THE TEN-YEAR CYCLE IN NUMBERS OF THE LYNX IN CANADA

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(*With* 10 *Figures in the Text*)

CONTENTS

1. Introduction

The cycle in populations of *Lynx canadensis* has received wide attention from biologists on account of the regularity and great amplitude of the rhythm it has produced in the fur catches of the Hudson's Bay Company over a long period. Discussion of this periodicity has been based entirely on the total fur returns or total sales of the Company, except for a nearly complete series of fur returns for the MacKenzie River District for the years 1822–1927 (Elton, 1933). The present paper contains further material for analysis of the total fur returns into regions, derived from archives of the Hudson's Bay Company that have not previously been published.

The search for material has been in progress since 1925, and has been aided by grants at different times from the Hudson's Bay Company; New York Zoological Society; the Leverhulme Research Fellowship Trust; the Christopher Welch Trust; Oxford University; Corpus Christi College, Oxford; the Department of Scientific and Industrial Research; and the Carnegie Corporation of New York (through the Carnegie Institution of Washington). The Governor and Committee of the Hudson's Bay Company have given very full facilities for the examination of archives and the publication of material for scientific purposes. It is a pleasure to acknowledge the assistance given by many of the Company's officials. The help of the Archivist, Mr R. Leveson Gower, has been particularly valuable. We are indebted to Dr Willard E. Ireland, Archivist of British Columbia, for supplying copies of some early fur returns of the Hudson's Bay Company that are not in the latter's own collection. We also wish to thank Mrs Phoebe Jackson, who did part of the work of extracting material from the archives in London.

2. Total lynx catches of the Hudson's Bay Company

Before describing the results of regional analysis, it is necessary to clear up some confusion that has arisen about the total collections, which have been frequently used in research publications and text-books. It can be assumed that practically all the lynx

furs were brought into the posts by trappers in the same season that they were caught. But after this they might be recorded under any of three different calendar years: the year of the Outfit in which they were caught (the actual 'year of production'), the year in which the furs were rendered to headquarters, or the year in which they were sold at auction in London. Thus a collection of lynx brought into Fort Simpson in the MacKenzie River District in March 1891 would be counted in the collection of Outfit 1890 (which ran from 1 June 1890 to 31 May 1891). It would reach the headquarters of the Company in Canada and be shipped to England in the summer and autumn of 1891 (i.e. in Outfit 1891). It would normally have been sold at auction in London in March 1892 (i.e. still in Outfit 1891). This was the sale arrangement up to about 1915. In the Company's own accounting system, furs until sold were recorded by the original Outfit in which they were caught (in this case 1890), but the sales were recorded by the calendar year of the sale (in this case 1892). In the body of this paper we have converted *all* dates into the Outfit in which they were presumably caught. One has to say presumably, because there will always have been a certain number of furs that failed to reach England in the Outfit after they were caught; but these are believed not to be more than a small fraction of the total.

The Company therefore used only two of the three possible methods of dating. But those who have used the figures for scientific purposes have often made mistakes in converting the dates into 'years of production'. In order to try and clear up this confusion finally, we give below a comparative table of the different figures that have been published for the total annual lynx collections of the Hudson's Bay Company. Those in Seton (1912) and Hewitt (1921) have been read off as closely as possible from their curves, as no tables of figures are given.

Table 1. *Comparison of published Hudson's Bay Company total lynx figures, re-dated by Outfits*

	H.B. Co. (1878) moved back 2 years	Poland (1892) moved back 1 year	Seton (1912) moved back 1 year	Jones (1914) moved back 2 years	Hewitt (1921)	
					Moved back 1 year	Moved back 2 years
1821	—	8,986	9,000	—	9,000	—
1822	—	7,173	5,000	—	4,000	—
1823	—	6,456	4,000	—	3,000	—
1824	—	5,104	3,000	—	2,000	—
1825	—	5,161	3,000	—	3,000	—
1826	—	7,254	7,000	—	7,000	—
1827	—	11,550	10,000	—	10,000	—
1828	—	20,558	20,000	—	21,000	—
1829	—	24,611	24,000	—	25,000	—
1830	—	38,200	36,000	—	36,000	—
1831	—	16,347	14,000	—	15,000	—
1832	—	870	2,000	—	3,000	—
1833	—	14,255	15,000	—	14,000	—
1834	—	6,990	5,000	—	5,000	—
1835	—	4,440	5,000	—	5,000	—
1836	—	31,887	30,000	—	29,000	—
1837	—	45,152	45,000	—	44,000	—
1838	—	66,691	65,000	—	63,000	—
1839	—	35,843	35,000	—	35,000	—
1840	—	45,143	46,000	—	45,000	—
1841	—	10,034	10,000	—	10,000	—
1842	—	8,247	6,000	—	5,000	—
1843	—	7,173	5,000	—	6,000	—
1844	—	10,359	10,000	—	10,000	—
1845	—	21,180	20,000	—	17,000	—
1846	—	31,062	30,000	—	29,000	—

Table 1 (*continued*)

	H.B. Co. (1878) moved back 2 years	Poland (1892) moved back 1 year	Seton (1912) moved back 1 year	Jones (1914) moved back 2 years	Hewitt (1921)	
					Moved back 1 year	Moved back 2 years
1847	—	47,065	45,000	—	44,000	—
1848	—	43,253	40,000	43,738	41,000	—
1849	—	20,604	20,000	20,353	19,000	—
1850	—	9,303	10,000	8,519	10,000	—
1851	5,361	6,722	9,000	5,361	8,000	—
1852	4,552	4,850	6,000	4,552	7,000	—
1853	5,682	4,907	5,000	5,682	5,000	—
1854	11,358	10,764	10,000	11,358	10,000	—
1855	23,362	21,511	20,000	23,362	20,000	—
1856	31,642	32,264	30,000	31,642	30,000	31,000
1857	33,757	33,038	32,000	33,757	—	32,000
1858	23,226	27,460	25,000	23,226	—	25,000
1859	15,178	15,968	14,000	15,178	—	18,000
1860	7,272	7,927	7,000	7,272	—	11,000
1861	4,448	4,616	4,000	4,448	—	4,000
1862	4,926	4,570	4,000	4,926	—	5,000
1863	5,437	4,760	6,000	5,437	—	6,000
1864	16,498	17,044	15,000	16,498	—	16,000
1865	35,971	34,732	35,000	35,971	—	35,000
1866	76,556	68,097	65,000	76,556	—	77,000
1867	68,392	70,372	70,000	68,392	—	67,000
1868	37,447	39,119	36,000	37,447	—	40,000
1869	15,686	19,992	15,000	15,686	—	13,000
1870	7,942	8,806	6,000	7,942	—	7,000
1871	5,123	5,679	5,000	5,123	—	5,000
1872	7,106	4,839	4,000	7,106	—	9,000
1873	11,250	10,045	10,000	11,250	—	13,000
1874	18,774	17,849	15,000	18,774	—	18,000
1875	30,508	18,868	16,000	30,508	—	29,000
1876	—	43,575	40,000	42,834	—	41,000
1877	—	37,490	36,000	27,345	—	28,000
1878	—	21,291	20,000	17,834	—	17,000
1879	—	14,767	14,000	15,386	—	15,000
1880	—	10,053	10,000	9,443	—	8,000
1881	—	7,581	5,000	7,599	—	5,000
1882	—	8,016	9,000	8,061	—	8,000
1883	—	27,119	26,000	27,187	—	27,000
1884	—	51,414	50,000	51,511	—	50,000
1885	—	73,878	71,000	74,050	—	74,000
1886	—	78,555	78,000	78,773	—	78,000
1887	—	33,720	31,000	33,899	—	37,000
1888	—	18,726	17,000	18,886	—	17,000
1889	—	11,445	10,000	[11,520]	—	12,000
1890	—	—	6,000	8,352	—	7,000
1891	—	—	5,000	8,660	—	6,000
1892	—	—	10,000	12,902	—	12,000
1893	—	—	20,000	20,331	—	20,000
1894	—	—	34,000	36,853	—	36,000
1895	—	—	55,000	56,407	—	55,000
1896	—	—	38,000	39,437	—	37,000
1897	—	—	26,000	26,761	—	26,000
1898	—	—	14,000	15,185	—	15,000
1899	—	—	5,000	4,473	—	5,000
1900	—	—	9,000	5,781	—	6,000
1901	—	—	11,000	9,117	—	8,000
1902	—	—	25,000	19,267	—	18,000
1903	—	—	37,000	36,116	—	37,000
1904	—	—	55,000	58,850	—	57,000
1905	—	—	60,000	61,478	—	61,000
1906	—	—	36,000	38,501	—	32,000
1907	—	—	7,000	9,704	—	7,000
1908	—	—	—	3,410	—	2,000
1909	—	—	—	3,774	—	2,000
1910	—	—	—	—	—	6,000
1911	—	—	—	—	—	12,000
1912	—	—	—	—	—	—

The basic series for fixing the real dates of the collections is that in the Company's published report (1878) on Outfit 1876, which clearly says: 'Statement of furs and skins sold by the Hudson's Bay Company in each year, 1853 to 1877 inclusive.' The text also refers to the Spring Sales of 1877, 'when Furs of all descriptions, fine and common, were sold...'. The lynx sales figure for 1877 therefore refers to the Spring Sales of 1877, i.e. to the furs caught in Outfit 1875. These sales figures for 1853–77, that is Outfits 1851–75, overlap and agree with those given by Jones (1914). These are correctly entitled: 'Fur Sales of the Hudson's Bay Company (supplied to the High Commissioner for Canada for the Commission of Conservation).' Much the same figures appear to have been used by Hewitt, though referred to by him as 'returns', for he says: 'Through the kindness of Mr W. H. Bacon, late fur commissioner of the Hudson's Bay Company, I have been able to obtain the fur returns of that company covering a long period of years, from 1821 to 1914....From these figures the accompanying charts have been prepared.' These figures can only be brought into line with those already mentioned by assuming a mistake in transcription. For his years 1857 and 1858 he seems to have used two versions of the same figure, so that we have had to move his figures up to 1857 back by one year, and those from 1858 onwards back by two years. This gives as good an agreement as can be expected, considering that we have taken the figures from a very small diagram. Another way of describing this is that Hewitt records the first part of his series under the Outfit year of the sales, and the second part of the series under the calendar year of the sales. Elton (1924) copied Hewitt's chart, and stated that they could be converted into 'years of production' by subtracting one year. We can now see that this procedure was correct up to Outfit 1856, but wrong after that. Poland (1892) makes quite clear the situation about lag between collection and sales, and MacLulich (1937) has properly drawn attention to its importance, and suggested a correction of Elton's treatment. But Poland, though implying that his figures are London sales, has evidently dated them by the year after the Outfit of collection. This is curious, because he clearly stated: 'In the subjoined list of the Hudson's Bay Company's sales, the quantities quoted are those that are imported towards the end of the previous year, excepting those shipments which are delayed by the ice to the north of Hudson's Bay; these do not arrive till the year after. The goods from the North-west district were originally sold in the year in which they arrived, but since the September sales have been suspended, they are sold the following year. As they take much longer in the voyage than those from other districts, they have been quoted for the year in which they arrive.' Poland was dating the sales by their Outfit year instead of their calendar year, i.e. by the second of the possible methods of recording, but not one used by the Company itself. (His reference to delayed furs from the North-west clearly applies (as the earlier text proves) to those from British Columbia, which formed a small fraction of the total. His adjustment may give a slightly truer record of the real annual collection, but does not affect the general picture. We have no material for making a similar correction now.) MacLulich, by using Poland's figures as if they were in calendar sales years, therefore made a mistake in the opposite direction from that of Elton. Because Seton's curves agreed with Poland's figures, MacLulich naturally concluded that they also were sales, whereas Seton had stated: 'Through the courtesy of its officials I have secured the Company's returns for the 85 years—1821–1905 inclusive.' (On his graphs he added points also for 1906–8.)

