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Changes in the net export of Mallard from western Canada and the contiguous US, 1972–82

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Abstract

Surveys by the USFWS/CWS show that the number of Mallard in May in the main production areas of the US and western Canada has dropped from 10.4 million in 1970 to 7.1 million in 1983. The decline in numbers in May has been accompanied by reduced production and fall flight. Kill by hunting has been shown to respond to this decrease in supply. The single exception is Saskatchewan, which is not dependent on a supply of birds from other political units. The net export of Mallards, derived by subtracting an estimate of kill, including crippling and illegal take (135% of reported retrieved kill), and May populations from the fall flight, has been declining faster than the decrease in kill. This decline has generally accelerated since 1976 and large exportable surpluses from the prairie breeding grounds no longer exist. It is proposed that serious attempts to stockpile birds should be made when habitat conditions improve. This will require severe restrictions in kill in breeding areas and in areas deriving a large proportion of their fall flight from those areas.

Introduction

In May 1970 the number of Mallard (*Anas platyrhynchos*) estimated to be present in the prairie provinces of Canada, the western NWT, Alaska, and the north-central contiguous states was nearly 10.4 million. In May 1983 it was 7.1 million, a reduction of 31.5%. The decline in breeding numbers was accompanied by reduced production in most of those areas for which data exist and by an increased kill rate in the US. In this potentially hazardous situation close monitoring of supply and effective demand is obviously prudent, along with continuing attempts to elucidate the relationship of losses from hunting, total losses, and population size, about which conflicting views are held depending on which data have been used and how they have been analysed (Anderson and Burnham 1976, Hochbaum and Caswell 1979, Patterson 1979, Rogers *et al.* 1979, Brace and Caswell 1983).

One of the inconvenient characteristics of the western Mallard population, on which attention has been focused (because of their abundance and the existence of a run of May surveys extending back to 1955), is that it seems not to form discrete sub-populations and has in consequence to be treated either as a single entity or by assemblies defined by political or other quite arbitrary boundaries. Though females that have bred in a locality tend to return to it in subsequent years as long as they live and young females tend to return to where they were born, the population is not closed and substantial internal shifts also occur, especially in years when water is scarce in parts of the breeding range, as it has been since 1977.

Another inconvenient characteristic of western Mallards is that, because of adult moult migrations and extensive dispersal of young ducks soon after they can fly, the distribution of Mallard at the start of the Canadian hunting season, in September or early October, does not correspond in a simple way to their distribution in the previous May.

Despite these awkward limitations on defining and enumerating groups of Mallard, we attempt here to draw up a balance sheet for the region as a whole, and for its southern Canadian components in particular. We compare the number of Mallard killed locally with the number produced, to see what differences exist between regions and what changes within each region have occurred during these lean years for the Mallard. Even though much of the kill in a breeding area may be of birds *not* bred locally, this kind of accounting is instructive. It suggests that the traditional picture of the Canadian prairies producing large surpluses of Mallard that can be relied on to provide American hunters with sport is now obsolete except in Saskatchewan, where it soon will be unless events take an unlikely turn.

The estimates of population size, production, and reported kill that we use are neither very accurate nor very precise. In an attempt to make them more representative we introduce over-simplified adjustments that further reduce their precision. Yet we believe that the tenor of our account would not be significantly altered were it possible to replace our crude estimates with more refined ones. Recent trends have been so strong that, even if our data are more biased than we think, the findings we draw from them are likely to be of the right sign and order of magnitude.

Materials and methods

The basic data for this study were provided by the USFWS/CWS May survey of duck numbers and the July survey of duckling production and by the CWS and USFWS national harvest (NHS) and species composition surveys (SCS). The May and July surveys are line transects, using low-flying fixed-wing aircraft that sample very large areas in a stratified plan intended to put most searching effort where there are most Mallard. These surveys were made in the southern prairie provinces and north-central states (Fig. 1).

The harvest and species composition surveys depend on responses by hunters to mailed questionnaires sent

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to samples of purchasers of Migratory Game Bird Hunting Permits (MGBH permits) in Canada and Duck Stamps in the US. The Canadian surveys were described in detail by Cooch *et al.* (1978). The US surveys, which came first, are similar to the Canadian surveys apart from the sampling frames. Their reliability was reviewed by Couling *et al.* (1982). In using the Canadian harvest surveys we have assembled area estimates to correspond as closely as practicable with the strata of the aerial surveys. The published estimates of retrieved kill by hunting zones are largely unsuitable, so we turned instead to the estimates of kill in each degree block (1° lat. × 1° long.) that have been compiled routinely each year but are not published. The choice of data for the study, the 11 seasons 1972–82, was determined by using the longest run of years for which consistently obtained estimates of Canadian kill are available. Though the Canadian harvest surveys began in 1967, the estimates in 1967–71 are not comparable with and are less reliable than those from 1972 onwards (Cooch *et al.* 1978). The choice of starting date can have a great effect on apparent trends. As noted in the introduction, western Mallard numbers peaked in 1970. In May 1972 they were estimated at 9.87 million, compared with 10.38 million in 1970.

We modified the estimates of "reported kill" by adding 10% for unreported kill (by native people not required to possess MGBH permits, by people killing ducks under the authority of depredation permits, and illegally taken birds, and a further 25% for crippling losses, i.e. birds hit hard enough to die within a short time but not retrieved by the hunter.

Three estimates of kill were used: *(a) retrieved kill* $(K)_i$ as published in NHS/SCS and USFWS reports, *(b) retrieved and unreported kill* including an *arbitrary* addition of 10% to represent kill by Indians, birds shot outside the season or above bag limits under the authority of depredation permits, and illegal kill in excess of daily bag limits not likely to be reported on the NHS; and *(c) Total estimated kill* calculated as $(K)_1 \times 10\% \times 25\%$ = Total kill, where a 25% allowance for crippling losses is made. The use of simple arbitrary adjustments ignores a variety of local circumstances that presumably affect the kill and its reporting in ways of which our knowledge is fragmentary. The reason for introducing this "correction" is because it is unwise to lose sight of the fact that the reported kill is a substantial underestimate of the total kill. Even though the enlarged estimates are of less precision than the unadjusted ones, they are more realistic for some purposes. All political and geographical units were treated in identical fashion. This procedure probably underestimates the total kill in northern areas due to hunting by people not required to hold a hunting permit and overestimates illegal and depredation permit kill within the settled portions of the provinces. These two biases should roughly balance out.

Immature to adult ratios (I/A) were derived from the SCS in both Canada and the US and, in Canada, were divided by 2 to allow for age related differences in vulnerability. We computed local vulnerability quotients for each province from recoveries within that province and total first-year vulnerability quotients from all first year recoveries of mallard banded preseason in each province. The local vulnerability quotient (V_L) is given by $V_L = ({}_LR_1/M_1)/(R/M)$ where M is the number of adults banded and ${}_LR$ the number of within-province recoveries within 1 year, and M_1 and ${}_LR_1$ are the corresponding number of young. Similar data were not readily available to us from production areas lying outside Canada. Though pre-season banding is largely accomplished south of the boreal forest, the vulnerability quotients were applied to each province as a whole. We use a blended average (unweighted as to origin) of 1.90. Northern zones in all three prairie provinces, NWT, and Alaska consistently had I/A ratios in SCS samples more than 50% greater than those obtained from the southern zones. For example, in Alberta an I/A vulnerability based on 1.65 would yield an adjusted ratio of 1.00 in the south and 1.78 in the north and a provincial total of 1.15 I/A in the fall flight. Because the hunted sample and often the total fall flight was less in the north than in the south, but the birds were presumably more vulnerable there, an arbitrary I/A vulnerability of 2 was used for all zones in all years. Although this does not take account of annual variation in vulnerability, it has the advantage of consistent application, even for areas with little or no banding or recovery data.

For the NWT, where insufficient numbers of wings were available to permit derivation of meaningful I/A ratios and vulnerabilities, wing receipts from the adjacent provincial boreal zone were added to the territorial receipts, the assumption being that, as most wings from the NWT were taken in the southern part of the Territories, they would be somewhat similar in I/A ratio to those found in northern Alberta.

The distribution between northern and southern zones in the three prairie provinces was based on the strata used by the USFWS/CWS May survey, grouped as follows:

	Strata
South Alberta	26, 27, 28, 29
North Alberta	19, 20
South Saskatchewan	30, 31, 32, 33, 34, 35
North Saskatchewan	21, 22, 23
South Manitoba	36, 37, 38, 39, 40
North Manitoba	24, 25
NWT	13, 14, 15, 16, 17, 18
Alaska	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 (Old Crow)

Estimates of kill were taken from Table 23 of the CWS National Harvest Survey/Species Composition Survey (NHS/SCS) series, not from the published zonal and provincial totals given in Table 14 of the NHS/SCS series. This was done in an attempt to relate May populations to calculated production and kill. The standard NHS sampling zones are based primarily on commonality of opening dates, bag limits, and species mix in the bag and are not tied to breeding populations or numbers of ponds in May, so are unsuitable for our purpose.

Several terms are used to describe the contribution made by each production unit:
(1) *net export*, defined as net production minus local hunting season kill in that zone, is derived as follows: May population × 0.90 (assuming 10% mortality of adults in the period May to 1 September) × adjusted I/A = number of young produced. Net breeding population as of 1 September (that is, May population of adults × 0.90) is summed with the calculated number of young produced to yield
(2) an estimate of *fall flight*;
(3) *net production*, which could also be described as replacement production, is the remainder when the unadjusted May population in year t is subtracted from the fall flight in year t and represents the number of birds that may die in the period 1 September to mid-May to bring the population level back to that of the previous year, assuming no immigration or emigration.

Net export is an attempt to relate take to contribution. Of all political zones considered, only Saskatchewan and the northern territories appear to be independent of birds raised elsewhere. In Manitoba, for example, it cannot be assumed that all of the kill was of Manitoban origin and that, of a net production in Manitoba of 200 000, hunters there took 150 000. In reality they took 150 000 from the total fall flight available to them and, in effect, left 50 000 to be killed or die elsewhere. These calculations are summarized in Tables A1–A9 of Appendix A and cover the main areas surveyed in Canada, i.e. Manitoba, Saskatchewan, Alberta, and the NWT. In the US, the areas considered were Alaska, eastern Montana, North and South Dakota, and Minnesota.

It is not possible to extend the analysis of net export in Canada further back than 1972, as before that year the NHS sampling universe was based entirely on hunters who had held a permit the previous year. Estimates of kill in Canada published before 1972 are inflated by the difference between the lower average kill of beginning and intermittent hunters (samples A and B) and the higher average kill of experienced hunters, extrapolated to the universe as a whole. A further complication is that before 1972 no facility existed in the sampling scheme to transfer kill to province of hunt from province of residence. Although this deficiency had little impact on national totals, estimates in some provinces and zones having large numbers of non-resident hunters were badly skewed.

