3 422 000 and ranged from a maximum of 7 303 000 in 1955 to a minimum of 1 636 000 in 1968 a post-hunting season population goal might be one associated with that breeding habitat plus appropriate allowances for other breeding areas. As data on May ponds and breeding Canvasback in the Prairie Provinces are commonly available in quantitative form they may serve as a basis for a quantitative goal. Comparison of the mean, minimum and maximum May ponds and breeding Canvasback since 1955 with the conservative estimate of the expected number of breeding Canvasback and assuming the recorded number of breeding Canvasback accounts for unequal sex ratio the following goals emerge:

	Mean	Min.	Max.
No. May ponds	3422	1636	7303
Obs. breeding Canvasback index	574	385	713
Goal breeding Canvasback index	381	182	812

As the currently recorded breeding Canvasback indices (Table 6) are close to the maximum and as the potential breeding habitat likely has been reduced and not replaced since the recorded maximum in 1955, the recent continental breeding population must be close to the post-hunting season goals for the potential breeding habitat. Those goals are independent of time (seasonal or annual change) and of merit because time-related events such as precipitation or evaporation cannot be managed. Those goals are certainly better than managing by administrative or public fiat. To apply those goals to Canvasback management specifically merely requires reasonably accurate or conservative prediction of availability of breeding habitat the following season prior to establishment of a regulation framework for a hunting regime. Partitioning the models by geographic or population segments or additional ecological parameters as the cost of re-analysis of available data or obtaining additional data warrants would permit derivation of sub-goals referable to administrative units or provide more reliable predictions. Observed over-

achievement of mean and minimum population goals for Canvasback in the past may indicate defects in the tools for measurement or prediction of Canvasback management.

On the basis of this analysis the critical hunting regimes for Canvasback management appear to occur in the United States. With regard to Canada, no grand, new, expensive management programs for Canvasback could be recommended. Indeed if social and economic conditions had warranted, the restrictions on hunting Canvasbacks in the Prairie Provinces could have been removed as this analysis indicates they were biologically ineffective.

Acknowledgements

I acknowledge the advice and assistance of D.G. Peden, M.C.S. Kingsley and G.E.J. Smith in planning and interpreting statistical analyses; and L.G. Sugden, J.B. Gollop, H.J. Boyd and J.H. Patterson in reviewing an early draft of the manuscript.

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Figure 1
Index to Canvasback harvest, Prairie Provinces, 1969-1976