The table gives all the figures that are available for constructing a curve for the total

lynx collections since 1821, except that the series for 1821–48 which Jones copied from Poland's book, and which are identical with the latter's, has been omitted. It can be seen that Poland, Seton and Hewitt agree substantially in the period up to 1848, for which no direct evidence is available. The differences, sometimes amounting to over two thousand skins, may be chiefly due to Poland's system of dealing with the British Columbia returns, partly also to the difficulty of plotting and then reading off accurately figures from a graph. There were also some irregularities of delivery between 1833 and 1837, which are noted by Poland. All three sources register the same peak years, though there are slight differences in the minima. From 1848 to 1911 it is best to rely upon the Hudson's Bay Company and Jones's figures. In the printed figure for Outfit 1889 in Jones there is an obvious printer's error, which we have allowed for, the last digit having dropped out of the type.

In MacLulich's curve (Fig. 16, p. 109) for lynx, where it is compared with the sunspot numbers, the figures should be moved one year forward for 1750–1906, where he uses Poland and Seton. This applies also to the varying hare figures in his paper.

Having cleared up this astonishing confusion in nomenclature and transcription, we are left with a reasonably good record of the total numbers of lynx killed in Canada by the Company's trappers every year from 1821 to 1911. To these we have added records for 1915–40 (Tables 1 and 2). Discussion of the periodicity will be deferred until § 6.

Table 2. *Total collection of lynx furs, Hudson's Bay Company*, 1912–13, 1915–25; *Dominion Bureau of Statistics, all Canada*, 1919–40

Outfit	H.B. Co.	Outfit	H.B. Co.	Season	Dominion	Season	Dominion	Season	Dominion
1912	22,877	1919	1,695	1919	9,499	1927	21,369	1934	22,014
1913	30,991	1920	2,571	1920	6,509	1928	11,604	1935	22,456
1914	—	1921	4,599	1921	11,673	1929	7,621	1936	17,539
1915	13,817	1922	6,028	1922	17,317	1930	7,976	1937	10,538
1916	16,259	1923	10,682	1923	26,437	1931	8,454	1938	8,109
1917	5,606	1924	11,349	1924	29,608	1932	11,932	1939	7,473
1918	2,325	1925	16,106	1925	33,054	1933	16,799	1940	6,642
				1926	28,706				

3. REGIONAL UNITS

The ultimate unit of furs in the Hudson's Bay Company's summarized accounts is the collection at each post. But these have not often survived, at any rate in series complete enough for studying cycles. We have therefore depended mainly on the returns of fur-trade districts, containing the collections of one or more posts. For most of the districts in Central and Western Canada, long runs of figures are available since 1821. But the boundaries of these districts changed a good deal from time to time, when posts were transferred and when districts were split up or amalgamated. It was therefore necessary to choose regional units which would remain as far as possible constant over long periods of years, and this has meant in a good many cases making rather large ones, including several fur-trade districts. Our aim has been to convert, with as little inaccuracy and assumption as possible, a mosaic of administrative areas of varying size and shape into a pattern of standard biological units for expressing the fur cycle. The danger of reading figures off from the administrative districts only can be illustrated by these examples: (1) Athabasca District in 1901 was half as big again as Athabasca District in 1881; (2) Nelson River District in 1828 does not overlap at all with Nelson River District in

1911; (3) Lake Huron District in 1901 is about four times the size of Lake Huron District in 1897. In this paper we shall distinguish between *Districts* (administrative and accounting units) and *Regions* (either the same or larger groupings made by us).

The history of changes in the fur-trade districts was worked out and summarized on a chart (not published here). The main sources for 1821–86 are the Annual Minutes of Council for the Northern Department and the two-yearly Minutes of Council for the Southern Department, confirmed where possible by, and sometimes amplified from, Journals, Correspondence Books and Post Fur Returns. It must be mentioned that the lists in the Minutes of Council record decisions (taken in Canada) for the transfer and establishment of posts, and although it can be learned from subsequent post lists whether or not these arrangements did eventually take place, there is no way of checking on possible delays (without a tremendous search in the archives of individual posts), and in some cases therefore the date taken from the Minutes may be a year or so too early. The Annual Reports on Fur Trade provide lists of posts for all Districts from 1886 to 1915. Some historical material assembled by Elton (1942) for the Labrador and Ungava Districts has also been drawn upon.

The sites of most of the historic posts are known, and given on the Company's published maps. Information about many of the obscurer ones has been found in the Company's archives, and in Morton's *History of the Canadian West*. Miss Johnson, of the Hudson's Bay Company archives department, has helped us over some special points. Modern place names, although not completely reliable, have occasionally been useful. The only posts not satisfactorily located are some which were in existence for a very few years. Most of them are only mentioned once. It seems likely that these were either unsuccessful posts from the start or else winter outposts of some known post.

Our information covers the whole of Canada from 1886 to the present time. The earlier records cover British Columbia from 1825 to 1857; the Middle West provinces, and those areas of the North-west territories, the Yukon and Alaska which lay in MacKenzie River fur district, from 1821 to 1870, and from 1874 on; all Ontario, except the south-east corner, from 1822 to 1857 and in 1863, and northern Ontario in 1875; the Eastmain and Rupert's River areas of Quebec from 1822 to 1857 and in 1863 and 1875. From all this material a series of maps was compiled, with the approximate position of the districts marked on them. These are not published here, but are deposited in the Bureau of Animal Population. Although minor changes were often made in these districts, the main features of many remained unchanged over long periods. The dates chosen for the maps were decided by periods of major reorganization and are: 1828, 1848, 1875, 1881, 1897, 1901.

One handicap has been the almost complete absence of accurate maps showing the boundaries of nineteenth-century districts, which have therefore had to be fixed in relation to the network of posts in each district, and the known or probable limits of trapping activities radiating from each post at the edge of a district. We have been guided by the following principles in plotting these boundaries:

(1) Districts have always, on account of the early system of transport over canoe routes, tended to occupy water basins, or sections of them. So, where there are no other indications to go by, we have marked the line of watershed as the district boundary. This rule has settled many of the main difficulties. We have not been able to make much use of Arrowsmith's maps of the Company's fur-trade districts, because he starts with an incomplete and incorrect picture of the geography of Canada, and there is no satisfactory

way of transferring his Districts on to a modern map, where the pattern of coast and rivers is different. Where our maps differ from his, it is quite likely that he also meant to follow the line of the watershed, but had no means of knowing accurately where it was.

(2) The distribution of posts being known, a line can be drawn half-way between posts in neighbouring districts, where the watershed method is not applicable.

(3) Where the boundary crossed a river valley, a compromise has to be made between methods 1 and 2, in the light of available historical information.

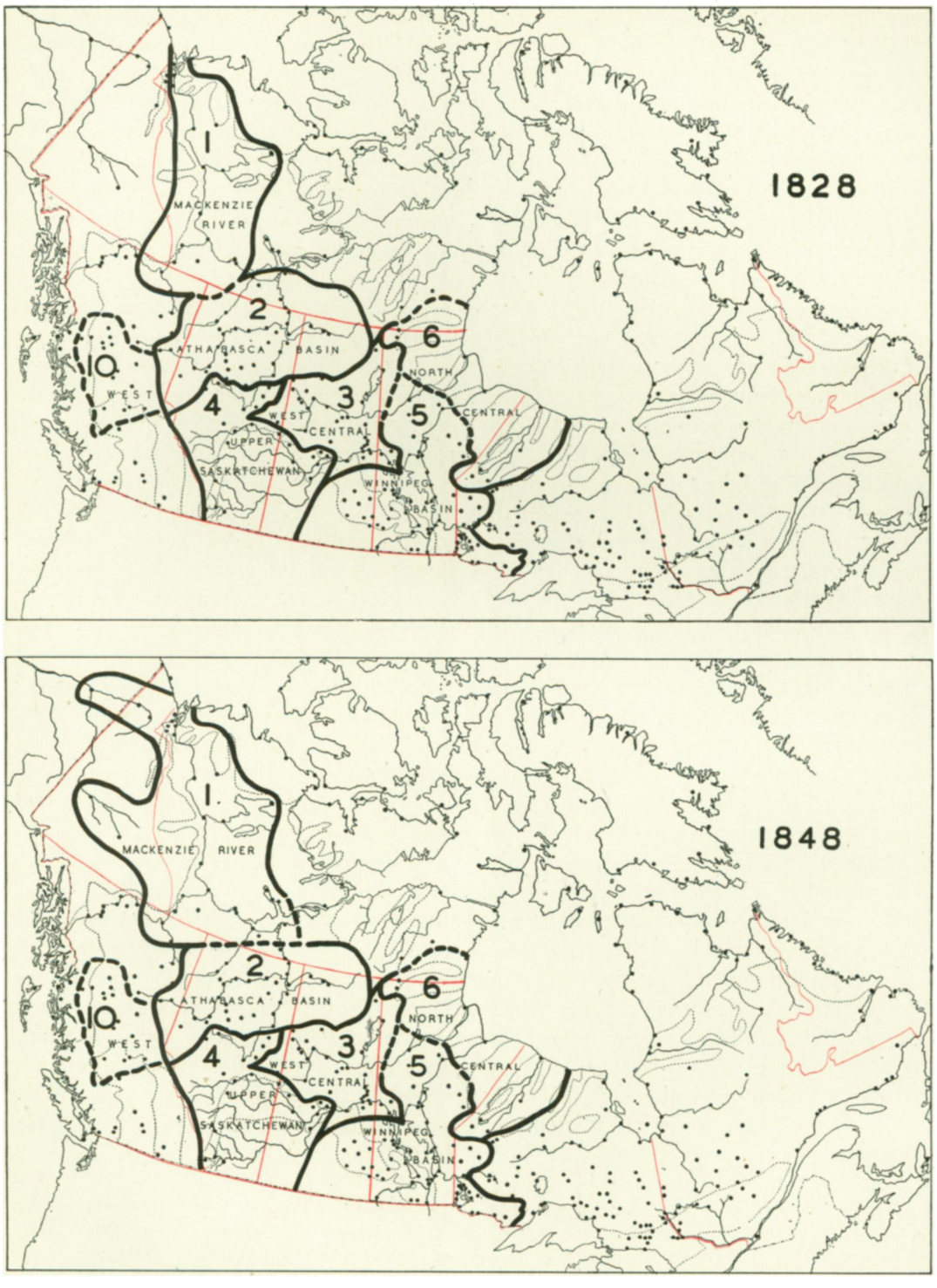
(4) Some guesswork has been inevitable in the case of the outer boundaries of frontier districts. Where we have reason to be doubtful about this or any other conclusion, a broken line has been used.

It must be emphasized that the boundary is not usually a demarcation line in the same sense as a political frontier. Our only claim is that it probably gives a good indication of the area over which the natives sought for furs; but this area, even when the Company's arrangements remained unchanged, must have varied to some extent from year to year, depending (to give only a short list) on the activity of the trappers, their disposition of mind and body, and conditions (such as supplies of game for food, forest fires, winter cold or depth of snow) regulating the direction and distance of their search. There must have been some overlapping between districts, when the Indians of one locality preferred to carry their custom to some other post. In the MacKenzie River District archives, which have been rather fully extracted by us, there is a good deal of information on these topics, notably in E. Smith's description of the district in 1828, which we have drawn upon. Further historical investigation of the huge mass of archives still unanalysed should make it possible to define boundaries more accurately, and make corrections.