Annual variations (1972–82) in fall flight, populations, kill, net production, and net export for each production area are given in Tables A1–A9 in Appendix A. These data are presented in their entirety to save others the tedious task of summing the estimated kill of Mallards by degree block to calculate the kill that occurred in those portions of NHS sampling zones lying north of the appropriate USFWS/CWS May population strata. The approximate boundary between north and south was 54°N in Alberta, 53°N in Saskatchewan and 53°N in Manitoba.

Results

Table 1 is a summary of net production in 1972–82 and Table 2 is a summary of net export in 1972–82. A further summary of production and export restricted to the southern portions of the three prairie provinces is given in Table 3. The data used for calculating Table 3 are given in Tables B1–B3 in Appendix B.

Estimates of adjusted (total) kill in each area are summarized in Table 4. An attempt was made to relate kill to various fall flight parameters. Only the best fits are presented in Figures 2–5. Some of the various scenarios considered are given in Table 5 along with the correlation coefficients derived.

To facilitate discussion, changes in May population, production, kill, and net export from the total production area are summarized in Table 6. This is essentially a summary of production and kill in production areas in Canada and in the US. It is designed to show changes that have occurred pre- and post-1975, periods of high and low fall flights. Also included in Table 6 are estimates of the adjusted kill occurring elsewhere in those flyways that derive most of the benefit from the production area. Tables 7 and 8 contain summaries of production and kill in the Canadian and US production areas, respectively. Table 9 is restricted to the southern prairies to document the dramatic changes that have occurred there.

Figures 6 and 7 are comparisons for each of the prairie provinces of changes in kill, expressed as the percentage of net production killed, and of net export, expressed as percentages of net production in two zones and for the entire province. These two figures are closely interdependent, as the percentage of net production killed is directly related to the size of the net export. They are presented to show the marked decline in net export that has occurred in the southern prairies. Figure 8 is a similar treatment for Montana, and North and South Dakota, the three largest production areas in the contiguous United States. Figure 9 compares: (a) the percentage kill of net production taken in the three prairie provinces; and (b) that occurring in the three adjacent states. The decreasing export from southern Canada is shown in Fig. 10.

An attempt is made in Table 10 to relate export from Canada to changes in kill that have occurred in the US. Details by state are given in Tables C1, C2, and C3 of Appendix C. Results given in Table 10 are largely derived from results presented by Munro and Kimball (1982) on the origin of kill in different regions in the period 1967–75. Any changes in distribution or contribution that have occurred since then are not reflected in results from the latter part of the decade or the early 1980s. Munro and Kimball (*op. cit.*) based

their analysis on the unfortunate decision by Anderson and Henny (1972) to create banding and recovery reference areas that are not compatible with existing population survey strata. This incompatibility has probably increased since 1976, when breeding populations and/or production in many formerly important production areas began to decline. It seems unlikely that fixed percentage contributions to the kill in major wintering states such as Arkansas would be valid in the 1980s, given the changes in fall flight from Canada that have occurred. The tables do, however, make the point that the kill in major wintering areas, which derive their populations from a large region, where the numbers of birds involved are very large, tends to show slow response to low populations and reduced production from the breeding grounds. This is somewhat analogous to the situation illustrated in Figures 4 and 5, where the kill by hunters in Alberta and Manitoba did not apparently respond to declining fall flights until several years *after* a major decline had occurred in local breeding populations. No relationship was found between the size of the fall flight or midwinter inventory and kill in such major wintering states as Arkansas, Mississippi, or Louisiana, despite the marked decline in the available stocks emanating from the breeding grounds.

Finally, the I/A ratios used in this study are given in Table 11. The general decline in productivity is especially evident in the northern portions of the production area of prairie Canada, particularly northern Alberta.

Discussion

In most major production areas in Canada, kill and the size of the fall flight or its components are highly correlated. In Saskatchewan, the correlation between local production and kill is very high ($r^2 = 0.844$, df 10, $p < 0.01$). Results from all other production areas become significant only if fall flights (or components thereof) from extralimital production areas are incorporated. In Manitoba, kill is weakly correlated with production from northern Saskatchewan but the correlation increases when production from North Dakota is included. Evidence that appreciable numbers of ducks shot in Manitoba originate from North Dakota was given by Munro and Kimball (1982) and confirmed by unpublished studies undertaken in connection with environmental assessment of the Garrison Diversion Project.

The reasons for the lack of high correlation between Manitoba kill and numbers of Mallard from Canadian sources are not clear. In Manitoba, as many as 15% of the hunters are now non-resident (Cooch 1982) and, although the primary target for most non-residents is geese, they kill about 25% of the ducks as an opportunistic adjunct to geese (Cooch, in press). A similar phenomenon may apply to kill by resident Manitoba hunters. The effect of the arrival in 1976 of large numbers of non-resident hunters may be deduced from Table 3 and Figures 6 and 7, which show that in 1977 the net export of Mallards from southern Manitoba returned to negative values, following three years in which restrictive local regulations had resulted in export surpluses.

In Saskatchewan, goose hunting and non-resident hunters tend to be restricted to one NHS zone. In Manitoba, there is a general mixing of ducks, geese, and non-resident hunters throughout much of the south (Cooch 1982). The result is that, although most hunters are primarily seeking geese, they have access to both quarry groups, a situation not generally found in much of Saskatchewan.

In Alberta, kill remained largely unchanged until 1981, despite significant decreases in local production and fall flight between 1975 and 1981. Alberta has some characteristics of both Saskatchewan and Manitoba in terms of the distribution of ducks, geese, non-resident hunters, and kill. In Alberta hunting zones 5 and 6, hunters have access to both ducks and geese, but over much of the remainder of the Province ducks are the principal quarry.

Table 9 shows clearly the declining contribution of the southern prairie provinces of Canada as net exporters of Mallards. By 1978 their net export had fallen below the net export of the four main US production states (excluding Minnesota) cited in this study (Table 8). Only Saskatchewan continues to be a consistent net exporter, and even there the rate is increasingly restrained. The decline has been most drastic in southern Alberta. In Alberta, although the kill by non-residents is significant, most occurs in the northern zone and that in the south is not sufficient by itself to have placed southern Alberta in a deficit.

Unless major reductions in kill take place in all three southern prairie provinces and in the wintering areas utilized by these prairie birds, the long-range outlook is not good. The situation in each province is quite different. Southern (01) Manitoba derives few birds from the area north of 53°N as these apparently slip southeast toward the Ontario–Minnesota border, or overfly southeast Manitoba. This interpretation of limited band recoveries is supported by the correlation between kill and fall flight from northern Saskatchewan plus southern Manitoba. The relationship is obscured by the increasing pre-eminence of goose hunting, which seemingly attracts more hunters than would be expected if ducks were the primary quarry.

Southern Alberta has been in a deficit position since 1977; since 1981 the entire province has been in this situation. Unlike Saskatchewan but like Manitoba, Alberta is dependent in part on production from areas lying outside the Province, notably the NWT and northwestern Saskatchewan. It is disquieting to note that, unlike the situation in northern Manitoba and Saskatchewan, I/A ratios in northern Alberta and the NWT have apparently declined while the populations there have stayed within historical limits. This reduced production has put added pressure on stocks of Mallards in Alberta because the total fall flight available in Alberta has declined. The situation in the south is further exacerbated by the fact that, unlike the situation in Saskatchewan and Manitoba, kill of Mallards in northern Alberta is significant. Southern Alberta has begun to acquire the attributes of Minnesota in terms of magnitude of kill and relatively small contribution to the continental supply of ducks.

The persisting high kill in Alberta, in relation to supply between 1975 and 1980, is hard to reconcile with what has been observed elsewhere. At least two hypotheses merit further investigation: (a) that, until 1981, the number of Mallards available to Albertans from all sources was so large as to be in excess of the capability of Albertans to harvest them, given today's regulations; and (b) a disproportionate amount of hunting in Alberta may be done in the vicinity of large, more or less permanent, lakes or irrigation impoundments; under such a regime, migrating ducks might be concentrated at the major waters during periods of drought as the smaller satellite areas disappear. In those conditions, hunting in Alberta would generally be unaffected by declines in fall flight until some lower threshold was reached. This is analogous to the situation in Arkansas, Louisiana, and Mississippi.

Conclusion

With very large populations of prey, success (kill) in production areas seems to vary about a high level mean in relation to the number of young (vulnerable) prey. As populations decrease in size, total numbers of birds become more important in determining the size of the kill.

As populations and productivity fall, relative vulnerability as determined by pre-season banding should also fall, increasing only when (a) the population increases and (b) the proportion of immatures available to be killed exceeds the population of adults available to be killed. Only Saskatchewan, Alaska, and the NWT still meet these primitive criteria. Until 1976, Alberta was in that group. It has since joined Manitoba, the Dakotas, and other northern tier states in reliance more on the size of the total fall flight than on the number of immatures available. All of the production states in this latter category are at or near the threshold of having little or no exportable surplus.

A major need for the immediate future is a strategy to restore populations rapidly when habitat conditions again become conducive to production. It might be argued that maintenance of a high level of exploitation during a period of deteriorated habitat helped maintain the population near or at carrying capacity. Anderson and Burnham (1976) argued that waterfowl cannot be stockpiled. The general conservatism of the size of the kill, especially in parts of Canada and in winter-concentration areas such as Louisiana and Arkansas, and the generally slow response of hunting effort and success to declining local populations where a large migrant contribution occurs, tend to support that view by maintaining a level of kill above what can be supported on the basis of local production alone. The tendency in the past has been to liberalize regulations when breeding habitat improved and May surveys indicated a return of ducks to the prairies in anticipation of large increases in fall flight. In 1979, productivity and populations improved slightly over a very large part of the southern production area. In apparent response to increased opportunities, kill rose to remain at nearly the same percentage of the fall flight, net production, and number of immature birds as taken previously. Some improvement was noted in May population estimates in 1980 as a result of the enhanced production in 1979, but the impact was blunted by the increased kill that had occurred.

The kill in northern US production areas and in states that have small overwintering populations exhibits annual variation more or less in direct response to the size and character of the fall flight. We suggest that birds *can* and should be stockpiled in the initial years of improving habitat and productivity. This would require imposition of additional hunting restrictions both in those parts of the range where local populations had undergone a severe decline as well as in those wintering and staging areas where a significant kill of that local population occurred.

Such a strategy was first proposed by Walter Crissey, of the USFWS, in the early 1960s. The mid-1980s may be the opportune time to put it into effect. To be successful, additional restraint must be exercised in both breeding and wintering areas. The experience of Manitoba in the 1970s, when local activity was not matched further south, has made Canadian hunters wary of accepting severe restrictions unilaterally. We share the concern of others that a major increase in either the number of ducks or ponds or both will not necessarily lead to greatly enhanced fall flights. The habitat loss and degradation that has occurred in the period under review may be sufficient to prevent a rebound to population levels that existed in 1972.