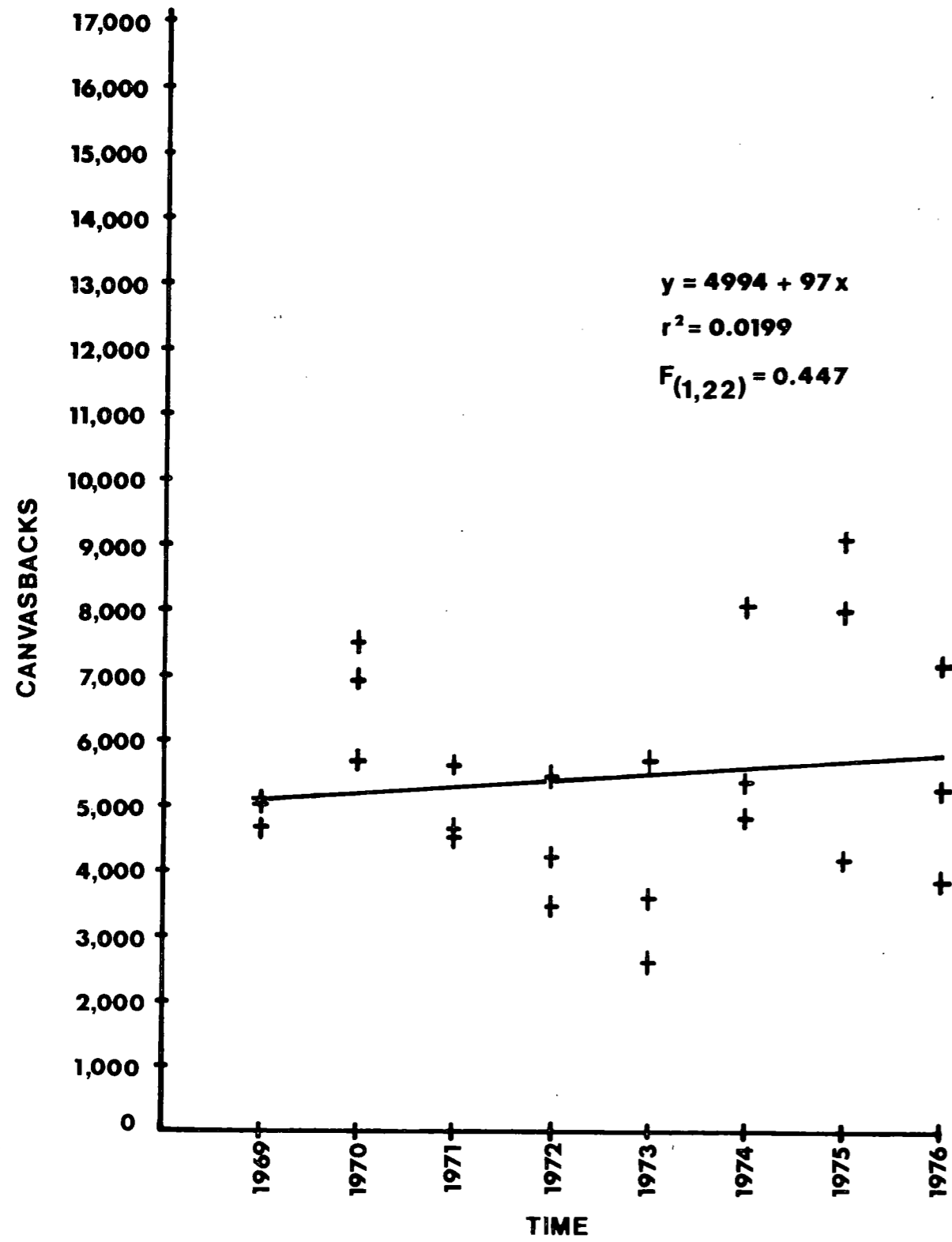


Figure 2
Index to Redhead harvest, Prairie Provinces, 1969-1976