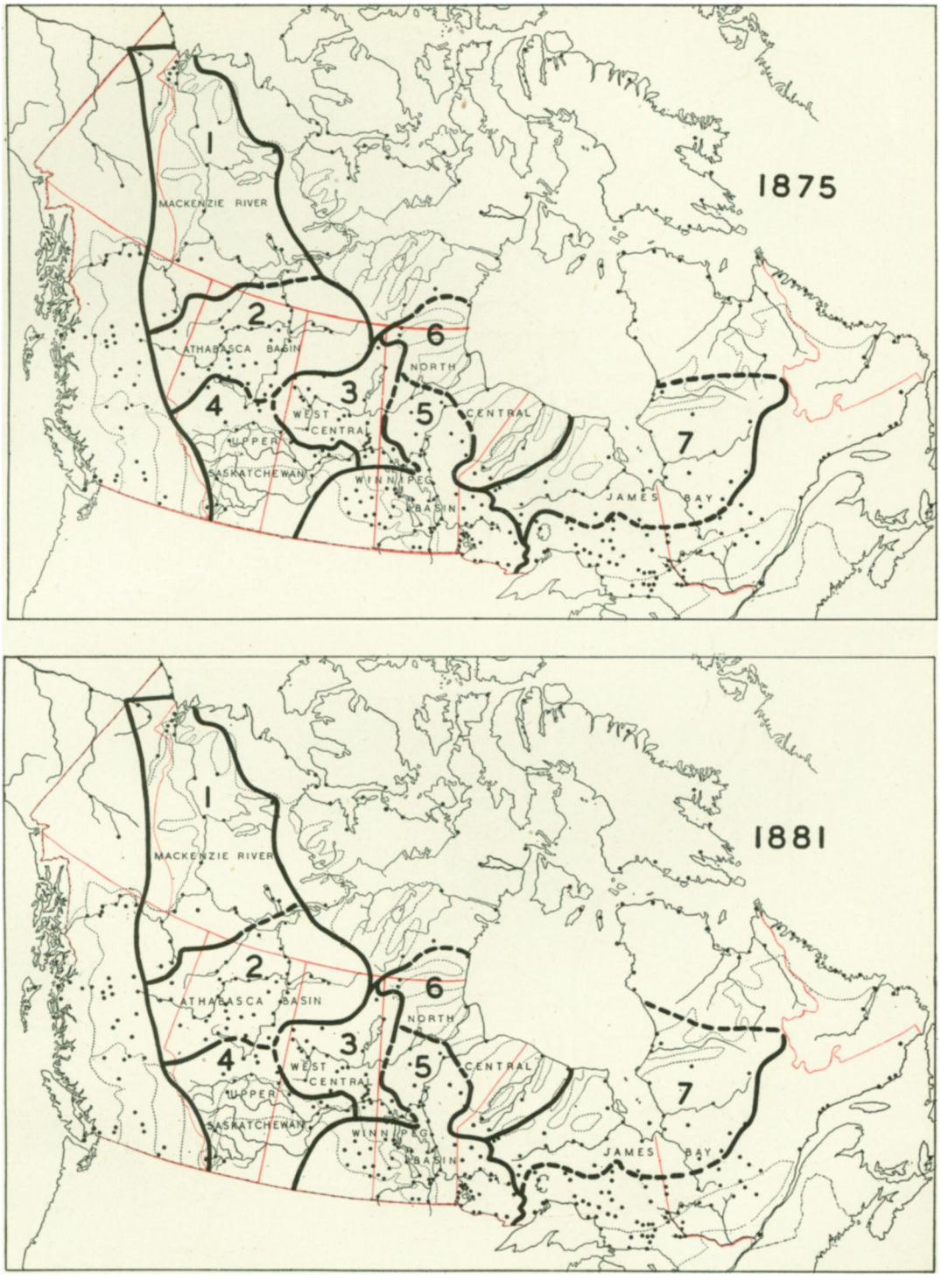
By grouping these districts together, many of the changes in area can be eliminated from consideration, and more or less stable regions obtained. These are shown in Figs. 1–6, and the details of their construction noted in small type below. No maps after 1901 are given: the few changes which were made between 1901 and 1914 are mentioned in the notes; and after 1915, when the returns of every post are available, we have been able to group the figures to correspond with the earlier regions.

As far as possible we have chosen for the regions titles which prevent confusion with the names of Hudson's Bay Company fur-trade districts, or with political provinces. But where the region is identical with the district through all or part of the period (MacKenzie River, James Bay), we have used the district name. Otherwise we have invented short descriptive titles. These are: Athabasca Basin, West Central, Upper Saskatchewan (i.e. River Valley), Winnipeg Basin, North Central, Lakes (i.e. Great Lakes), Gulf (of St Lawrence), West (Central, and later all British Columbia). The exact position of these can easily be seen on the maps, which give political boundaries, main rivers, and main vegetation zones, also the position of the Company's fur posts in 1927. Table 2, in § 4, shows how the available district fur returns have been grouped into these Regions.

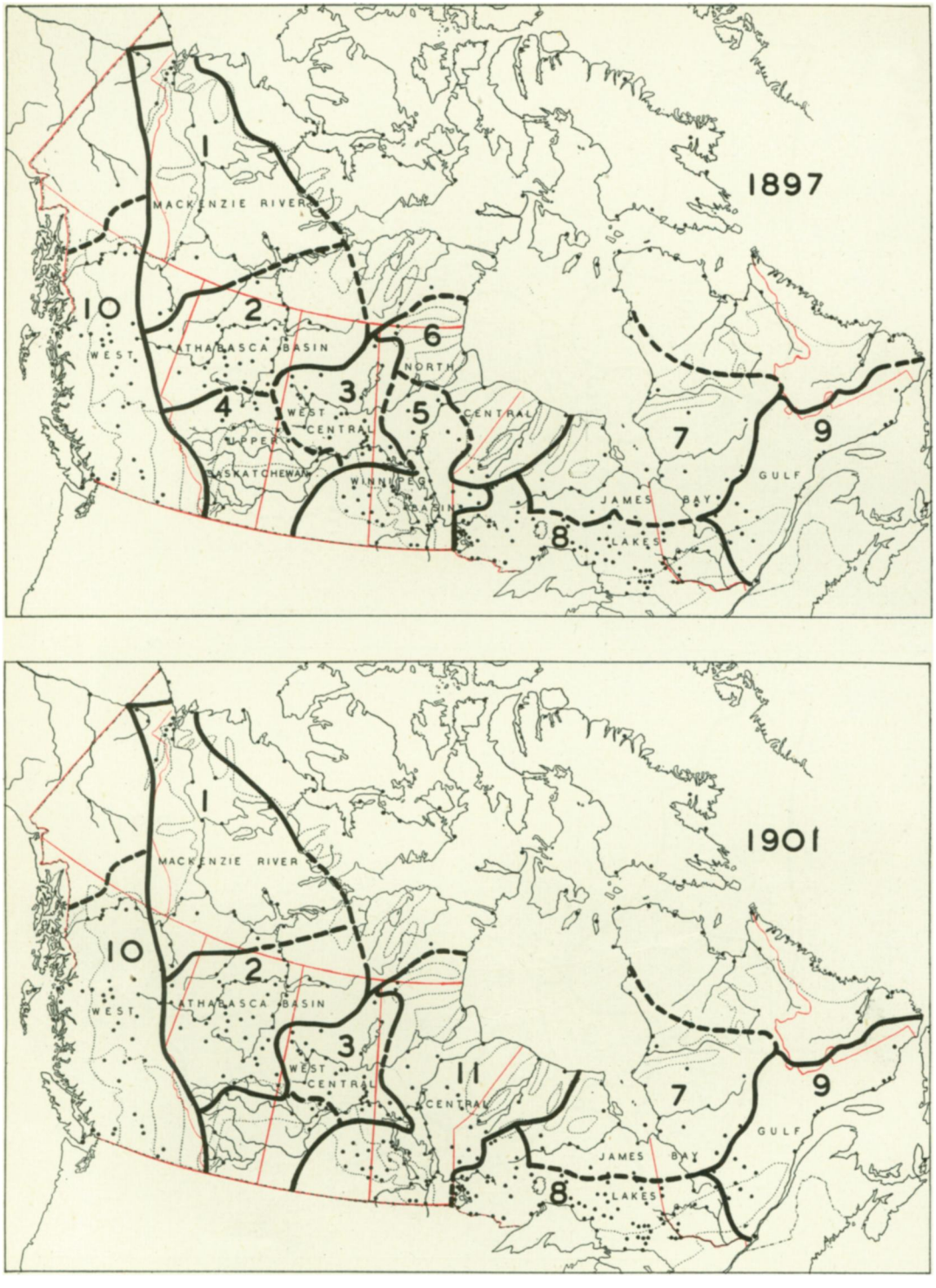
1. *MacKenzie River Region.* This is the Hudson's Bay Company MacKenzie River District from 1821 to 1913. It covered the lower Liard, the Nelson and the MacKenzie River Basins. From 1846 to 1869 it extended into modern Alaska, with Fort Youcon on the forks of the Yukon and Porcupine rivers. At different times between 1842 and 1852 there were posts (Frances Lake, Pelly Banks, and Selkirk) in the southern section of the Yukon. The somewhat vague eastern boundary seems to have moved slowly farther east. Fort Resolution, on the south shore of Great Slave Lake, was sometimes returned under



Figs. 1, 2. Regions formed by the grouping of Fur Trade Districts of the Hudson's Bay Company. Except for James Bay 1881, only those for which lynx fur returns are given have been mapped. Red lines are political boundaries. Thick broken lines are approximate region limits, where little information is available. Thin broken lines define vegetation zones. Small black dots are Hudson's Bay Company posts in 1927.


1875
1
MACKENZIE RIVER
2
ATHABASCA BASIN
3
WEST CENTRAL
4
UPPER SASKATCHEWAN
5
CENTRAL WINNIPEG BASIN
6
NORTH
7
JAMES BAY
1881
1
MACKENZIE RIVER
2
ATHABASCA BASIN
3
WEST CENTRAL
4
UPPER SASKATCHEWAN
5
CENTRAL WINNIPEG BASIN
6
NORTH
7
JAMES BAY

Figs. 3, 4.


1897
MACKENZIE RIVER
1
2
ATHABASCA BASIN
3
WEST CENTRAL
4
UPPER SASKATCHEWAN
5
CENTRAL
6
NORTH
WINNIPEG BASIN
7
8
LAKES
9
GULF
JAMES BAY
10
WEST
1901
MACKENZIE RIVER
1
2
ATHABASCA BASIN
3
WEST CENTRAL
11
CENTRAL
7
8
LAKES
9
GULF
JAMES BAY
10
WEST

Figs. 5, 6.

MacKenzie River District (1843–78, 1899–1928), and sometimes under Athabasca District (1820–42, 1879–98).

In the grouping of the posts into older districts, in the period after 1915, we have used the map for 1901, on which, except for the transfer of Fort Smith from Athabasca District, the region was not altered until 1915.

2. *Athabasca Basin.* This region covered the Peace River Basin down from Fort St Johns and Hudsons Hope, the surroundings of Lake Athabasca, and much of the Athabasca River Basin. For the boundary between it and MacKenzie River Region, see the note above. Fort St Johns was not in operation from 1824 to 1857, which probably reduced the proportion of furs coming from the Upper Peace River. In the south the establishment of Fort MacMurray in 1871 extended the Athabasca District's trade along the upper Athabasca River; and there was further increase towards the south when the post of Lesser Slave Lake was transferred from Saskatchewan District to Peace River District in 1881. In 1899 Athabasca District was reconstituted to include Peace River and Edmonton Districts, thus extending the Athabasca Basin Region again farther into southern Alberta, as far as Onion Lake. There was a slight retraction in 1911, when Onion Lake was put back into Saskatchewan District (part of West Central Region).

For the grouping after 1915, we have used the 1901 map.