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Table 1
Net production of Mallards, 1972–82 (in 1000s), by political production unit

Year	Alta.	Sask.	Man.	NWT	Alaska	Mont.	ND	SD	Minn.	Total
1972	2446	2047	568	750	224	273	506	413	46	7305
1973	2000	1991	710	314	426	288	513	424	122	6789
1974	2988	2564	610	499	212	328	484	538	186	8410
1975	2580	2945	604	761	145	512	555	347	129	8578
1976	1629	3340	1180	228	166	535	367	266	177	7888
1977	870	2019	758	577	359	132	132	141	213	5201
1978	1169	1630	782	395	240	306	451	478	168	5619
1979	1275	2206	826	313	183	387	733	517	238	6678
1980	1043	1140	718	513	295	181	345	240	203	4670
1981	521	914	661	336	332	196	191	99	143	3393
1982	612	1045	507	197	191	174	226	181	172	3305
Mean	1557.54	1985.54	720.36	443.91	252.09	301.09	409.36	331.27	163.36	6166.91
SD	837.77	775.72	180.48	193.75	89.35	133.60	178.19	154.79	52.42	1873.74
Trend (slope)	−218.10	−152.53	−1.19	−30.58	−1.29	−16.21	−24.23	−25.47	+8.85	−462.48
Signif. (5%)	S	S	NS	NS	NS	NS	NS	NS	NS	S

Table 2
Net export of Mallards, 1972–82 (in 1000s), by political production unit

Year	Alta.	Sask.	Man.	NWT	Alaska	Mont.	ND	SD	Minn.	Total
1972	1701	1390	272	700	189	122	176	331	−440	4110
1973	1271	1511	520	264	389	164	359	174	−107	4545
1974	2123	1879	410	449	182	209	273	298	169	5621
1975	1865	2162	392	700	113	357	327	221	−227	6217
1976	789	2512	908	180	123	363	163	190	−29	5259
1977	158	1480	532	530	311	−28	20	63	−51	3048
1978	644	1088	453	350	186	159	150	247	−284	2839
1979	605	1627	495	270	128	240	473	337	−227	4041
1980	393	652	436	460	245	65	143	130	142	2382
1981	−15	598	420	280	300	89	−25	17	−184	1480
1982	210	716	304	143	153	7	45	89	−146	1521
Mean	885.82	1419.55	467.45	393.27	210.82	158.82	191.27	190.64	−125.82	3733.00
SD	740.93	622.95	167.07	192.13	89.62	127.70	153.35	108.38	179.44	1613.13
Trend (slope)	−185.94	−119.97	−3.74	−30.71	−2.31	−15.86	−20.93	−18.66	+7.51	−379.04
Signif. (5%)	S	S	NS	NS	NS	NS	NS	NS	NS	S

Table 3
Net production and export of Mallards in southern Manitoba, Saskatchewan, and Alberta

	Alberta		Saskatchewan		Manitoba	
Year	Prodn.	Export	Prodn.	Export	Prodn.	Export
1972	968	351	1720	1138	292	29
1973	1162	581	1573	1206	323	185
1974	1671	846	2146	1289	304	154
1975	1583	1048	2416	1775	310	144
1976	1151	513	2729	2035	520	290
1977	368	−159	1615	1175	186	−12
1978	348	−89	1120	690	220	−56
1979	539	−6	1644	1171	182	−104
1980	335	−160	901	516	260	39
1981	288	−150	659	399	195	−11
1982	341	−11	716	458	241	79
Mean	795.82	253.27	1567.18	1077.45	275.73	67.00
SD	529.35	437.47	680.44	528.78	95.94	116.71
Trend (slope)	−123.00	−94.11	−141.49	−104.55	−13.23	−15.65
Signif. (5%)	S	S	S	S	NS	NS

Table 4
Average adjusted* kill of Mallards by production area, 1972–82 (in 1000s)

Year	Alta.	Sask.	Man.	NWT	Alaska	Mont.	ND	SD	Minn.	Total
1972	745	657	296	50	35	151	330	238	486	2888
1973	728	480	190	50	37	124	154	250	229	2242
1974	865	685	200	50	24	119	211	83	355	2592
1975	715	784	212	58	32	155	228	126	356	2666
1976	840	828	272	62	43	172	204	76	206	2703
1977	712	539	226	74	48	160	112	78	264	2213
1978	525	542	329	68	54	147	301	231	452	2649
1979	670	579	331	56	55	147	260	180	465	2743
1980	650	488	282	61	45	116	202	110	345	2299
1981	536	316	241	58	32	107	216	82	327	1915
1982	402	328	203	53	38	135	181	92	319	1751
Mean	671.64	566.00	252.91	58.18	40.27	139.36	218.09	140.55	345.82	2423.73
SD	138.16	165.14	51.71	7.76	9.70	20.62	62.05	70.38	92.89	365.73
Trend (slope)	−32.12	−32.62	+2.54	+0.74	+1.04	−1.80	−3.30	−9.62	−0.08	−70.65
Signif. (5%)	S	S	NS	NS	NS	NS	NS	NS	NS	S

* Reported retrieved kill × 1.35 (see text).

Table 5
Scenarios used to select best fit (kill)

Region		Aggregation fall flight, 1972–82	RXY	R^2	F
MN	1	FF MN	−0.1363	0.0186	1.1704
	2	FF MN + FF ND	0.5484	0.3008	3.875
	3	FF MN + ND + S. Man.	0.2740	0.0751	0.7306
	4	FF MN + ND + S. Man. + N. Sask.	0.3311	0.1096	1.1082
	5	FF MN + ND + Man. + N. Sask.	0.1908	0.0364	0.3400
	6	FF MN + Net Prodn. ND, Man, N. Sask.	0.0542	0.0029	0.0265
	7	As in 5 but excluding 1976*	*0.6121*†	0.3746	4.7928
	8	As in 6 but excluding 1976*	0.4803	0.2307	2.3990
Sask.	9	FF Sask.	*0.9131*	*0.8338*	45.1580
	10	Net Prodn. Sask.	*0.9416*	*0.8866*	70.3935
	11	IMM Sask.	*0.9281*	*0.8613*	55.9088
Alta.	12	FF Alta.	*0.7212*	*0.5201*	9.7544
	13	FF Alta. + FF NWT	*0.6867*	*0.4716*	8.0312
	14	FF Alta. + FF NWT, Alaska	*0.6826*	*0.4660*	7.8539
	15	FF Alta. + FF NWT, N. Sask.	*0.7391*	*0.5463*	10.8367
	16	FF Alta., NWT, 1/3 N. Sask.	*0.7607*	*0.5787*	12.3624
	17	FF Alta., Net Prodn. NWT, 1/3 Net Prodn. N. Sask.	*0.8062*	*0.6499*	16.7074
	18	FF Alta., Net Prodn. NWT & 1/3 FF N. Sask.	*0.7644*	*0.5843*	12.6525
Man.	19	FF Man.	0.4840	0.2343	2.7533
	20	FF Man. + FF N. Sask.	*0.6074*	*0.3690*	5.2622
	21	FF Man. + N. Sask. + ND	*0.6937*	*0.4813*	8.3504
	22	FF Man. + Net Prodn. ND & N. Sask.	0.5437	0.2956	3.7767
	23	FF Man. + FF ND	*0.6750*	*0.4556*	7.5309

* Northern part of Minnesota closed to hunting because of forest fires in 1976.
† Values of all numbers in italic are significant at 0.05.

Table 6
Summary of production, adjusted kill throughout the production areas, and kill in US, 1972–82

Year	May	Sept.	IMM	FF	Net prodn.	Prodn. area kill	Net*† central kill	Pacific† kill	Net*† Miss. kill	Total kill
1972	9472	8525	8252	16 777	7305	2888	971	1767	2191	7817
1973	8294	7465	7618	15 083	6789	2242	799	1556	2005	6602
1974	6319	5687	9043	14 730	8410	2592	573	1385	2515	7065
1975	7610	6849	9337	16 186	8578	2666	738	1537	3049	7990
1976	8212	7391	8709	16 100	7888	2703	808	1292	2794	6979
1977	7771	6994	5978	12 972	5201	2213	680	1709	2595	7705
1978	7234	6511	6342	12 853	5619	2649	752	1427	2659	7485
1979	7819	7037	7459	14 496	6678	2743	656	1460	2824	7217
1980	7485	6737	5427	12 164	4679	2299	634	1395	2454	6401
1981	6173	5556	4010	9 566	3393	1915	637	1211	1788	5212
1982	6238	5614	3929	9 543	3305	1751	537	1171	1517	4976
Mean	7511.54	6760.55	6918.55	13 679.09	6167.73	2423.73	707.73	1446.36	2399.18	6859.00
SD	1001.55	901.48	1922.65	2509.74	1873.05	365.73	123.19	188.16	472.38	1001.20
Trend (slope)	−197.42	−177.68	−481.98	−659.66	−462.24	−70.65	−25.95	−39.54	−45.51	−207.25
Signif. (5%)	S	S	S	S	S	S	S	S	NS	S

* Net Central Flyway is flyway total less flyway production area kill (in Montana, North and South Dakota).
Net Mississippi is less flyway production area kill (in Minnesota).
† Makes no allowance for local production in U.S. or production in Canada outside survey area.

Table 7
Summary of production and adjusted kill within Canadian production areas, 1972–82

Year	May	Sept.	IMM	FF	Net prodn.	Total kill	Net export
1972	7374	6637	9589	16 226	5811	1748	4063
1973	6568	5911	6018	11 929	5015	1448	3567
1974	5059	4553	7398	11 951	6661	1800	4861
1975	5958	5362	7485	12 847	6890	1769	5121
1976	6643	5979	7043	13 033	6377	2002	4375
1977	6198	5578	4844	10 422	4224	1551	2673
1978	5456	4910	4521	9 431	3976	1464	2512
1979	5872	5285	5198	10 483	4620	1636	2984
1980	5851	5266	3999	9 265	3414	1481	1660
1981	4819	4337	2913	7 250	2432	1152	1280
1982	4768	4291	2839	7 130	2362	988	1374
Mean	5869.64	5282.64	5622.45	10 906.09	4707.45	1549.00	3133.64
SD	813.05	731.89	2103.64	2676.55	1606.49	292.94	1372.99
Trend (slope)	−172.81	−155.55	−576.94	−732.58	−402.35	−61.32	−348.48
Signif. (5%)	S	S	S	S	S	S	S

Table 8
Summary of production and adjusted kill within US* production areas, 1972–82

Year	May	Sept.	IMM	FF	Net prodn.	Total kill	Net export
1972	2029	1826	1619	3445	1416	754	662
1973	1622	1460	1813	3273	1651	565	1086
1974	1162	1046	1678	2725	1562	437	1125
1975	1506	1355	1710	3065	1559	541	1018
1976	1417	1275	1476	2751	1334	495	839
1977	1355	1220	899	2119	764	398	366
1978	1589	1430	1634	3064	1475	733	742
1979	1749	1574	1995	3569	1820	642	1178
1980	1406	1265	1202	2467	1061	473	588
1981	1153	1038	933	1971	818	437	381
1982	1298	1163	870	2033	735	446	289
Mean	1480.54	1332.00	1439.00	2771.09	1290.45	538.27	752.18
SD	259.37	233.71	397.36	567.45	383.34	122.79	323.51
Trend (slope)	−37.65	−34.12	−72.41	−106.55	−68.88	−13.67	−55.21
Signif. (5%)	NS	NS	NS	S	NS	NS	NS

* Alaska, Montana, North and South Dakota.