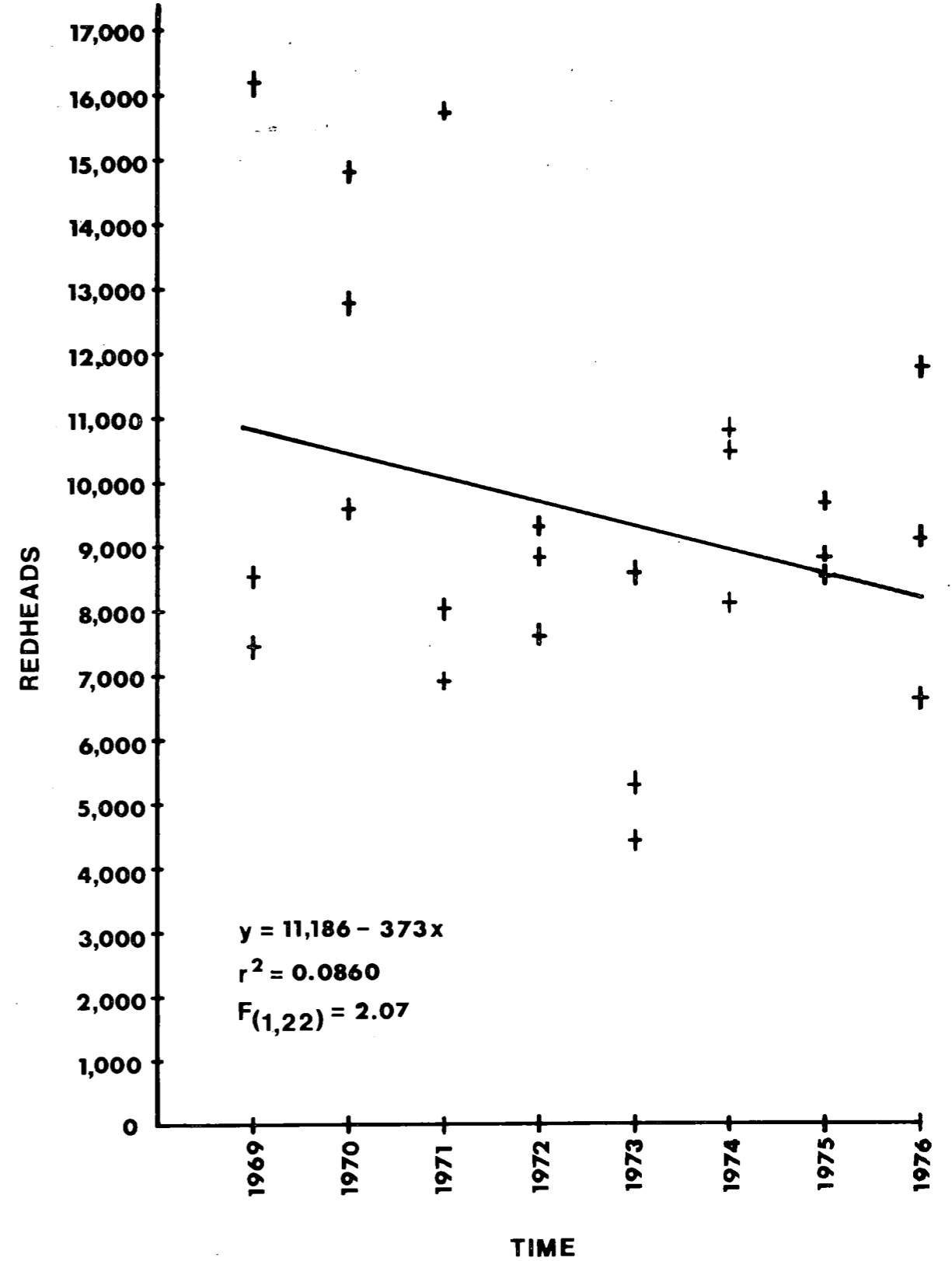
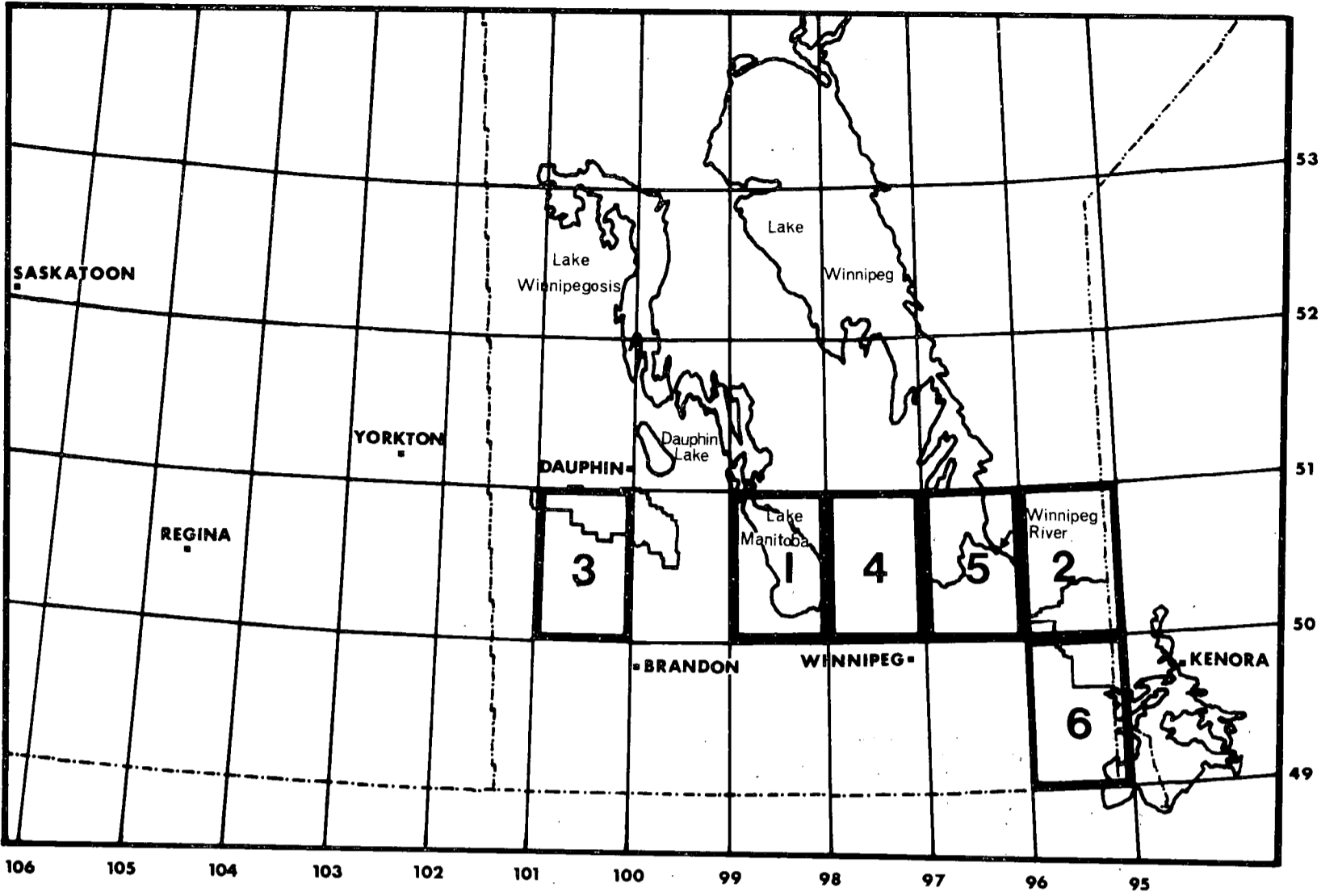