3. *West Central.* Most of this region lies in the basin of the Upper Churchill River, from Lac du Brochet and the Manitoba border on the east, to the Alberta border on the west. It also includes the lower stretch of the Saskatchewan River, from below Prince Albert down to Lake Winnipeg. In the early years the immediate north-west shore of Lake Winnipeg came under Norway House District, included in our Winnipeg Basin Region, but after the establishment of Grand Rapids post in 1865 it was in Cumberland District. The boundary with Upper Saskatchewan Region was shifted from time to time by the transfer and retransfer of Fort á la Corne, which was in Cumberland District (West Central Region) in 1853, 1857–73, and from 1892 onwards, but in Saskatchewan District (Upper Saskatchewan Region) in 1874–91. Moose Woods post, operating from 1859 to 1875, went with it.

For the grouping after 1915, we have used the 1901 map, the only transfer between 1901 and 1914 having been Onion Lake post.

4. *Upper Saskatchewan.* This covered the drainage basin of the Saskatchewan River and its tributaries as far down as Prince Albert, and for some years Fort á la Corne (see above). The series cannot be continued after 1898, when Edmonton District was incorporated in the Athabasca District, leaving no other posts in operation.

5. *Winnipeg Basin.* This rather complex grouping of districts covered the whole of the (Canadian) basin draining into Lake Winnipeg, not including the Saskatchewan River Basin, but including also the outlet of Lake Winnipeg through the upper Nelson River. The western boundary was stable, except for the smallish area on the north-west shore of Lake Winnipeg, noted under West Central Region. The boundary with North Central was stable. The area covered in Ontario varied with the development of the Lac la Pluie District. Lac Seul post was put into it from Albany District (James Bay Region) by 1870. After 1892, when Osnaburgh was similarly transferred, it seemed better to include Lac la Pluie under Lakes Region. For the four years 1897–1900 therefore Winnipeg Basin Region included no Ontario posts; only Little Grand Rapids on the Manitoba border may have received some Ontario-caught furs.

For 1901–10 no comparable series of figures is available, because of the amalgamation of Norway House and York Districts as Keewatin District. To give some indication of what was going on in the Winnipeg Basin and North Central Regions during this period, we have made a combined Central Region, which includes Keewatin, Manitoba and Winnipeg Districts, and covers roughly both regions. After 1911, when Nelson River District, which corresponds almost exactly with our North Central Region, was split off from Keewatin District, the group Keewatin-Winnipeg Districts can again be used as comparable with the earlier Winnipeg Basin Region. But it should be noted that, as in Alberta, the contribution from the south was decreasing with the settlement of the country, and that 1911 was the last year when any returns came in from the Manitoba District posts. Weenusk post was included after 1907, extending the region somewhat south along Hudson Bay.

As Winnipeg Basin does not show separately on the 1901 map, we have used the 1897 map (which also applies to 1900) as a basis for the grouping of posts after 1915.

6. *North Central.* This region covered the coastal districts of Manitoba on Hudson Bay, probably extending into what are now the North-west Territories in the north, and to the south including the Severn River Basin in Ontario, with Severn post at the mouth from 1821, and Trout Lake on its upper waters from 1834. From 1829 to 1830 inclusive, Severn post was abandoned as unprofitable; but some Indians may have made their way either to York Factory, or Island Lake (Winnipeg Basin Region). There is a gap from 1901 to 1910, discussed under Winnipeg Basin Region. The new District of Nelson River, started in 1911 (and utterly different from the old Nelson River District), covered roughly the same area as North Central. Its extension northwards by the inclusion of the new post at Chesterfield Inlet in 1911 cannot have affected the lynx collection, as this is Subarctic country.

The 1897 map has been used as basis for the grouping after 1915.

7. *James Bay.* This region covered the area draining into James Bay, except for the headwaters of rivers running from the south. It gradually extended up the Hudson Bay coast of Quebec, on which Great Whale River post was established in 1854. It became reduced in Ontario by the transfer of Lac Seul post to Lac la Pluie District some time between 1857 and 1870, and of Osnaburgh post in 1892, and Fort Hope post to Lake Superior District in 1910.

We have used the 1901 map as basis for the grouping after 1915.

8. *Lakes.* This region included all the Ontario posts not disposed of between Winnipeg Basin Region and James Bay Region, also the upper basins of the Temiscamingue and Gatineau Rivers in Quebec. The early periods, for which we have fur returns (1852–62, 1887–90), fall between the dates of our regional maps, but the component districts are listed in Table 3. The accounts gave no returns for Lake Huron District, 1857–62, and it is uncertain whether it remained in Lakes Region and was included in another district or not. (It might have gone into Montreal Department for 1857–62, but we have no material for checking this.) The region probably remained the same in 1887–90.

9. *Gulf.* From 1886 this region covered the rivers flowing into the north side of the St Lawrence from about Montreal in the west to the height of land between Natashquan River and Hamilton River in Labrador. The northern boundary did not strictly follow the watershed, as it included the headwater of the Nottaway River flowing into James Bay, and excluding Misstassiny post. Montreal Department, 1839–52, must have covered much the same area, except that it included Esquimaux Bay District on the Labrador coast. Our knowledge of adjoining districts shows that the western and north-western boundary of Montreal Department roughly corresponds with the later outline of Gulf Region. So we have used these figures, but do not show Gulf Region on the 1848 map, because we have no means of plotting the districts exactly.

10. *West.* Through the first half of the nineteenth century this region was the same as New Caledonia District, which covered the upper Skeena River, and the Fraser River and its tributaries above Fort Alexandria. For the period 1857–96 inclusive we have no fur returns and have not gone into the history of the area. From 1897 we have used a much larger area for this region, but the northern extension (which included a part of the Yukon) is the chief important addition, as the coast and southern British Columbia are not good lynx country.

4. Fur returns since 1821

With two exceptions, noted below, all figures from 1821 to 1913 have been obtained from the London archives of the Hudson's Bay Company; and those for 1915–39 are from detailed statements supplied by the Company's Fur Trade Department in Winnipeg. The figures for MacKenzie River Region, 1892–6 and 1914, are from a series of returns for the MacKenzie River District, 1863–1927, which was supplied to Elton in 1928 by Mr Charles French, then Fur Trade Commissioner of the Company in Canada, who said that they were obtained from private records kept by some of the older fur-trade factors. The series for New Caledonia 1825–56 is from a manuscript 'Skinbook' (now in the Provincial Library, British Columbia) kept by James Douglas, a famous chief factor of the Hudson's Bay Company. This book also gives returns, over the same period, for the posts in Columbia District. Our attention was first drawn to it through the paper by

Dr Ian McT. Cowan (1938), who kindly put us in touch with the Provincial Archivist. As will be seen in § 6, these western fur returns are of particular importance from a theoretical point of view.

Table 3. *Hudson's Bay Company fur returns: grouping of returns into regional returns*, 1821–1913

Region	Districts or Fur Purchasing Agencies
1. MacKenzie River	MacKenzie River, 1821–1914
2. Athabasca Basin	Athabasca, 1821–91, 1897–1913 Peace River, 1878–98
3. West Central	English River, 1821–91, 1897–8 Cumberland, 1821–91, 1897–1900 Saskatchewan, 1901–13 Grand Rapids, 1877–82
4. Upper Saskatchewan	Saskatchewan, 1821–91, 1897–8 Edmonton, 1874–91, 1897–8 Battleford Fur Purchasing Agency, 1897 Prince Albert Fur Purchasing Agency, 1897–8
5. Winnipeg Basin	Nelson River, 1821–36 Island Lake, Swan River, Lac la Pluie, 1821–91 Norway House, 1821–91, 1897–1900 Red River, 1821–88 Winnipeg, 1821–31, 1889–91, 1897–1900, 1911–13 Manitoba, 1875–91, 1897–1900 Lake Winnipeg, 1889–91 Keewatin, 1911–13
6. North Central	Churchill, 1821–86 York, 1821–91, 1897–1900 Severn, 1821–8, 1831–86 Trout Lake, 1834–86 Nelson River, 1911–13
7. James Bay	Albany, Ruperts River, Moose, 1852–62, 1865–75, 1895–1900 Eastmain, 1854–62, 1865–75, 1895–1900 James Bay, 1901–13
8. Lakes	Abitibi and New Brunswick, 1852–62, 1865–75, 1887–90 Kinogumissee, 1852–62, 1865–75, 1889–90 Temiscamingue, 1852–62, 1887–90, 1897–1900 Grand Lac, Pic, Long Lake, Fort William, 1852–6 Michipicoten, Nipigon, 1852–6, 1887–90 Saulte Ste Marie, 1852–62 Lake Huron, 1852–6, 1887–90, 1897–9, 1901–13 Lake Superior, 1857–65, 1897–1913 Lac la Pluie, 1897–9 Mattawa Fur Purchasing Agency, 1897–9 Rat Portage Fur Purchasing Agency, 1897–1902
9. Gulf	Montreal Department, 1839–52 St Maurice and Saguenay, 1897–1900, 1912–13 Montreal Fur Purchasing Agency, Bersimis and Mingan, 1897–1900 St Lawrence, 1901–13
10. West	New Caledonia, 1825–56, 1897–1900 Cariboo and Port Simpson, 1897–1900 Victoria Fur Purchasing Agency, 1897–1907 Kamloops Fur Purchasing Agency, 1897 British Columbia, 1901–13
11. Central	Winnipeg, 1901–2, 1905–8 Manitoba, Keewatin, 1901–10

For certain dates, independent versions of the MacKenzie River District and Athabasca District fur returns are available in the Post and District Account Books, sometimes in the form of detailed post returns, and sometimes as a District total. Since the series compiled from these sources is incomplete, it is impossible to make a systematic comparison between them and those from the Department Account Books, but they agree fairly well.