Table 9
Summary of production and adjusted kill in the southern prairies, 1972–82

Year	May	Sept.	IMM	FF	Net prodn.	Total kill	Net export
1972	4902	4412	3682	8094	3192	1421	1771
1973	4329	3896	3491	7387	3098	1179	1879
1974	3852	3467	4407	7874	4022	1561	2461
1975	4190	3771	4728	8499	4309	1342	2967
1976	5016	4515	4901	9416	4400	1562	2835
1977	3973	3575	2567	6142	2169	1174	995
1978	3022	2720	1990	4710	1688	1143	545
1979	3577	3220	2722	5942	2365	1304	1061
1980	3446	3101	1841	4942	1496	1110	386
1981	2802	2522	1422	3944	1142	913	229
1982	3100	2790	1609	4407	1298	750	548
1983	2896	2607					
Mean	3758.75	3383.00	3032.73	6487.00	2652.64	1223.55	1425.18
SD	752.01	676.80	1277.77	1862.71	1219.14	251.48	1006.78
Trend (slope)	−172.95	−155.64	−302.38	−462.03	−286.11	−56.97	−227.65
Signif. (5%)	S	S	S	S	S	S	S

Table 10
Estimates of adjusted kill of Canadian-produced Mallards in the US, 1972–82 (in 1000s), after Munro and Kimball (1982)

	Flyway				
Year	Pacific	Central	Missis-sippi	US total	Canada export
1972	431	866	1181	2478	4063
1973	392	656	1016	2064	3567
1974	333	560	1342	2235	4861
1975	373	672	1624	2669	5121
1976	372	687	1577	2636	4375
1977	297	590	1522	2409	2673
1978	406	766	1413	2585	2512
1979	329	652	1457	2438	2984
1980	356	576	1584	2516	1660
1981	352	526	1368	2246	1280
1982	340	485	1099	1924	1374
Mean	361.91	639.64	1380.27	2381.82	3133.64
SD	38.20	109.82	204.89	238.77	1372.99
Trend (slope)	−5.45	−21.25	+11.15	−15.56	−348.48
Signif. (5%)	NS	S	NS	NS	S

Table 11
Adjusted immature to adult ratio in Mallards in Canadian production areas

	Alberta		Saskatchewan		Manitoba		NWT
Year	N	S	N	S	N	S	N
1972	1.33	0.70	0.98	0.72	1.48	0.97	1.33
1973	0.97	0.85	1.23	0.84	1.83	1.66	0.97
1974	1.73	1.29	1.49	1.13	1.48	1.16	2.04
1975	1.82	1.37	1.73	1.21	1.29	1.13	1.82
1976	1.48	0.99	1.38	1.11	1.46	1.19	1.48
1977	1.06	0.60	1.06	0.74	1.56	0.93	1.06
1978	1.13	0.58	0.83	0.76	1.37	0.97	1.13
1979	1.03	0.70	1.11	0.93	1.39	0.97	1.03
1980	0.70	0.49	0.74	0.58	1.22	0.98	1.10
1981	0.54	0.47	0.70	0.57	1.15	0.73	0.97
1982	0.82	0.60	0.77	0.52	0.88	0.80	1.00
Mean	1.15	0.79	1.09	0.83	1.37	1.04	1.27
SD	0.41	0.31	0.34	0.24	0.24	0.25	0.37
Trend (slope)	−0.08	−0.06	−0.07	−0.04	−0.06	−0.05	−0.06
Signif. (5%)	S	NS	S	NS	S	S	NS

Appendix A
Net production of Mallards, 1972–82 (in 1000s), by political unit

Table A1
Mallard production in Alberta, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	2863	2577	1.06	2732	5308	2446	563	760	1686
1973	2712	2441	0.93	2270	4711	2000	529	728	1271
1974	1836	1652	1.92	3172	4824	2988	714	963	2025
1975	2049	1844	1.51	2789	4634	2585	530	715	1870
1976	1849	1665	1.09	1823	3488	1639	611	840	799
1977	1442	1298	0.78	1014	2312	870	518	712	158
1978	1496	1346	0.98	1321	2665	1160	389	525	644
1979	1868	1681	0.87	1458	3140	1272	487	670	602
1980	1814	1633	0.75	1013	2857	1043	473	650	393
1981	1503	1353	0.50	671	2024	521	390	536	−15
1982	1392	1253	0.60	752	2004	612	298	402	210

Table A2
Mallard production in Saskatchewan, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	3091	2782	0.77	2142	5138	2047	478	657	1390
1973	2801	2522	0.90	2270	4792	1991	349	480	1511
1974	2417	2175	1.29	2806	4981	2546	500	685	1861
1975	2800	2520	1.28	3226	5746	2946	570	784	2162
1976	3572	3215	1.15	3697	6912	3340	602	828	2512
1977	3338	3004	0.78	2353	5357	2019	392	539	1480
1978	2701	2431	0.78	1900	4331	1630	394	542	1088
1979	2855	2569	0.97	2492	5061	2206	421	579	1627
1980	2646	2381	0.59	1405	3786	1140	355	488	652
1981	1985	1787	0.62	1112	2899	914	230	316	598
1982	2377	2139	0.60	1283	3422	1045	243	329	716

Table A3
Production of Mallards in Manitoba, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	735	661	0.97	641	1302	568	215	296	272
1973	648	583	1.33	776	1359	710	138	190	520
1974	518	466	1.42	662	1128	610	145	200	410
1975	615	554	1.28	664	1218	604	154	212	392
1976	1036	932	1.38	1283	2210	1180	198	272	908
1977	747	672	1.24	833	1505	758	164	226	532
1978	829	746	1.16	865	1611	782	239	329	453
1979	772	695	1.30	903	1598	826	241	331	495
1980	816	734	1.09	800	1534	714	205	282	432
1981	895	806	0.93	750	1555	661	175	241	420
1982	752	677	0.86	582	1259	507	150	203	304

Table A4
Mallard production in NWT, 1972–82 (in 1000s)

	Adults						Kill*		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	685	616	1.33	819	1435	750	7	50	700
1973	407	366	0.97	355	721	314	7	50	264
1974	288	259	2.04	528	787	499	7	50	449
1975	494	445	1.82	810	1255	761	6	61	700
1976	186	167	1.48	247	414	228	7	48	180
1977	671	604	1.06	640	1248	577	6	43	520
1978	430	387	1.13	437	824	395	6	45	350
1979	377	340	1.03	350	690	313	7	43	270
1980	575	518	1.10	570	1088	513	7	53	460
1981	436	392	0.97	380	772	336	7	56	280
1982	247	222	1.00	222	444	197	6	54	143

* Adjusted for high proportion of kill by non-holders of Canadian MGBH Permit.

Table A5
Mallard production in Alaska, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	224	201	1.23	247	448	224	24	35	189
1973	207	186	2.40	477	633	426	25	37	389
1974	237	214	1.10	235	449	212	17	24	187
1975	106	96	1.62	155	251	145	16	32	113
1976	146	131	1.38	181	312	166	30	43	123
1977	380	342	1.16	396	739	359	32	48	311
1978	262	236	1.13	267	502	240	40	54	186
1979	221	199	1.03	205	404	183	41	55	128
1980	326	293	1.12	328	621	295	31	45	245
1981	411	370	1.01	374	743	332	22	32	300
1982	216	194	1.10	213	407	191	28	38	153

Table A6
Mallard production in Montana*, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	516	464	0.70	325	789	273	112	151	122
1973	360	324	1.00	324	548	288	92	124	164
1974	198	175	1.95	348	526	328	88	119	209
1975	479	431	1.30	560	991	512	113	155	357
1976	480	432	1.35	583	1015	535	125	172	363
1977	333	300	0.55	165	465	132	116	160	−28
1978	283	255	1.31	335	590	306	107	147	159
1979	359	323	1.31	423	746	387	107	147	240
1980	256	230	0.90	207	437	181	85	116	65
1981	246	221	1.00	221	442	196	78	107	89
1982	323	291	0.66	174	465	147	100	135	7
1983	230	207							

* Production – eastern part of state; Kill – entire state.

Table A7
Mallard production in North Dakota, 1972–82 (in 1000s)

	Adults						Kill*		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	114	642	0.90	578	1220	506	244	330	176
1973	577	519	1.10	571	1089	513	114	154	359
1974	453	408	1.35	530	938	484	156	211	273
1975	567	510	1.20	612	1122	555	169	228	327
1976	459	413	1.00	413	826	367	151	204	163
1977	375	338	0.55	169	507	132	83	112	20
1978	507	456	1.11	502	958	451	223	301	150
1979	685	617	1.30	801	1418	733	192	260	473
1980	486	437	0.90	394	831	345	150	202	143
1981	309	278	0.80	222	500	191	160	216	−25
1982	467	420	0.65	273	693	226	134	181	45
1983	404	363							

* Production – eastern part of state; Kill – entire state.

Table A8
Mallard production in South Dakota, 1972–82 (in 1000s)

	Adults						Kill*		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	575	518	0.9	468	984	413	176	238	175
1973	478	430	1.1	473	903	424	186	250	174
1974	274	246	2.3	566	812	538	61	83	455
1975	354	319	1.2	382	701	347	92	126	221
1976	332	298	1.0	298	596	266	55	76	190
1977	267	240	0.7	168	404	141	57	78	63
1978	537	483	1.1	531	1015	478	168	231	247
1979	484	435	1.3	565	1000	517	131	180	337
1980	338	304	0.9	273	578	240	80	110	130
1981	187	168	0.7	117	285	99	60	82	17
1982	292	263	0.8	210	473	181	68	92	89
1983	316	284							

* Production – eastern part of state; Kill – entire state.