Figure 3
 Geographic distribution of top-ranked locations of diving
 duck kill in Prairie Provinces, 1968-1975



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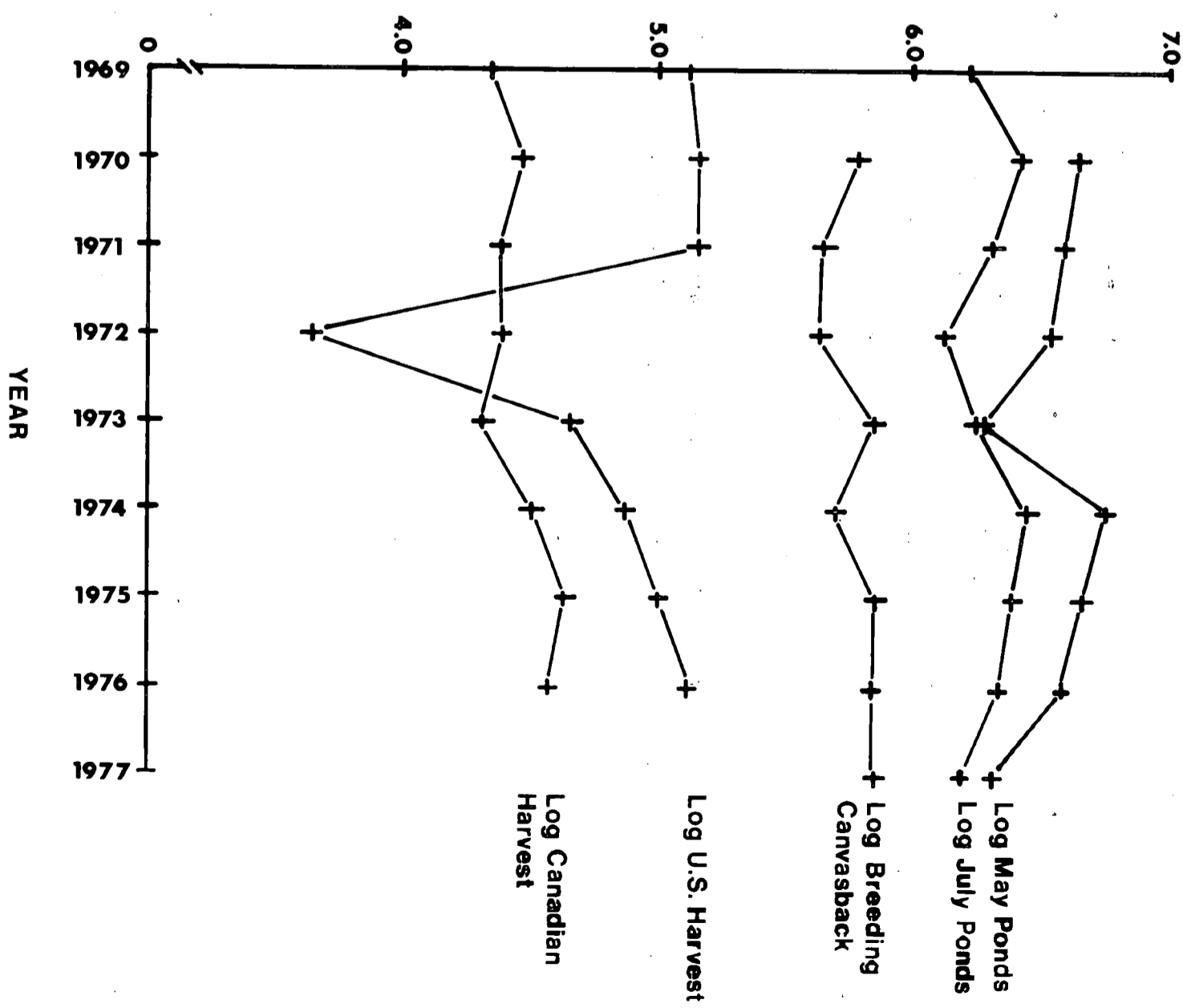


Figure 4
 Indices to May and July ponds, breeding Canvasback, Canadian and US harvest, 1969-1977

9