Table 4. *Lynx fur returns, Hudson's Bay Company, grouped into regions*

		Northern Department									
	West	Mac-Kenzie River	Atha-basca Basin	West Central	Upper Saskat-chewan	Winni-peg Basin	North Central	Total	James Bay	Lakes	Gulf
1821	—	269	62	135	276	4,059	48	4,849	—	—	—
1822	—	321	65	101	192	2,385	67	3,131	—	—	—
1823	—	585	25	128	116	2,208	68	3,130	—	—	—
1824	—	871	62	61	83	1,563	61	2,701	—	—	—
1825	171	1,475	106	66	33	872	58	2,610	—	—	—
1826	212	2,821	337	157	171	1,510	80	5,076	—	—	—
1827	737	3,928	1,295	457	256	1,572	19	7,527	—	—	—
1828	899	5,943	2,942	1,461	1,666	4,417	211	16,640	—	—	—
1829	1,238	4,950	2,338	2,650	2,863	10,271	1,030	24,103	—	—	—
1830	1,148	2,577	849	1,777	2,184	14,135	1,260	22,782	—	—	—
1831	96	523	64	894	826	6,676	439	9,422	—	—	—
1832	95	98	51	629	351	3,341	149	4,619	—	—	—
1833	170	184	23	293	150	2,436	30	3,116	—	—	—
1834	324	279	336	291	365	2,420	83	3,894	—	—	—
1835	282	409	711	411	1,132	3,034	180	6,311	—	—	—
1836	2,071	2,285	2,548	945	4,177	7,141	360	18,941	—	—	—
1837	3,491	2,685	4,453	1,830	10,008	14,168	565	34,744	—	—	—
1838	4,246	3,409	4,971	2,865	15,975	24,788	309	53,700	—	—	—
1839	2,673	1,824	1,148	4,244	9,158	23,572	584	42,256	—	—	191
1840	857	409	261	1,361	1,441	11,670	342	15,484	—	—	285
1841	127	151	27	427	116	3,033	158	3,912	—	—	312
1842	43	45	37	178	96	1,867	105	2,328	—	—	328
1843	64	68	179	206	186	2,226	70	2,935	—	—	203
1844	67	213	570	988	234	3,874	24	5,903	—	—	252
1845	223	546	1,714	3,016	1,741	7,063	33	14,113	—	—	258
1846	427	1,033	3,026	5,214	3,211	9,082	271	21,837	—	—	412
1847	443	2,129	4,365	6,378	11,705	10,610	755	35,942	—	—	485
1848	1,119	2,536	638	2,055	7,960	14,408	1,056	28,653	—	—	670
1849	1,080	957	86	775	1,075	3,823	589	7,303	—	—	723
1850	227	361	69	211	235	1,007	279	2,162	—	—	497
1851	185	377	45	77	112	649	126	1,386	—	—	242
1852	184	225	58	100	69	658	84	1,194	1,207	967	576
1853	420	360	4	178	109	852	37	1,540	1,282	824	—
1854	826	731	355	516	233	3,210	94	5,139	1,961	1,060	—
1855	1,512	1,638	633	1,347	518	8,668	258	13,062	2,889	1,865	—
1856	2,657	2,725	901	1,648	1,109	9,334	749	16,466	4,439	2,885	—
1857	—	2,871	1,154	1,349	2,088	17,144	786	25,392	4,397	3,800	—
1858	—	2,119	547	1,034	2,018	7,718	550	13,986	3,029	3,884	—
1859	—	684	154	641	2,255	4,372	364	8,470	1,803	2,969	—
1860	—	299	114	236	692	1,846	204	3,391	779	1,604	—
1861	—	236	92	93	186	992	64	1,663	447	1,093	—
1862	—	245	152	121	131	827	10	1,486	362	1,146	—
1863	—	552	307	430	165	1,385	82	2,921	—	—	—
1864	—	1,623	1,947	1,498	966	3,377	118	9,529	—	—	—
1865	—	3,311	3,511	6,138	4,185	9,743	163	27,051	1,352	—	—
1866	—	6,721	1,756	12,584	14,671	21,096	448	57,576	1,876	—	—
1867	—	4,245	1,432	7,940	11,258	23,588	1,045	49,508	2,641	—	—
1868	—	687	1,057	2,527	4,860	15,363	1,102	25,596	2,337	—	—
1869	—	255	375	1,181	1,589	4,780	420	8,600	778	—	—
1870	—	473	146	484	762	2,252	141	4,258	349	—	—
1871	—	358	125	101	366	701	61	1,712	279	—	—
1872	—	784	368	243	285	712	83	2,475	339	—	—
1873	—	1,594	930	556	819	1,834	125	5,858	482	—	—
1874	—	1,676	1,902	1,381	1,152	3,578	412	10,101	569	—	—
1875	—	2,251	3,006	4,117	8,857	7,235	282	25,748	883	—	—
1876	—	1,426	1,500	4,137	6,850	14,523	349	28,785	—	—	—
1877	—	756	810	2,856	3,865	12,126	320	20,733	—	—	—
1878	—	299	451	1,192	1,986	6,429	193	10,550	—	—	—
1879	—	201	401	788	1,370	7,072	116	9,948	—	—	—
1880	—	229	202	195	698	3,153	63	4,540	—	—	—
1881	—	469	851	214	282	1,318	84	3,218	—	—	—
1882	—	736	1,726	699	128	1,560	86	4,935	—	—	—
1883	—	2,042	5,736	3,015	1,161	3,587	110	15,651	—	—	—
1884	—	2,811	12,882	9,580	6,336	10,331	145	42,085	—	—	—

Table 4 (*continued*)

		Northern Department									
	West	Mac-Kenzie River	Atha-basca Basin	West Central	Upper Saskat-chewan	Winni-peg Basin	North Central	Total	James Bay	Lakes	Gulf
1885	—	4,431	14,566	12,644	16,615	15,097	298	63,651	—	—	—
1886	—	2,511	5,900	10,928	15,774	26,636	933	62,682	—	—	—
1887	—	389	1,279	3,600	6,623	19,522	545	31,958	—	2,835	995
1888	—	73	435	731	3,153	10,399	320	15,111	—	2,956	1,151
1889	—	39	89	189	486	5,618	236	6,657	—	3,185	1,261
1890	—	49	391	137	540	2,055	85	3,257	—	2,581	710
1891	—	59	667	345	1,396	1,396	35	3,898	—	—	—
1892	—	188	—	—	—	—	—	—	—	—	—
1893	—	377	—	—	—	—	—	—	—	—	—
1894	—	1,292	—	—	—	—	—	—	—	—	—
1895	—	4,031	—	—	—	—	—	—	1,344	—	—
1896	—	3,495	—	—	—	—	—	—	2,149	—	—
1897	900	587	1,952	3,511	1,227	7,252	390	14,919	2,190	3,703	970
1898	529	105	862	959	1,183	3,399	376	6,884	1,374	2,896	1,618
1899	480	153	355	148	—	1,303	111	2,070	496	1,573	1,776
1900	618	387	612	313	—	1,172	53	2,537	371	1,453	727

		Northern Department									
	West	Mac-Kenzie River	Atha-basca Basin	West Central	Winni-peg Basin	Central	North Central	Total	James Bay	Lakes	Gulf
1901	709	758	1,106	1,166	—	1,518	—	4,548	373	1,159	302
1902	1,757	1,307	5,150	3,063	—	3,993	—	13,513	615	1,657	365
1903	1,729	3,465	11,629	5,255	—	6,392	—	26,741	687	1,648	729
1904	2,619	6,991	21,761	7,749	—	10,438	—	46,939	1,182	2,162	617
1905	5,540	6,313	29,832	5,297	—	12,385	—	53,827	1,441	3,313	818
1906	4,299	3,794	16,276	2,767	—	6,600	—	29,437	1,844	2,623	856
1907	1,908	1,836	2,043	1,037	—	2,532	—	7,448	701	1,922	710
1908	560	345	254	326	—	816	—	1,741	258	913	504
1909	194	382	421	554	—	545	—	1,902	183	614	258
1910	409	808	1,204	1,594	—	718	—	4,324	195	989	465
1911	648	1,388	3,091	3,267	2,257	—	64	10,067	249	1,189	657
1912	1,537	2,713	5,326	3,400	2,165	—	77	13,681	420	1,132	540
1913	1,624	3,800	8,242	4,218	2,755	—	38	19,053	940	2,009	161
1914	—	3,091	—	—	—	—	—	—	—	—	—
1915	1,790	2,985	1,813	1,118	1,188	—	479	7,583	2,771	1,471	187
1916	1,710	3,790	1,864	1,557	1,232	—	408	8,851	2,442	2,222	513
1917	731	674	652	387	542	—	232	2,487	863	1,026	475
1918	327	81	239	338	234	—	64	956	380	342	173
1919	170	80	415	420	126	—	15	1,056	112	205	108
1920	192	108	1,013	609	179	—	9	1,918	70	217	95
1921	429	229	1,892	958	404	—	91	3,574	126	254	157
1922	687	399	2,400	819	650	—	112	4,380	392	370	130
1923	1,035	1,132	3,944	1,112	1,196	—	289	7,673	623	844	388
1924	1,337	2,432	3,555	490	733	—	108	7,318	882	1,022	646
1925	1,807	3,574	3,566	792	1,168	—	159	9,259	1,148	1,881	1,476
1926	1,539	2,935	2,227	567	1,170	—	179	7,078	801	2,377	1,027
1927	1,017	1,537	1,652	356	688	—	149	4,382	378	1,428	519
1928	823	529	1,345	353	375	—	122	2,724	157	507	186
1929	363	485	1,058	285	374	—	172	2,374	86	263	159
1930	274	662	1,274	398	395	—	159	2,888	75	213	81
1931	261	1,000	1,387	254	462	—	256	3,359	180	395	157
1932	292	1,590	1,877	526	450	—	333	4,776	408	523	282
1933	425	2,657	2,391	699	569	—	504	6,821	688	577	310
1934	499	3,396	2,084	699	828	—	446	7,453	967	725	478
1935	—	—	—	—	—	—	203	—	1,291	570	566
1936	—	—	—	—	—	—	110	—	870	382	741
1937	—	—	—	—	—	—	43	—	370	221	354
1938	—	—	—	—	—	—	23	—	247	198	136
1939	—	—	—	—	—	—	37	—	149	194	111

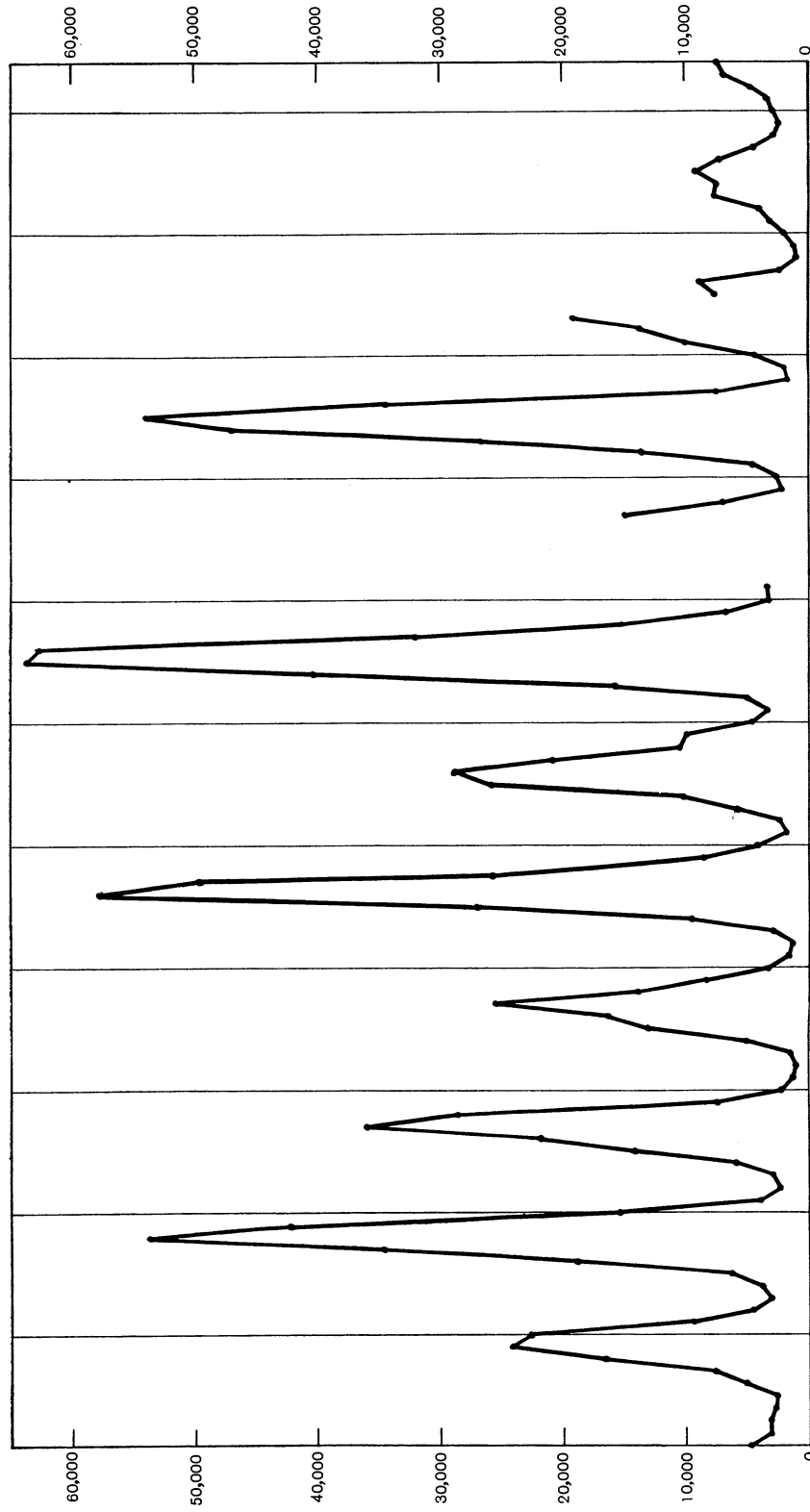


Fig. 7. Lynx fur returns of the Northern Department, Hudson's Bay Company, 1821–1913, and of equivalent area 1915–34.