Table A9
Mallard production in Minnesota, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	69	62	0.85	53	115	46	360	486	−440
1973	104	94	1.4	132	226	122	170	229	−107
1974	98	88	2.25	196	284	186	263	355	−169
1975	146	131	1.1	144	275	129	285	356	−227
1976	152	137	1.4	192	329	177	165	206	−29
1977	218	196	1.2	235	431	213	192	264	−51
1978	189	170	1.1	187	357	168	329	452	−284
1979	198	178	1.45	258	436	238	338	465	−227
1980	228	205	1.1	226	431	203	251	345	−142
1981	201	181	0.9	163	344	143	262	327	−184
1982	172	155	1.22	189	344	172	236	319	−146

Appendix B
Productivity, kill, and export of Mallards in the southern Prairies, 1972–82 (in 1000s)

Table B1
Productivity, kill, and export of Mallards in southern Alberta, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	1825	1643	0.70	1150	2793	968	457	617	351
1973	1730	1557	0.86	1340	2897	1167	434	586	581
1974	1576	1418	1.29	1829	3247	1671	612	825	846
1975	1398	1258	1.37	1723	2981	1583	396	535	1048
1976	1454	1309	0.99	1296	2605	1151	473	638	513
1977	853	768	0.60	453	1221	368	383	527	−159
1978	824	742	0.58	430	1172	348	318	437	−89
1979	983	885	0.70	637	1522	539	397	545	−6
1980	975	878	0.49	432	1310	335	367	495	−160
1981	901	811	0.47	378	1189	288	325	438	−150
1982	776	698	0.60	419	1117	341	245	330	+11
1983	846	761							

Table B2
Productivity, kill, and export of Mallards in southern Saskatchewan, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	2671	2485	0.72	1789	4274	1603	389	526	1077
1973	2367	2130	0.84	1789	3919	1552	282	381	1172
1974	2080	1872	1.13	2115	3987	1907	398	537	1370
1975	2443	2199	1.21	2660	4859	2415	416	561	1855
1976	3027	2724	1.11	3032	5756	2729	505	682	2047
1977	2867	2580	0.74	1902	4482	1615	320	432	1175
1978	1911	1720	0.76	1311	3031	1120	313	423	690
1979	2237	2013	0.93	1868	3881	1644	344	464	1171
1980	2139	1925	0.58	1115	3040	901	280	378	516
1981	1505	1354	0.57	768	2164	659	189	255	399
1982	1944	1750	0.52	910	2660	716	191	258	458
1983	1711	1540							

Table B3
Productivity, kill, and export of Mallards in southern Manitoba, 1972–82 (in 1000s)

	Adults						Kill		
Year	May	Sept.	I/A	IMM	FF	NetP	Retrieved	Total	Net export
1972	405	365	0.91	332	697	292	195	263	29
1973	232	209	1.66	346	555	323	102	138	185
1974	322	290	1.16	336	626	304	111	150	154
1975	348	313	1.13	345	658	310	121	166	144
1976	536	482	1.19	574	1056	520	167	225	195
1977	253	228	0.93	211	439	186	144	198	−12
1978	287	258	0.97	249	507	220	201	276	−56
1979	236	212	0.97	206	418	182	208	286	−104
1980	332	299	0.98	293	592	260	161	221	39
1981	351	316	0.73	230	546	195	150	206	−11
1982	389	350	0.80	280	630	241	120	162	79
1983	339	305							

Appendix C
Annual variation of kill of Canadian Mallards by state and flyway, 1972–82 (in 1000s)

Table C1
Estimated adjusted kill of Canadian-produced Mallards, by state, in the Pacific Flyway

Year	Ariz.	Calif.	Ida.	Nev.	Oreg.	Utah	Wash.	Total
1972	3	60	140	7	56	24	141	431
1973	5	46	113	7	42	24	155	392
1974	2	48	115	6	36	18	108	333
1975	2	54	120	8	42	22	125	373
1976	4	61	110	12	52	21	112	372
1977	2	41	64	4	44	16	126	297
1978	3	55	120	7	48	30	143	406
1979	3	50	85	6	41	20	124	329
1980	5	47	100	6	39	30	129	356
1981	3	45	133	6	34	18	113	352
1982	2	55	115	5	44	26	93	340

Table C2
Estimated adjusted kill of Canadian-produced Mallards, by state, in the Central Flyway

Year	Col.	Kans.	Mon.	Neb.	New Mex.	ND	Okl.	SD	Tex.	Wyo.	Total
1972	22	175	40	142	8	132	81	113	135	18	866
1973	16	106	36	105	5	64	87	118	100	19	656
1974	10	101	57	57	13	86	74	40	107	15	560
1975	14	91	51	92	14	92	83	60	154	21	672
1976	16	97	50	104	20	82	83	35	182	18	687
1977	11	122	46	116	8	45	52	37	134	19	590
1978	17	109	47	145	13	123	62	114	114	22	766
1979	14	88	40	104	12	105	64	87	118	20	652
1980	11	65	38	102	11	78	54	53	146	18	576
1981	16	70	47	109	8	90	33	40	98	15	526
1982	15	62	49	93	4	76	53	46	71	16	485

Table C3
Kill of Canadian-produced Mallards, by state, in the Mississipi Flyway

Year	Ala.	Ark.	Ill.	Ind.	Iowa	Kt.	La.	Mich.	Mn.	Miss.	Mo.	Oh.	Wisc.	Tenn.	Total
1972	14	216	165	9	87	22	166	48	144	73	107	10	57	63	1181
1973	17	249	119	10	67	14	106	53	66	64	97	13	56	85	1016
1974	9	378	108	8	70	18	150	57	102	133	140	10	88	71	1342
1975	18	397	144	9	85	32	265	56	110	175	152	13	75	93	1624
1976	32	374	115	10	62	24	389	66	66	174	110	15	63	77	1577
1977	33	415	138	16	90	21	262	37	80	134	130	12	51	103	1522
1978	21	328	135	13	88	15	302	50	131	82	104	10	52	82	1413
1979	23	349	129	7	130	26	241	49	135	104	121	8	61	74	1457
1980	27	474	119	9	85	15	332	46	100	135	102	12	82	46	1584
1981	24	307	128	7	93	17	297	40	104	148	97	11	51	44	1368
1982	18	225	100	6	119	14	196	49	95	93	92	8	43	41	1099

Figure 1
Co-operative waterfowl breeding ground survey strata

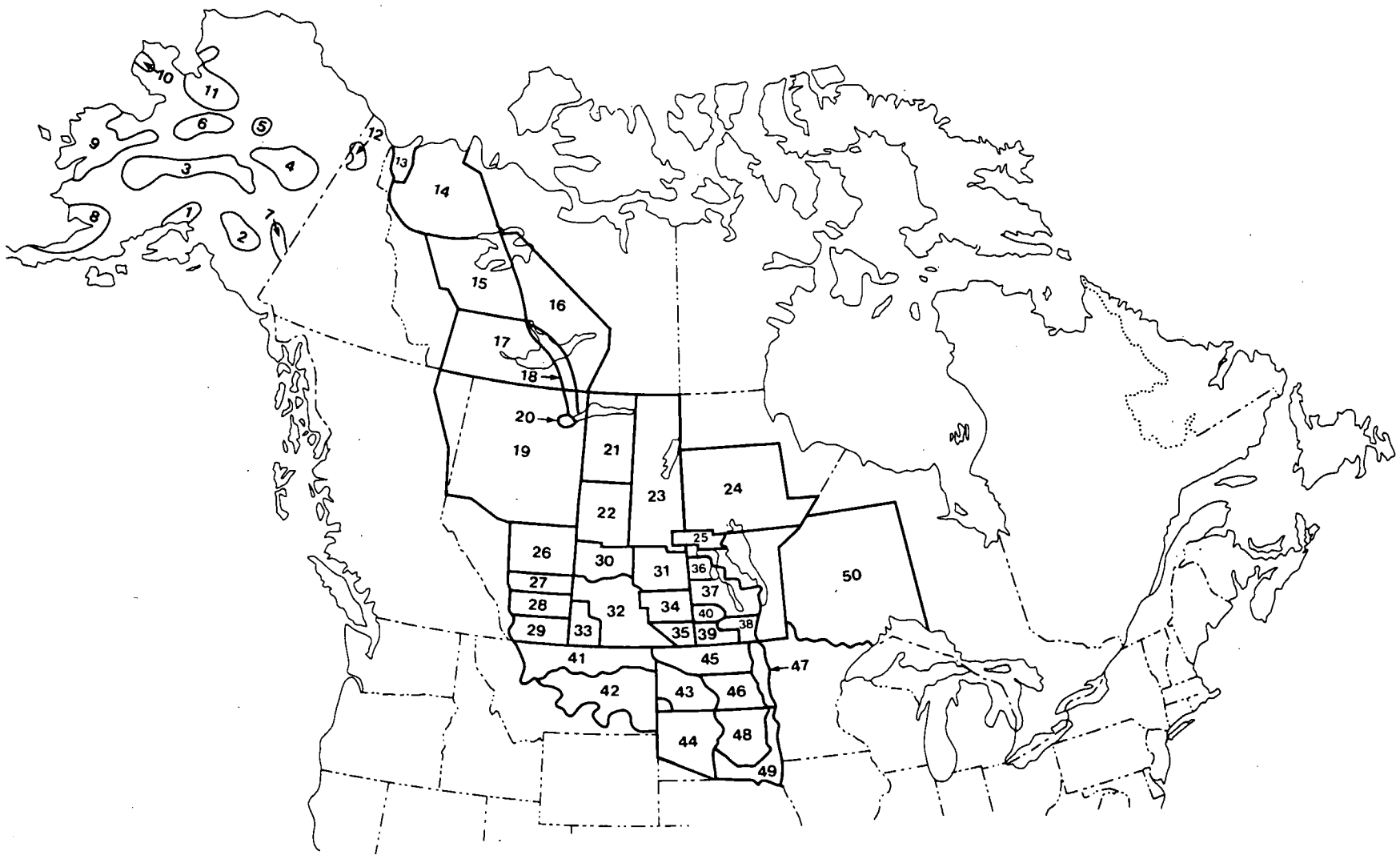


Figure 2
Best fit fall flight and kill (in thousands) in Minnesota, 1972–82, $R_{XY} = 0.6121$ ($r^2 = 0.364$)

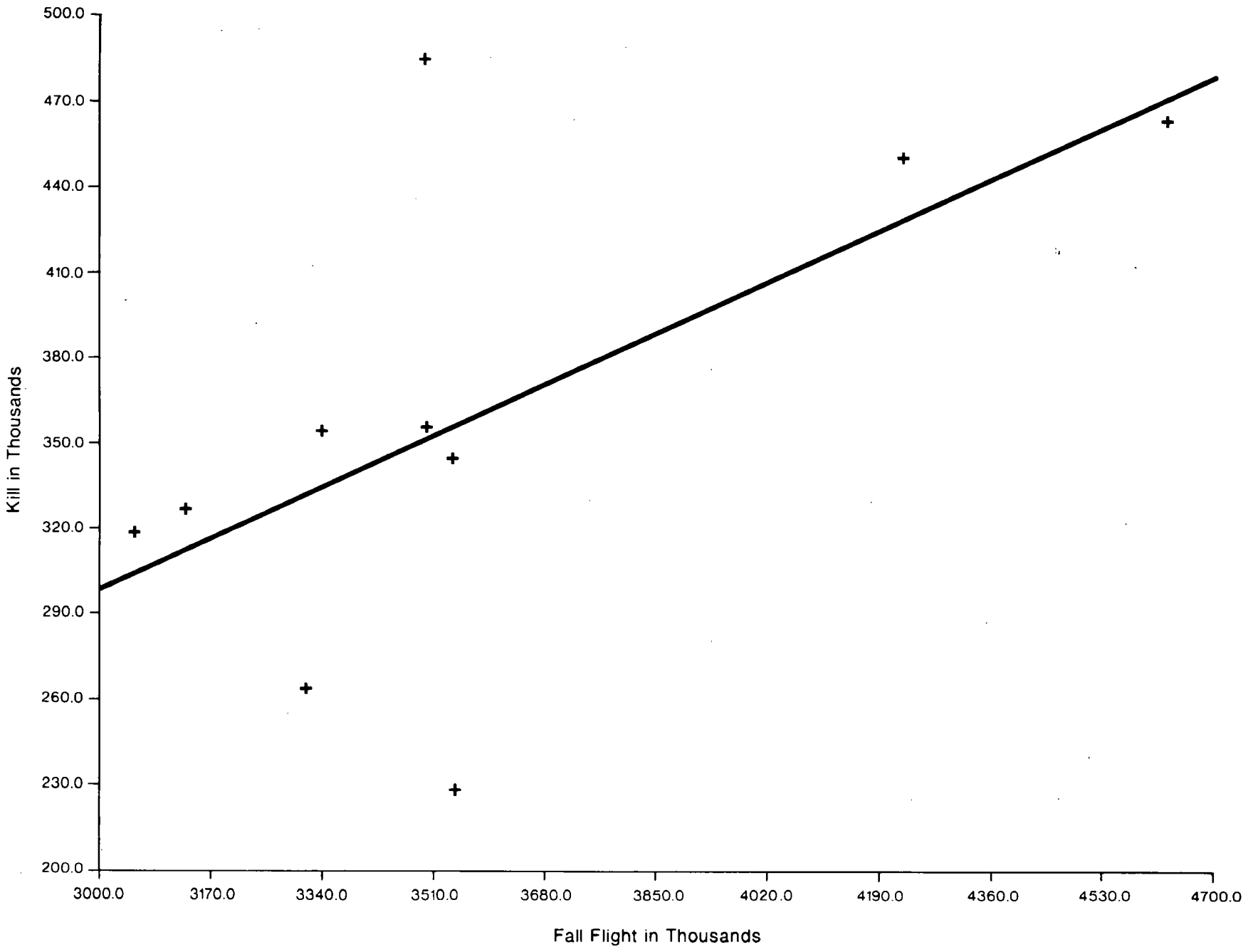


Figure 3
Best fit fall flight and kill (in thousands) in Saskatchewan, 1972–82, $R_{XY} = 0.9416$ ($r^2 = 0.8866$)

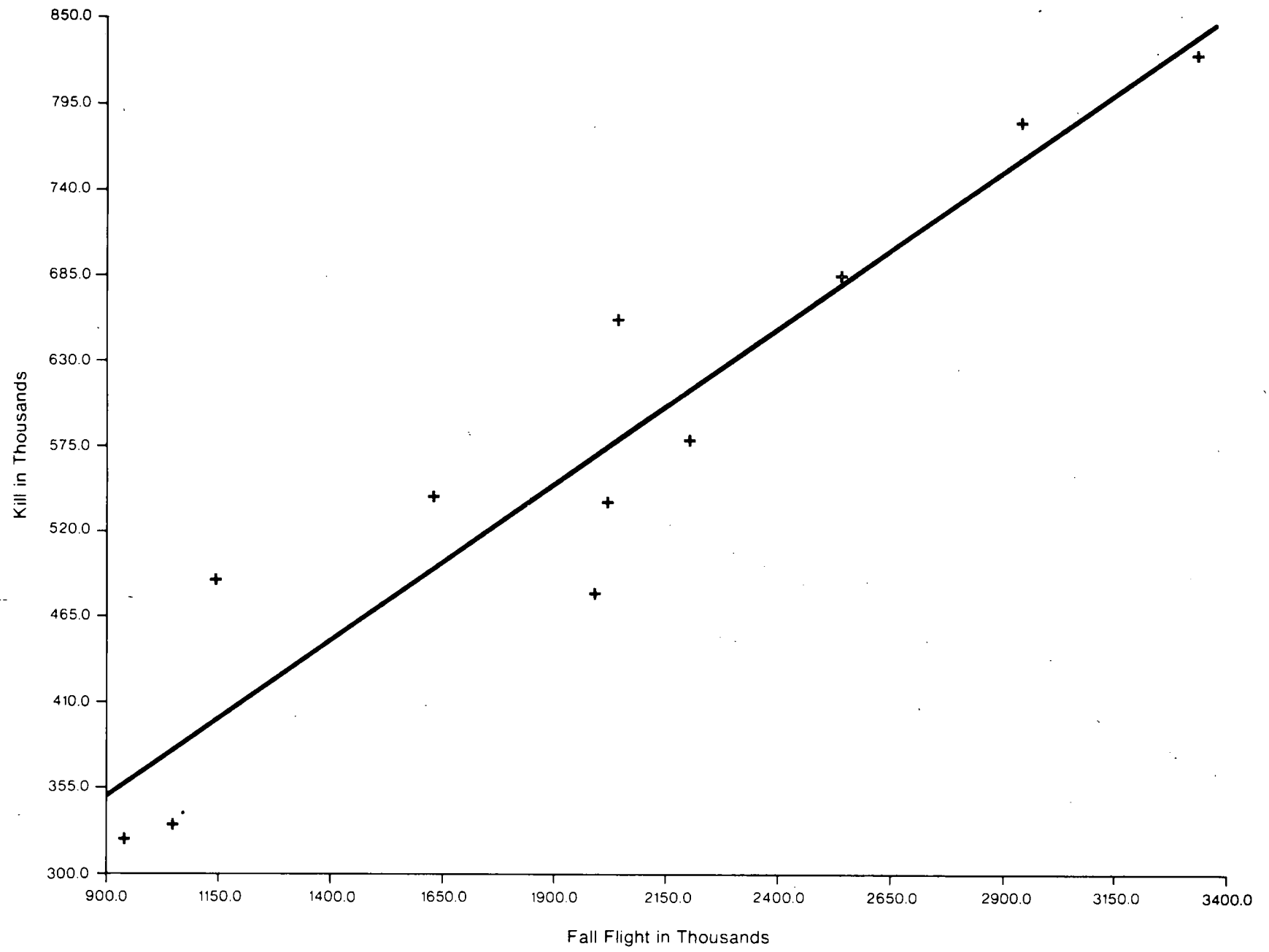


Figure 4
Best fit fall flight and kill (in thousands) in Alberta, 1972–82, $R_{XY} = 0.8062$ ($r^2 = 0.6499$)

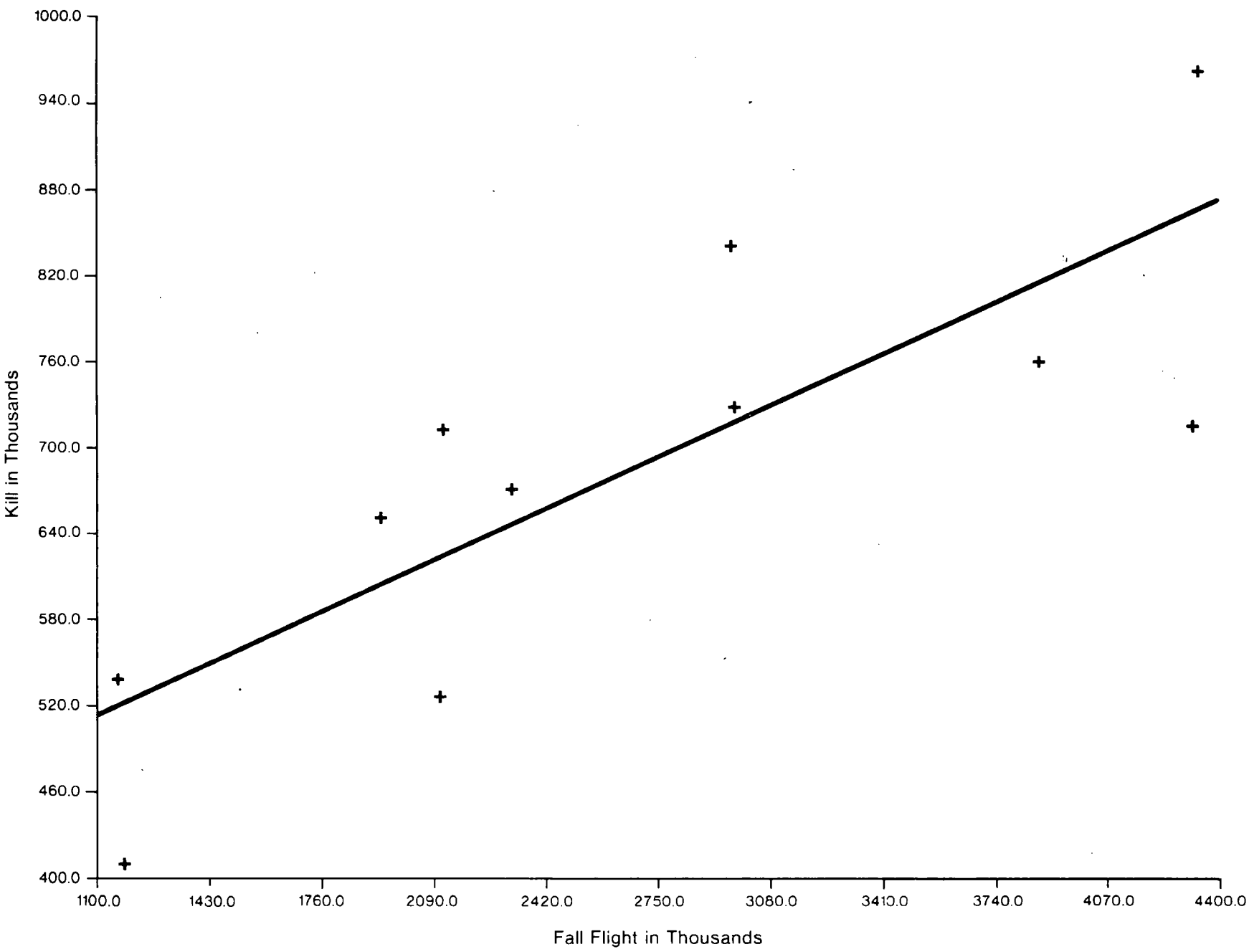


Figure 5
Best fit fall flight and kill (in thousands) in Manitoba, 1972–82, $R_{XY} = 0.6937$ ($r^2 = 0.4813$)