Some discrepancies, perhaps due to loss of damaged furs or errors in accounting or copying, are to be expected and do occur, but are not large enough to reverse the trend of the fluctuations, except in three cases. In two of these—MacKenzie River District, 1862 and 1866, where the Northern Department Accounts show returns of 3 and 2502 skins respectively—we have used instead the figures 245 and 6721 given in the District Account Books, which are satisfactorily confirmed by the detailed return for posts, and (1866 only) by Mr French's list. In the third case—Athabasca, 1838—we have not used the figure from the District Accounts (3831), because it is only a total, not supported by details of post returns, and because the total for the whole of the Northern Department is available for that year, and confirms the figure for Athabasca in the Department Accounts. For 1871, the Northern Department Accounts do not give any lynx for Athabasca, so we have used the total for the five Athabasca District posts, for which we have the returns for this Outfit.

The returns of the Fur Purchasing Agencies, or Saleshops, which may sometimes have handled furs from considerable distances, cannot be taken as an accurate record of local trapping. But it seems likely that the main bulk of furs traded would have come in through the centre most easily accessible, and we have therefore included agency figures in the appropriate regions, with the exception of Vancouver, which is believed to have handled Alaska furs mainly. St Johns, in Newfoundland, dealt chiefly in Labrador furs, and is omitted. Prince Albert from 1899 onward, Calgary and Saskatoon are also omitted, as they are in Upper Saskatchewan Region, for which we have no other figures after 1898 (see § 3).

The grouping of District and Fur Purchasing Agency returns into regions is shown in Table 3, and the returns themselves are in Table 4 and Figs. 7–9.

5. FUR RETURNS BEFORE 1821

A continuous record of the Hudson's Bay Company's London sales of lynx furs can be constructed, back as far as the sale year of 1736. In these early days the furs were sold at the Autumn Sales in the year they arrived, i.e. normally the Outfit after they were caught. In some years these 'Autumn Sales' included furs sold in the following January and February. Later in the eighteenth century there were also 'Spring Sales' in March. These differences have been taken into account in collating the figures, which for simplicity are described here in terms of the Outfit in which they are presumed to have been caught. There are two sources of figures, which overlap in time but show slight differences. We have extracted the original sale books for Outfits 1735–86 and 1794–9. For 1735–78 and 1786 there are 'fur marks' that record the lots from separate posts. There is also a published series of sales figures in Poland (1892), dated by him 1752–1821, obviously corresponding to Outfits 1751–1820. Both sets of figures are given in Table 5 and a composite curve in Fig. 10. The differences in most years are of the same order as those in the nineteenth-century figures, and presumably of the same nature. There is some anomaly in his year 1809, when the numbers of all species except beaver show an extraordinary drop followed by a rise to an unusual level in the following year. We conclude that either many of the furs were delayed in transit and sold a year late, or that a mistake in transcription was made.

In 1736 the Company had only six posts: Churchill River, York Factory, Severn River, Albany River, Moose River and Eastmain, all on Hudson Bay and James Bay. We

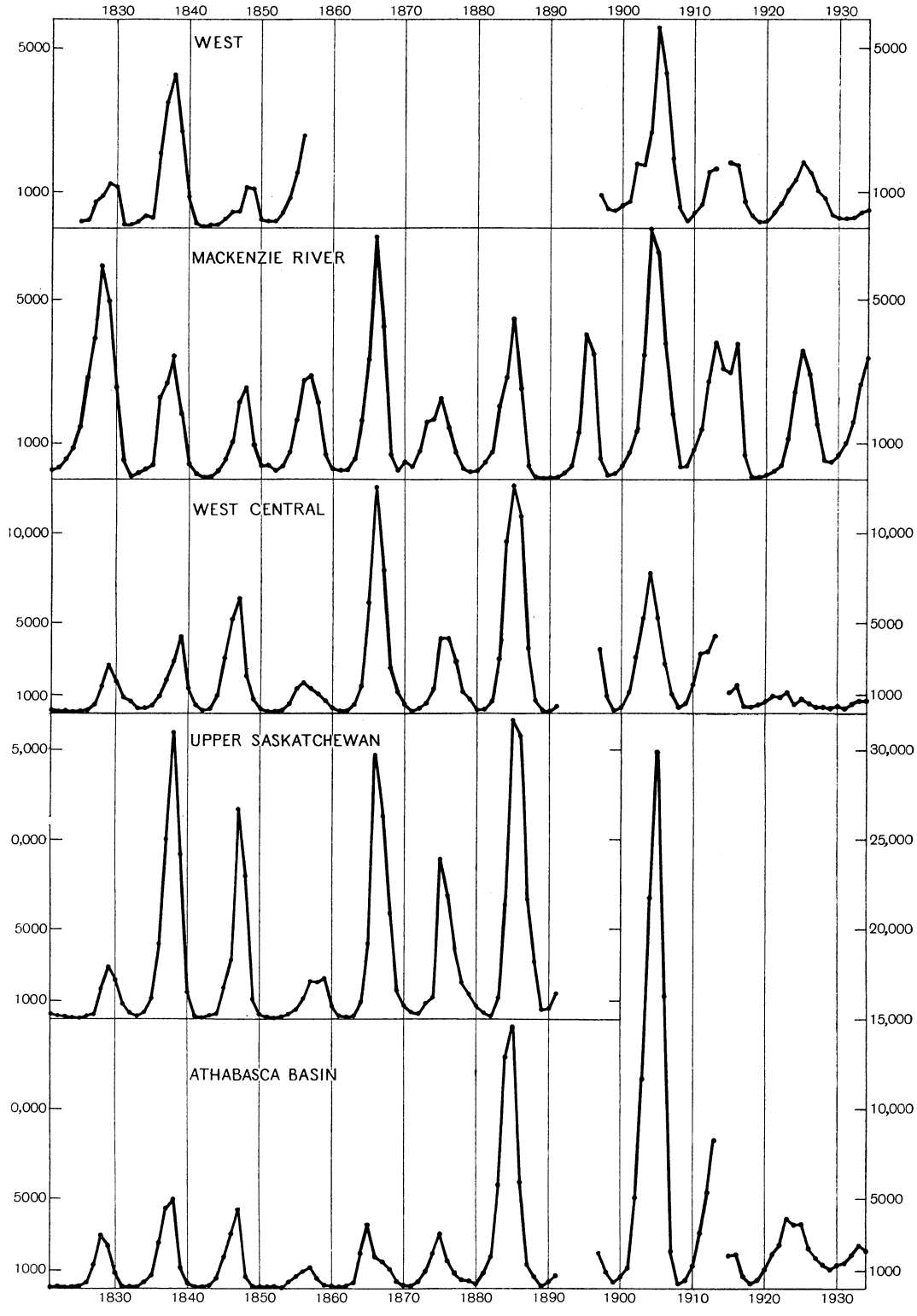


Fig. 8. Lynx fur returns of the Hudson's Bay Company, grouped into regions (West, MacKenzie River, West Central, Upper Saskatchewan, Athabasca Basin).

naturally wish to know from what area the furs were drawn, in order to be able to make comparisons with the nineteenth century and modern figures. Unfortunately, it is not easy to discover this from the historical material immediately accessible, and only a few

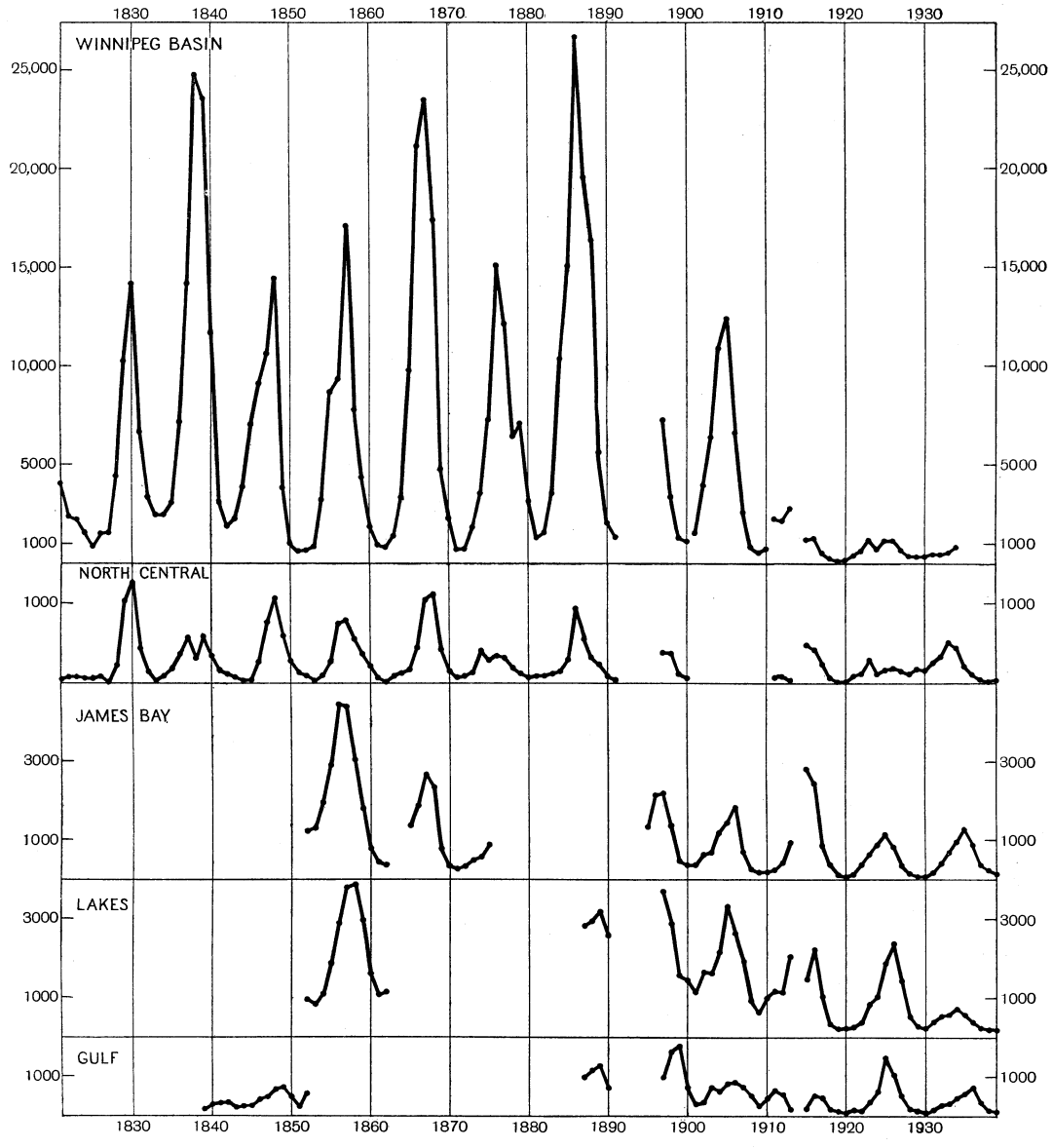


Fig. 9. Lynx fur returns of the Hudson's Bay Company, grouped into regions (Winnipeg Basin, North Central, James Bay, Lakes, Gulf).

general indications can be given, mainly based on Morton's *History* and on Innis (1930). Up to 1731 the Company had a good system of obtaining furs from inland. 'Trading Indians—with the furs of Lake of the Woods, of the valley of the Winnipeg River, and the southern basins of lakes Winnipeg and Winnipegosis—took the waterway up the

Table 5. *Hudson's Bay Company lynx sales, Outfits* 1735–1820

Outfit	Original Account Books: Churchill River	York Factory	Albany River	Moose River	Richmond Fort	Total	Poland (1892)
1735	97	1070	686	105	—	1958	—
1736	155	989	250	70	—	1464	—
1737	80	603	387	41	—	1111	—
1738	215	390	234	60	—	899	—
1739	67	280	328	65	—	740	—
1740	95	457	388	50	—	990	—
1741	132	761	227	44	—	1164	—
1742	344	640	85	50	—	1119	—
1743	365	629	395	55	—	1444	—
1744	113	930	180	187	—	1410	—
1745	82	1027	172	118	—	1399	—
1746	256	585	168	13	—	1022	—
1747	289	801	354	255	—	1699	—
1748	177	911	469	203	—	1760	—
1749	507	1096	258	86	—	1947	—
1750	584	1791	380	90	1	2846	—
1751	700	3018	206	86	—	4010	4009
1752	1371	3488	370	129	1	5359	7179
1753	1378	2329	293	196	1	4197	4198
1754	553	550	116	187	4	1410	1444
1755	218	543	75	120	—	956	838
1756	225	298	7	—	—	530	631
1757	205	538	133	42	—	918	917
1758	644	733	270	89	2	1738	1881
1759	532	2246	960	104	—	3842	3842
1760	1252	2831	1070	143	—	5296	5338
1761	590	3675	1438	117	—	5820	5820
1762	1196	4164	497	160	—	6017	6000
1763	171	1754	736	231	—	2892	3005
1764	208	806	604	141	—	1759	1771
1765	175	494	377	92	—	1138	1138
1766	170	469	368	79	—	1086	1088
1767	145	638	305	41	—	1129	1128
1768	215	1904	319	69	—	2507	2508
1769	1205	2385	512	2	—	4104	4012
1770	1297	2290	708	34	—	4329	4225
1771	2311	2475	594	91	—	5471	5463
1772	624	1314	221	140	—	2299	2301
1773	956	405	263	103	—	1727	1744
1774	38	314	182	173	—	707	705
1775	88	542	285	252	—	1167	1157
1776	300	1573	379	483	—	2735	2823
1777	228	1654	389	477	—	2748	2478
1778	628	?	341	282	—	?	1245
1779	—	—	—	—	—	2619	3168
1780	—	—	—	—	—	2950	2966
1781	—	—	—	—	—	1652	1553
1782	—	—	—	—	—	980	960
1783	—	—	—	—	—	993	980
1784	—	—	—	—	—	834	822
1785	—	—	—	—	Eastmain	758	801
1786	28	577	309	137	38	1089	1080
1787	—	—	—	—	—	—	2050
1788	—	—	—	—	—	—	1550
1789	—	—	—	—	—	—	970
1790	—	—	—	—	—	—	1603
1791	—	—	—	—	—	—	1400
1792	—	—	—	—	—	—	1546
1793	—	—	—	—	—	—	989
1794	—	—	—	—	—	1092	1102
1795	—	—	—	—	—	1160	1149
1796	—	—	—	—	—	1307	1625
1797	—	—	—	—	—	1471	1541
1798	—	—	—	—	—	2878	2269
1799	—	—	—	—	—	3732	3708
1800	—	—	—	—	—	—	4495

Table 5 (*continued*)

Outfit	Poland (1892)
1801	3658
1802	2083
1803	1091
1804	820
1805	1052
1806	1588
1807	2788
1808	277
1809	7029
1810	2593
1811	1884
1812	167
1813	122
1814	131
1815	116
1816	347
1817	845
1818	1533
1819	2901
1820	4128

English River, an easterly tributary of the Winnipeg, into the Albany River and so to Albany Fort' (Morton, p. 206). Other bands went down the Nelson River to York Factory. Innis says (p. 143): 'Trade from York Factory to the interior was rapidly developed after 1713, with no competition from the French in the interior. The Assiniboines and Crees were obliged, as in Kelsey's time, to depend upon Hudson Bay for a supply of European goods, and they became middlemen trading between the Plains Indians, who had no knowledge of canoes, and the post at the mouth of the Nelson River.'

The territory tapped by the Company's posts in 1731 was therefore contained within regions 5, 6 and 7 (Winnipeg Basin, North Central and James Bay) of the 1881 map (Fig. 4), with a further extension westwards which cannot be assessed. To the south and east, the French traders still had a monopoly. After 1734, the French under La Vérendrye began a strong drive to capture the inland trade of the Hudson's Bay Company, and were partly successful for fifteen years. In 1743 the Company set up Henley House as a protective outpost of Albany inland, but Morton states (p. 228) that this was not primarily a fur-collecting post. From 1749 onwards the Company's men, under A. Henday especially, began to regain the inland trade. By 1760 the French had abandoned all their Saskatchewan posts. The extension northwards on the east side of Hudson Bay, with the establishment of Richmond Fort from 1749 to 1759, caused a temporary though relatively slight addition to the lynx catch. It was not until 1774 that the Company's inland forays to Central Canada were crystallized into a permanent trading organization by the establishment of Cumberland House on the lower Saskatchewan River. From here furs were taken down the Nelson River to York Factory. From this time onwards there was a rapid extension. This period saw the intense duplication of fur trading resulting from competition with the North-West Company, which was ended in 1820 by the amalgamation of the two concerns under the Hudson's Bay Company's name. By that date their combined trade covered all the non-Arctic regions of Canada, except for northern Quebec, the Yukon, parts of British Columbia, and the outer zones of the MacKenzie River Basin. From 1821 onwards for a number of years there was the unified

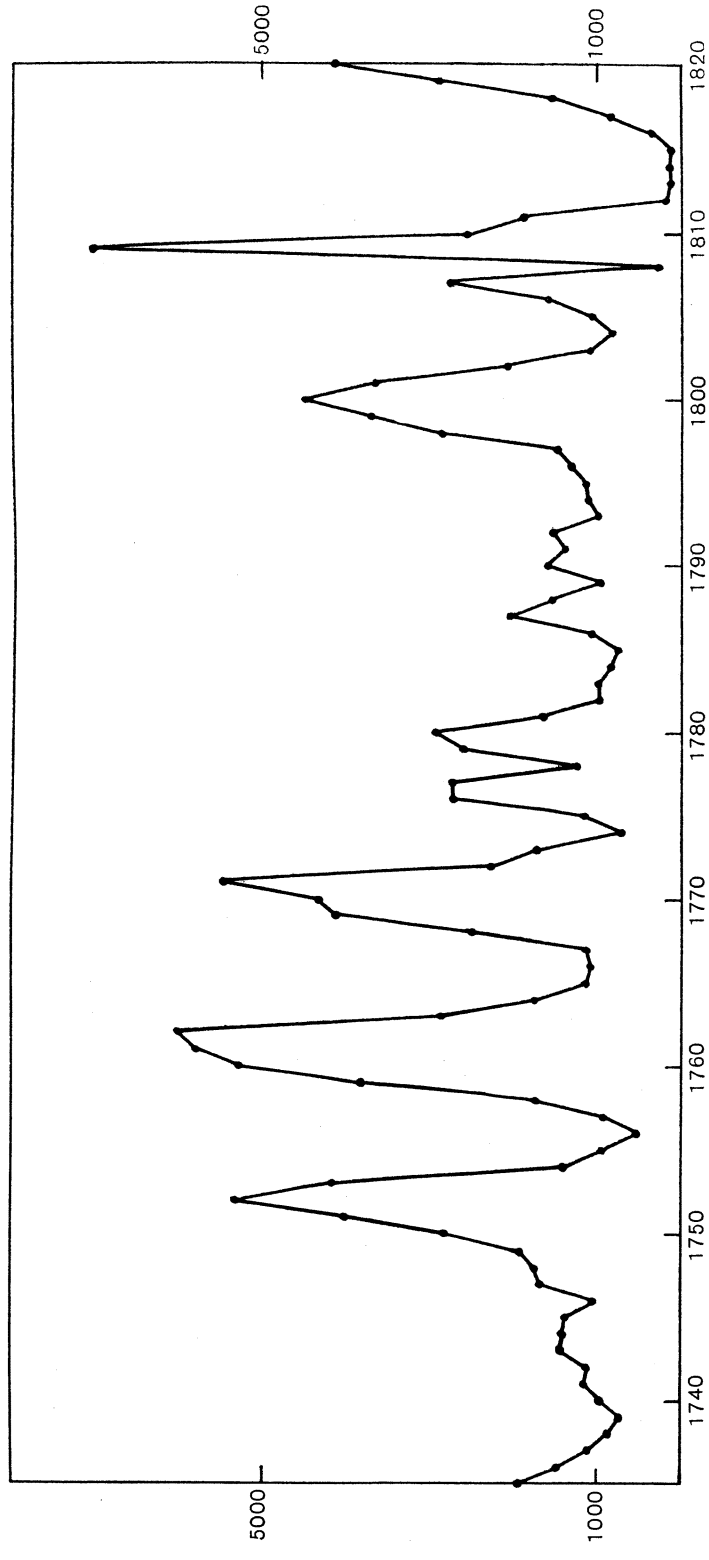


Fig. 10. Hudson's Bay Company lynx furs, Outfits 1735–1820. 1735–77, 1779–86, 1794–9 from the Company's sales records: 1778, 1787–93, 1800–20 from Poland (1892).

control of trading which gives the unique fur figures described in § 4, and this date marks a natural change in the sequence, which we have used in this analysis.

These historical notes are a necessary background for interpreting the fur figures, which were evidently subject to many changing influences, such as the irregular visits of native bands from great distances, and the trends of competition, as well as the real natural fluctuations which we are trying to detect. The main changes seem to have been the retraction of the Company's radius of influence in central Canada between 1734 and 1749, and the subsequent regaining of lost trade, and expansion to a far greater extent than before.

We have no independent check on Poland's figures for Outfits 1778, 1787–93 and 1800–20, but they are probably reliable for a general picture of fluctuations, judging by those sections of the lynx record that have been cross-checked, both before and after 1821. The anomaly in his year 1809 has already been mentioned. We have several direct bits of evidence about lynx numbers in central Canada, found in the Company's London archives, and doubtless others would be revealed by a more systematic search of the written material before 1821, which we have only investigated casually. In July 1776 Matthew Cocking recorded in the post Journal of Cumberland House, on the Saskatchewan River: 'Four or five years ago cats [lynx] were very plentiful here and in the woody parts to the Southward etc., but now the natives say there are scarce any; this is attributed to the scarcity of rabbits, these being the cats' chief food. The scarcity of rabbits was also remarked down to the northward where they used to be plentiful, owing to a supposed dearth among them.' This agrees with the high lynx catches of 1769–71, followed by a period of decrease. Peter Fidler, a remarkably keen observer who did special surveys for the Company, in his 'Report of the Manetoba District' for Outfit 1820, gives the first recorded description of the periodicity of the lynx cycle: 'There are in some seasons plenty of rabbits, this year in particular, some years very few, and what is rather remarkable, the rabbits are the most numerous when the cats appear. This winter the cats have come in considerable numbers, whereas these several years past there was scarce one to be had. Its flesh is good eating, sweet and tender, and they live principally on rabbits; the cats are only plentiful at certain periods of about every 8 or 10 years, and seldom remain in these southern parts in any number for more than two or three years. They are supposed to emigrate from the north towards the Hyperborean Sea.' He gives some further notes in his Report for 1821. The returns for lynx in the Manetoba District were: 2 in 1817 (record missing for 1818), 9 in 1819, 483 in 1820 and 883 in 1821. In this same Report he says: 'Had the martins been as plentiful as these several years there would have been a more valuable trade than would haven for these several years.... At Fort Dauphin House the Trade is better than last year, which is principally owing to the cats.... The martins this winter have been very scarce, but it is generally observed that when this happens the cats become plentiful. Four years ago there were only two cats procured in this district and had the cats not appeared, the trade would have been very little....' In the Journal of Fort Dauphin (which lay on Dauphin Lake, west of Lake Manitoba), for 25 February 1820, Fidler wrote: 'The blind fellow has near a hundred cat snares down and got lately twenty cats in going once round them.' 31 October 1821: '19 rabbits. They are very plentiful this year as well as the last.'