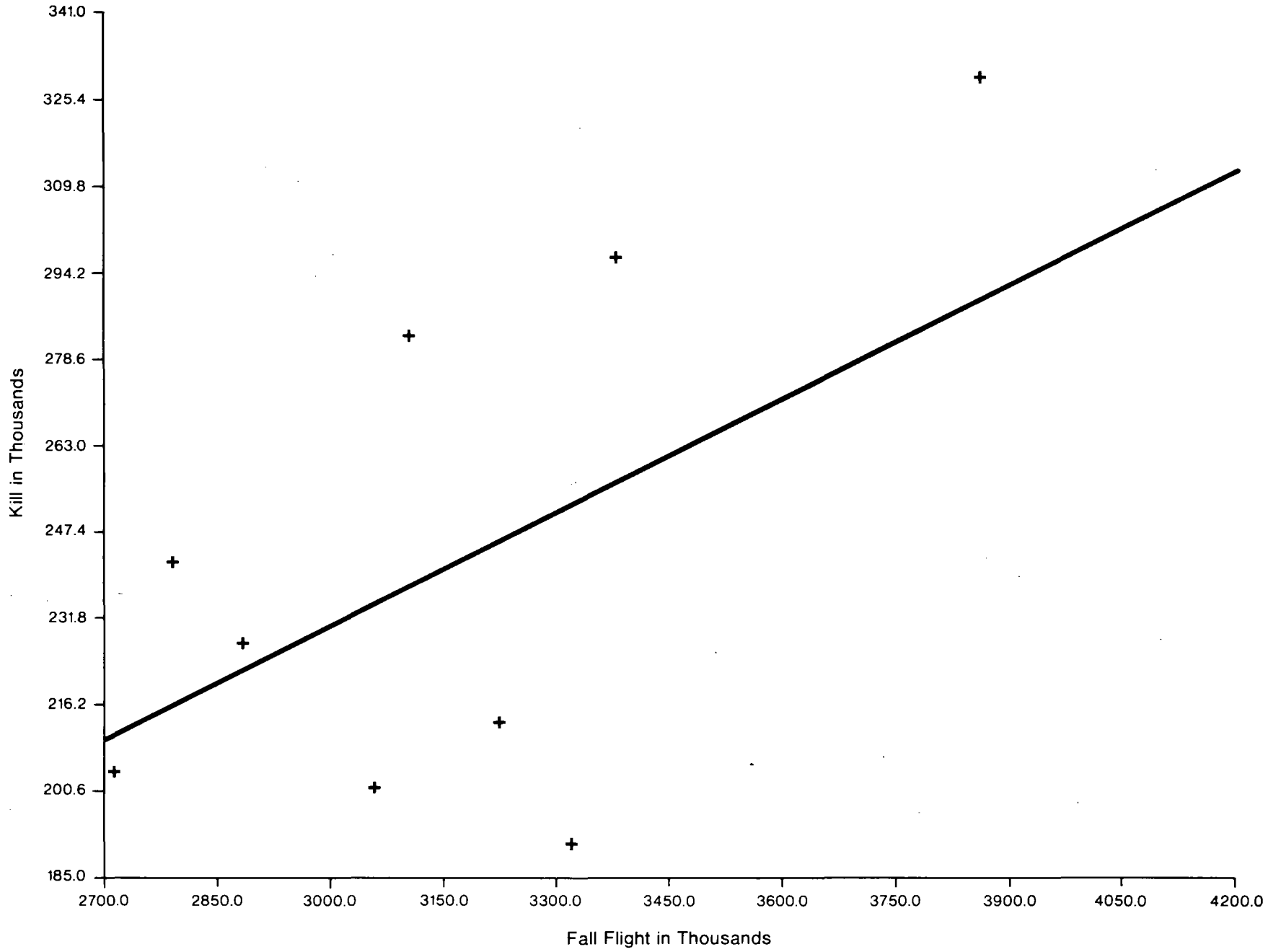
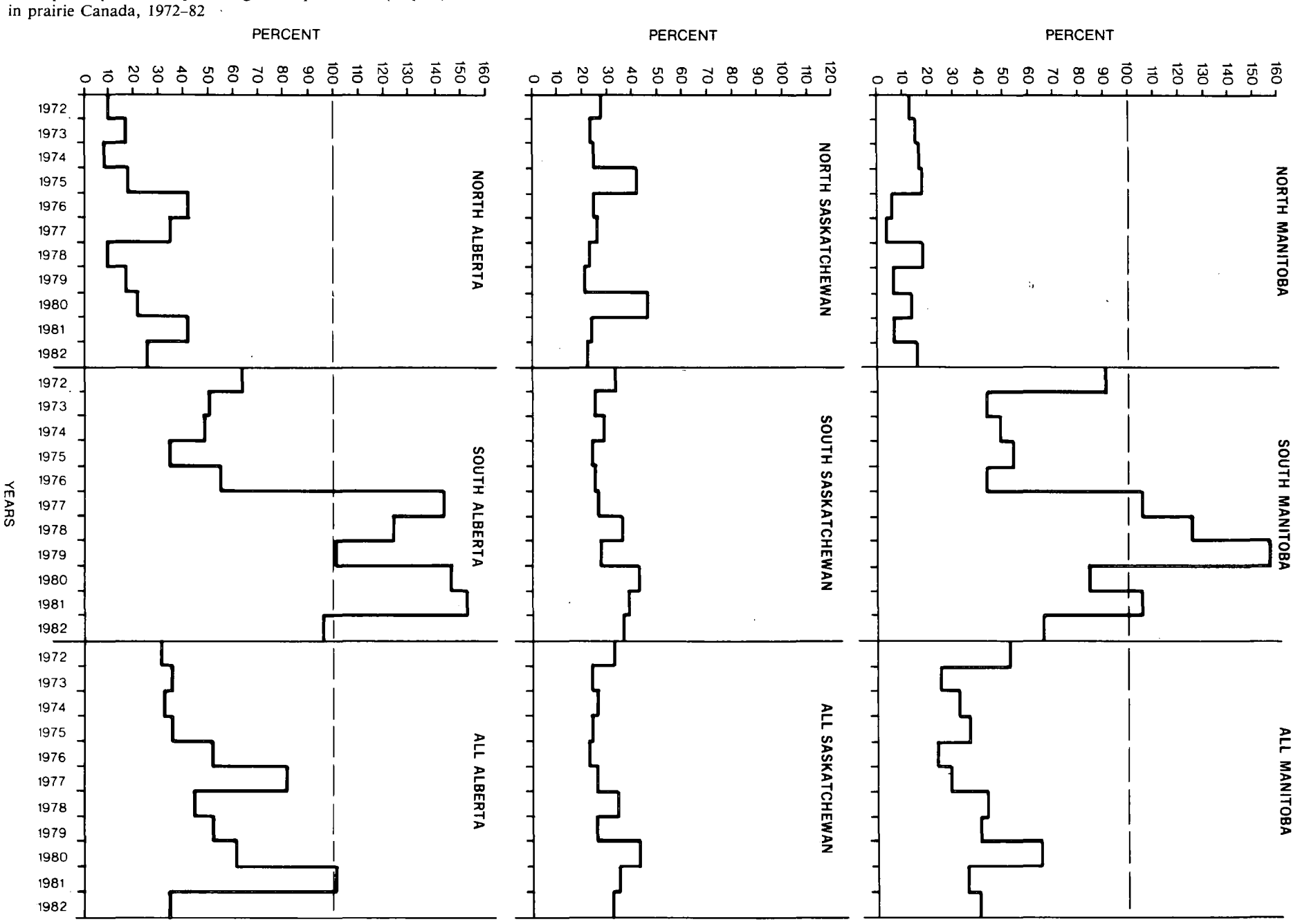


Figure 6
Net export expressed as a percentage of net production (surplus) in prairie Canada, 1972–82



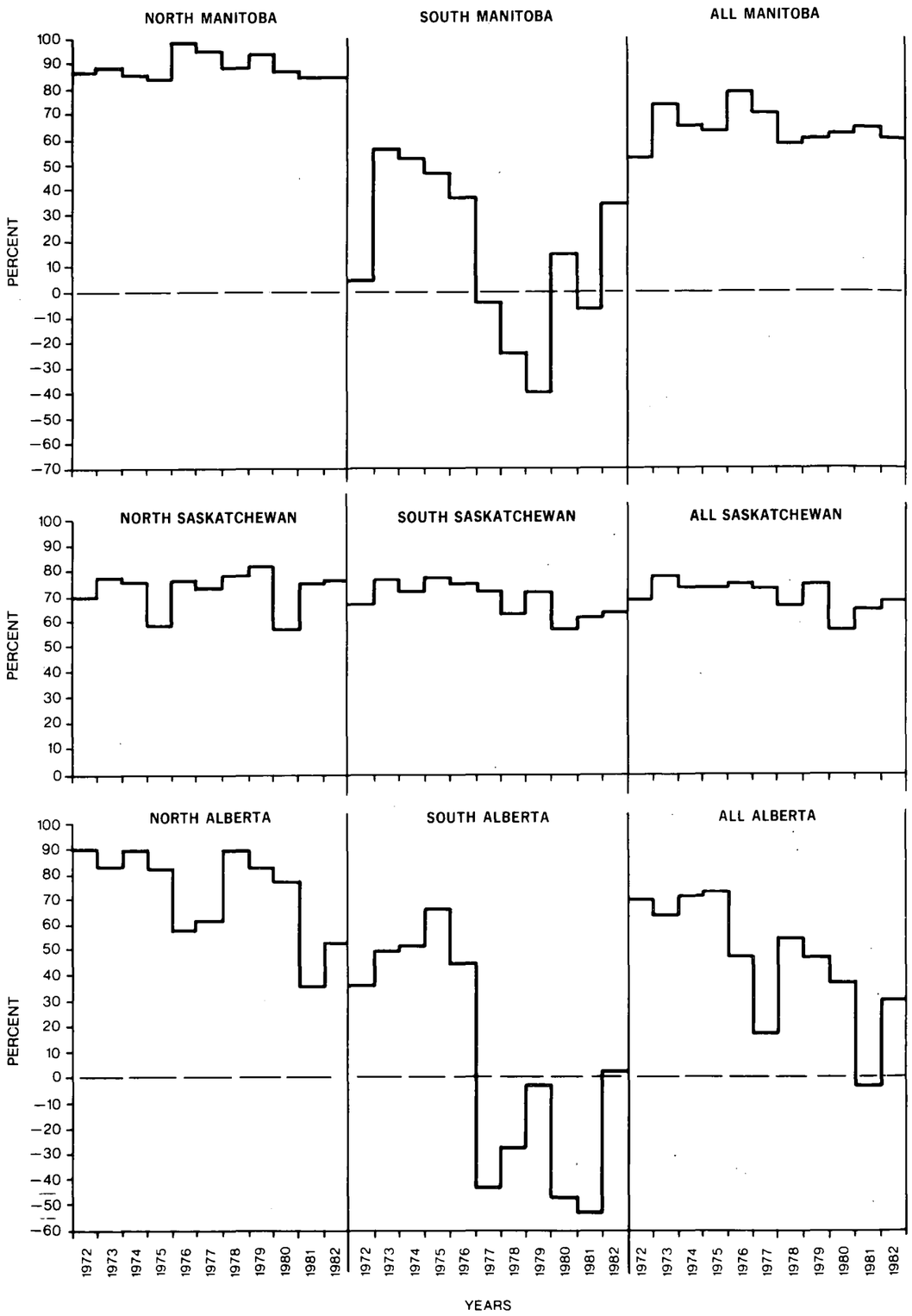


Figure 7
Kill as a percentage of net production in zones of prairie Canada, 1972–82

Figure 8
(a) Kill as a percentage of net production in three US production states, 1972–82; (b) net export as a percentage of net production in three US production states

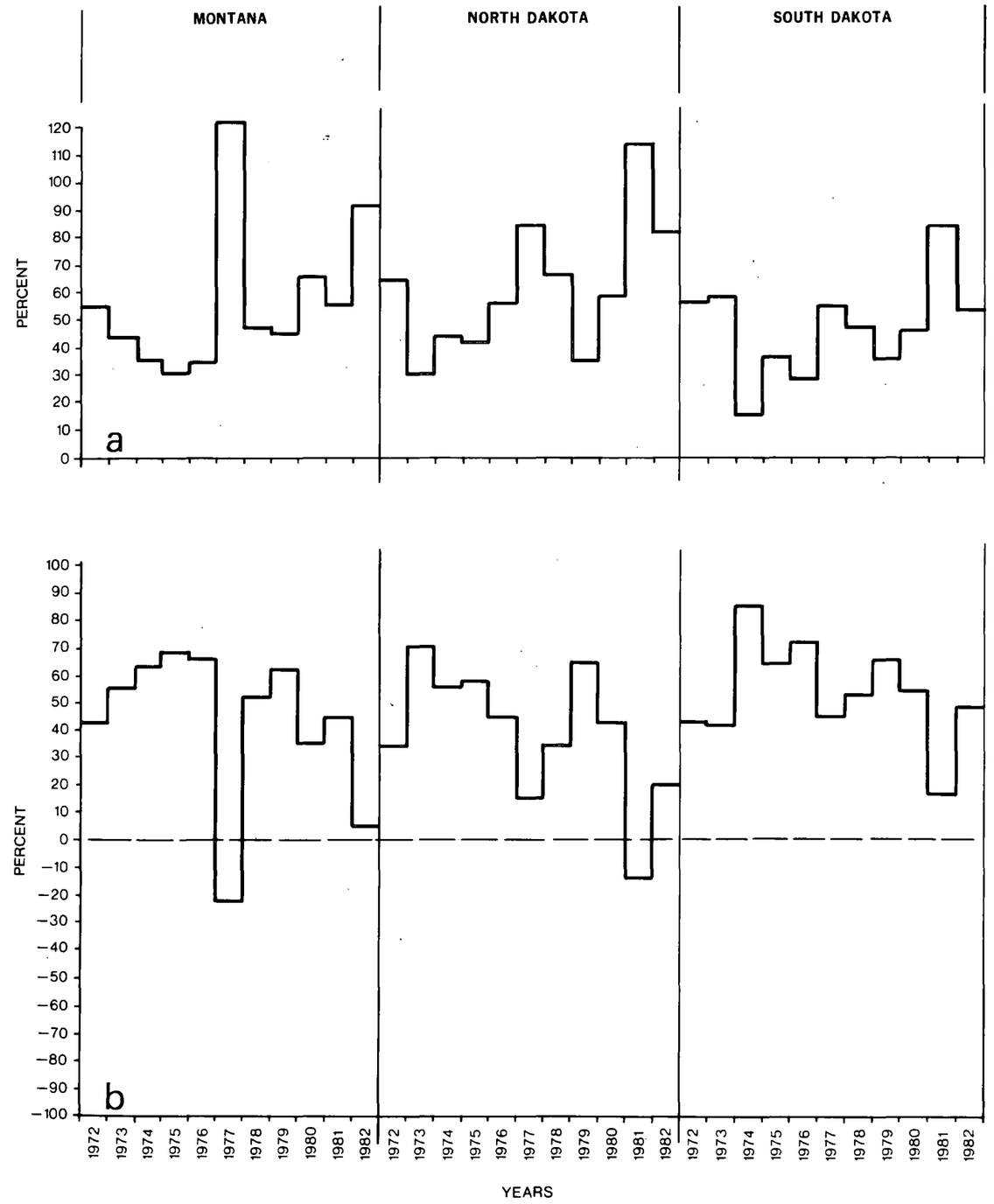
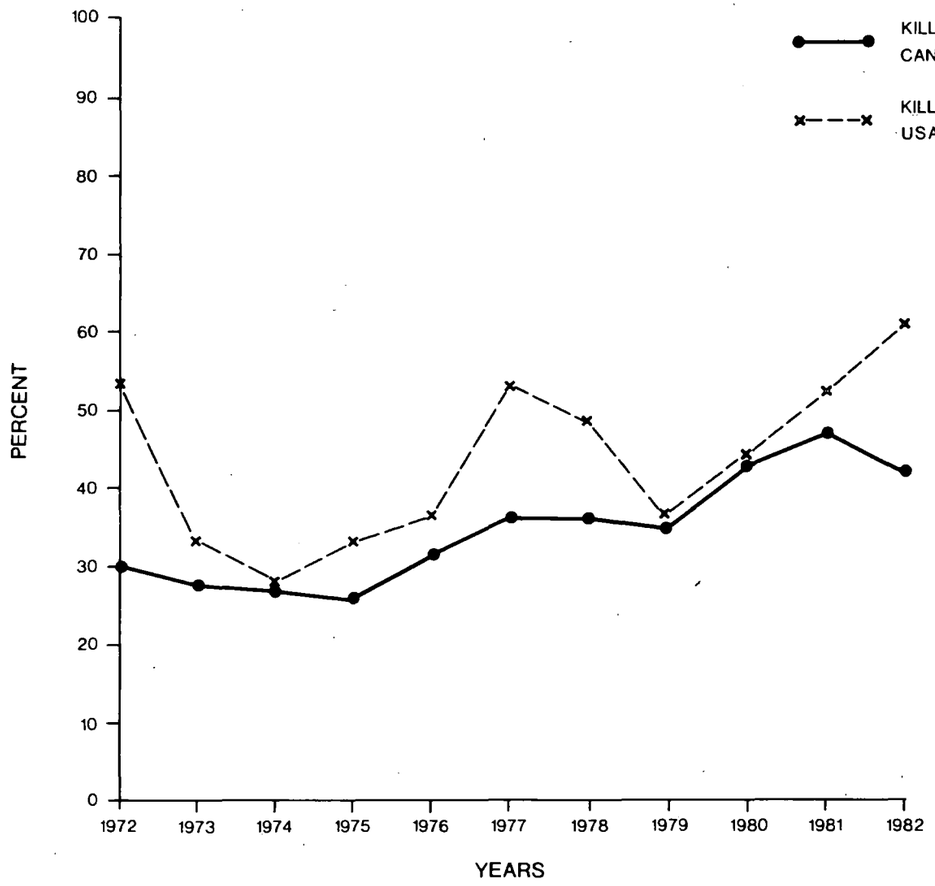


Figure 9
Kill in Canadian and US production areas as a percentage of production within those areas



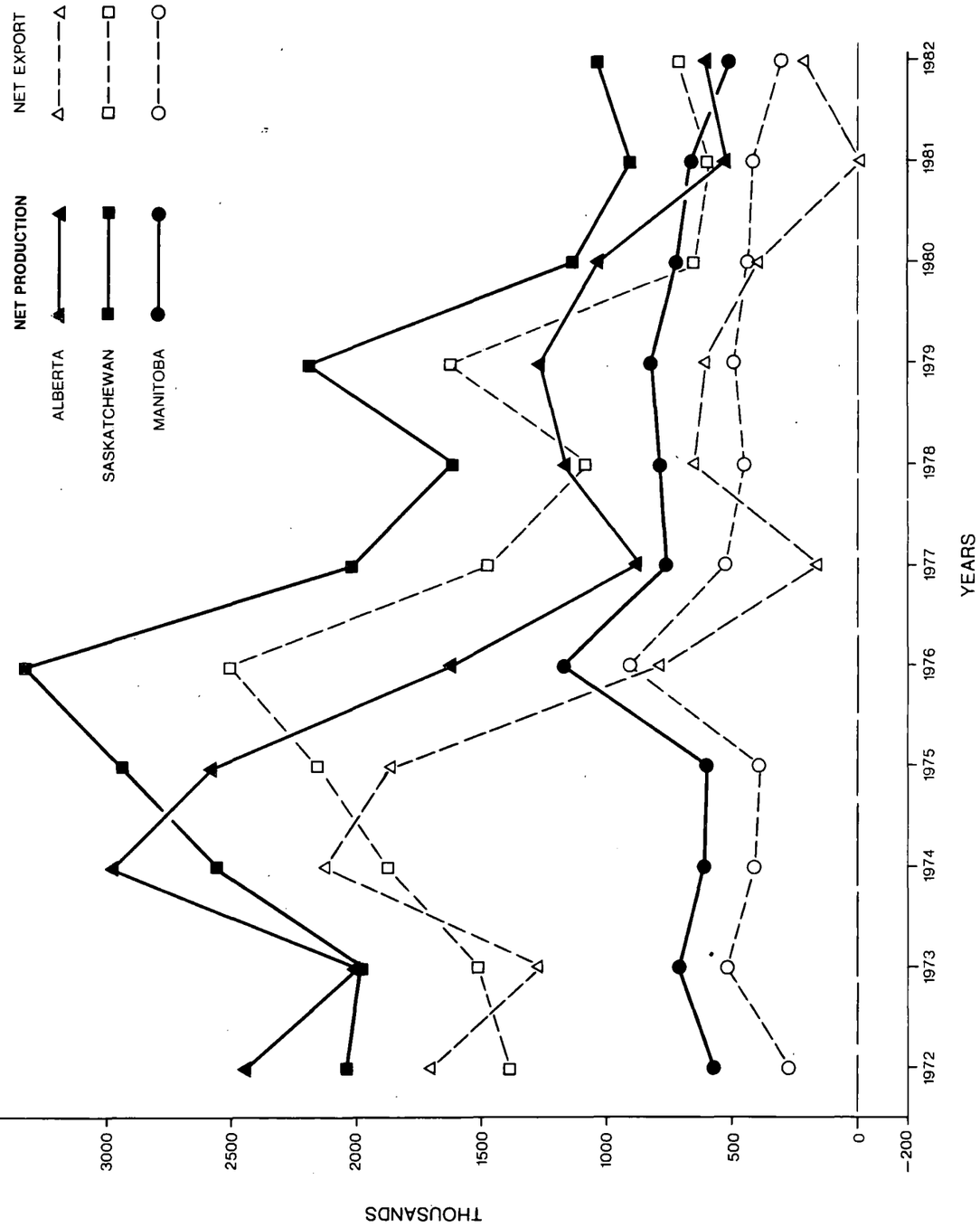


Figure 10
Net production and net export from southern Canada, 1972–82