These notes leave little doubt about the reality of the lynx peak shown in the fur returns for 1821–3. Although Fidler curiously got the relationship the wrong way round,

the correlation between lynx and rabbit abundance was realized, the phase sequence of the marten and lynx correctly stated, and the periodicity of eight to ten years remarkably close to the real average period of about 9·6, varying from 8 to 11. The statement implies a knowledge of the cycle among resident traders, that must have been the result of observation over more than one cycle, and therefore confirms the general run of Poland's figures during the previous twenty years or more. The journals of Alexander Henry (in Coues, 1897, pp. 184, 198, 221, 245, 259) contain a short series of fur returns for the Lower Red River Department of the North-West Company for 1800–5, which agree roughly with the run of the cycle shown in Poland's larger figures for the Hudson's Bay Company's whole catch:

Outfit	No. of lynx	Outfit	No. of lynx	Outfit	No. of lynx
1800	20	1802	194	1804	38
1801	67	1803	167	1805	0

The peak was 1802, compared with 1800 for the Hudson's Bay Company's total.

It will be noticed that the cycle in the Company's lynx catches, which shows up very clearly in the middle of the eighteenth-century curve, becomes rather irregular and confused between the years 1878 and 1890, though the main trend is clearly visible. There can be little doubt that this was to a great extent the result of a series of terrible pandemics of smallpox among the Indian tribes, which partly destroyed the whole basis of the interior fur trade. These epidemics have not been mentioned in the standard books on epidemiology, but Voorhis (1930) summarizes some of their dates. Although there had been earlier outbreaks in the country north of the Saskatchewan River, the culminating one advanced up the Assiniboine River in 1778 and thence spread through the West, incidentally putting a stop to the Indian wars. Between 1780 and 1783 the Lake of the Woods Region was partly depopulated and Red River and Winnipeg Regions severely affected. Hearne reported that it had destroyed nine-tenths of the Chipewyans and other northern Indians. It completely ended the fur trade in some areas for several years. Matthew Cocking, in a letter from York Factory, 12 August 1882, describes some of the disastrous effects of the smallpox on the Indians: 'Much the greatest part of the Indians whose furs have been formerly and hitherto brought to this place are now no more, have been carried off by that cruel distemper the smallpox. Mr Tomison informed me that the smallpox had destroyed most of the Indians inland, the whole tribe of Basquion Indians—their former assistants—are extinct, except one child; and that of the several tribes of Assinnee-Poets, Pigogomeu, and others bordering on Sackackiwan River, he really believed not one in fifty had survived. He said that some of the Indians who went to war last year, having met with a tent of Snake Indians who were ill of the smallpox, they killed and scalped them. By this means they received the disorder themselves and most of them died on their return. The few that reached their own parts communicated this disorder to their countrymen, and since then it has run with great rapidity through the whole country about here and is now raging among our poor Pungee deer-hunters, of whom almost every one that has been seized with it have died.... Thank God we have preserved our home Indians as yet, by keeping them at a distance...' (London archives, Hudson's Bay Company).

The smallpox, killing off a large fraction of the Indian population, accounts for the greatly reduced catches of the fifteen years that followed.

6. DISCUSSION

Persistence of the cycle. The combination in series of the total sales figures for 1735–1820 with the fur returns of the Northern Department or its equivalent area for 1821–1934, gives a continuous record (except for 1914) for 200 years. The area has probably been a fairly standard one for the last 150 years, but was more limited to the westward in the first 50 years. The series demonstrates beyond any reasonable doubt the persistence of the lynx fur cycle over a large part of Canada for 200 years. The Dominion fur statistics for the whole of Canada extend the series forward for another six years. We believe that it is a rough indication of the periodicity of fluctuations of the lynx population, and it must be one of the longest homogeneous records of the sort for any species of wild animal, though there is a general historical index of changes in the Baltic herring fisheries, covering many hundreds of years. We have an unpublished record of marten furs similar to that for the lynx, but the fluctuations are not so regular, and the length of the cycle changes greatly with the shift of fur trade towards the west. Pettersson (1912) analysed the Baltic herring history and sought to correlate the different cycles with tidal periodicities affecting the entrance of saline water over the shallow entrance to the Baltic.

Although the existence of a regular historical recurrence gives no scientific guarantee of its future persistence, it can at any rate be said that the lynx cycle has so far shown no sign of dying out or changing its main rhythm. Nevertheless, there have been instances of equally pronounced fluctuations beginning and then dying out, presumably under the limiting influence of long-term changes in the ecology of the species. Elton (1924) pointed out the presence of a persistent major cycle of about 22·5 years in the irruptions of Pallas's sandgrouse (*Syrrhaptes paradoxus*) from Central Asia into the British Isles. (The dates were re-analysed by Thomson (1926), who agreed that the cycle existed.) They began suddenly in 1863, and the last big one was in 1908. But the prediction that 'we should expect another big visit about 1930' has not been fulfilled. A similar long-term cycle in rainfall has apparently affected the muskrats in the prairies of the Middle West of Canada (Elton & Nicholson, 1942).

Another factor that might change the lynx cycle is over-trapping or other human activities pulling down the whole population level to a point where no cycle could occur at all. This seems to have happened to the marten (*Martes americana*) in Canada, which used to have a major cycle of about ten years, but in recent years has diminished very greatly and no longer shows marked periodic recovery in numbers (Elton & Swynnerton, 1936).

Geographical extent. The cycle covers the whole northern forest zone of Canada, from Labrador to British Columbia and the Yukon. We have evidence also that there is a strong cycle in Alaska, though it does not always follow the Canadian one very closely. But a cycle of about ten years occurs over practically the whole range of *Lynx canadensis*.

Regional correlation. The most extraordinary feature of this cycle is that it operates sufficiently in line over several million square miles of country not to get seriously out of phase in any part of it. Table 6 brings out the remarkable degree of coherence in the cycle in regions thousands of miles apart. There are certainly differences in the peak years, and the whole Canadian peak takes several years to develop and decline. But if

the populations were operating quite independently in the various regions, such differences would in a hundred years or less have accumulated to throw them entirely out of phase. The combination of regional differences amounting to several years, with an over-all broad synchronization through eleven cycles, makes it certain that some overriding process maintains the cycle in line over the whole extent of Canada.

It is not suggested that the regions we have chosen have any very significant ecological meaning, though they do tend to occupy river basins, whose watersheds may act as partial barriers, as shown by the presence of a separate subspecies of snowshoe rabbit *Lepus americanus macfarlani* in Alaska, Yukon and the lower MacKenzie River valley.

In reading the peak years marked in Table 6, it must be remembered that some of them differ by only a small number of skins from the year before or after. But any other method of choosing which is the peak year involves too much opinion to be safe from abuse. For the moment, we shall consider these as if they were real indices of the population peak, though this is not really the case. The peak that fell in or just before

Table 6. *Comparison of peak years (Outfits) of lynx fur returns in different regions*

West	Mac-Kenzie River	Atha-basca Basin	West Central	Upper Saskat-chewan	Winni-peg Basin	North Central	James Bay	Lakes	Gulf	Range in years of peaks
1829	1828	1828	1829	1829	1830	1830	—	—	—	3
1838	1838	1838	1839	1838	1838	1838	—	—	—	3
1848	1848	1847	1847	1847	1848	1848	—	—	1849	3
—	1857	1857	1856	1859	1857	1857	1856	1858	—	4
—	1866	1865	1866	1866	1867	1868	1867	—	—	4
—	1875	1875	1876	1875	1876	1876	1876	—	—	2
—	1885	1885	1885	1885	1886	1886	1885	(?1889)	(?1888)	2
—	1895	—	—	—	Central		1897	—	—	3
1905	1904	1905	1904	—	1905		1906	1905	1906	3
(1914 or 1915)	(1913, 1916)	(1913 or 1914)	(1913 or 1914)	—	(1913 or 1914)	(1914 or 1915)	(1914 or 1915)	(1913 or 1914, 1916)	(*c.* 1912–1916)	—
1925	1925	1923	1923	—	1923	1923	1925	1926	1925	4
—	—	—	—	—	—	—	1935	1934	1936	(3)

the war of 1914–18 cannot be defined with accuracy, partly because the figures for 1914 returns are missing except for MacKenzie River, and partly owing to the very serious disturbance of the trade with Indians that resulted from temporary variations in the Company's trading arrangements caused by market conditions at home. For this reason the probable limits within which the peaks fell are shown in brackets.

The range covered by the peak years in any one cycle has varied from two to four, the commonest number of years being three. That is to say, the peak of the lynx cycle shown in the fur returns takes several years, usually three, to develop and appear over the whole of the vast territory in which it occurs. There is no regular line of progression or geographical contouring in the incidence of peaks in different regions that can be easily seen when they are mapped in detail. But the results of a rough method of calculation suggest that there is a tendency for the peak to appear first in Athabasca Basin Region and spread west, north, south and east, and to appear last in Lakes and Gulf Regions. These figures are shown in Table 7. In each cycle the year in which the peak first appears in any region is taken as 0, the next as 1, and so on. These index figures are added up and (because the number of dates available for calculation is not the same for each region) divided by the total number of cycles for each region. The single peak for Central Region is omitted. Dates in brackets have not been used. The peak for North

Central in 1838 is taken as an average of 1837 and 1839. The Winnipeg Basin subpeak in 1926 has not been included. This broad trend from Athabasca outwards, and the late peaks in the east, confirm suggestions made to Elton some years ago by Prof. William Rowan, as a result of his studies of the snowshoe rabbit cycle in the Middle West.

Table 7

Region	Total lag in years	No. of cycles	Average lag per cycle	Region	Total lag in years	No. of cycles	Average lag per cycle
West	5	5	1·0	Winnipeg Basin	8	8	1·0
MacKenzie River	5	10	0·5	North Central	9	8	1·1
Athabasca Basin	2	9	0·2	James Bay	10	8	1·3
West Central	4	9	0·4	Lakes	6	4	1·5
Upper Saskatchewan	5	7	0·7	Gulf	8	4	2·0

Length of periodicity. Except in one or two instances where we have found substantial grounds for believing that the system of fur collection was temporarily dislocated, or mistakes had been made or records were missing (eighteenth-century smallpox, anomaly in 1808, gaps in 1892–6, war of 1914–18), it is possible to follow the cycle continuously from the middle eighteenth century. Even in years when the record was obscured, the major cycle persisted sufficiently to make any special analysis unnecessary. Such a general conclusion is made possible by the extraordinarily wide amplitude of the fluctuations. Between the peak years of 1752 and 1935 there were 19 complete cycles, giving an average period of 9·63 years. The frequency of variation around this average cannot be stated reliably from the total figures for Canada, because there is doubt as to the exact year of some of the peaks, e.g. 1809 might be 1808, 1913 might be 1914. It can be partly determined in another way, by counting all complete periods between peaks in Table 6, for the separate regions. Owing to the gaps in records for 1892–6 and 1914, the later series cannot be used except for the last cycle in James Bay, Lakes and Gulf. The result of this is to give a picture of the periodicity mainly for 1821–85. The frequency is: 1 cycle of 7 years, 6 of 8 years, 16 of 9 years, 20 of 10 years, 3 of 11 years, and 1 of 12 years. Of 47 cycles that can be measured, 36 or 78% are 9 or 10 years. The average of the whole lot is very near that given by the total curve for a longer period, but is not directly comparable.

Relation of the lynx to the snowshoe rabbit. Although no thorough food studies have been done for the lynx, it seems to be generally agreed that its chief prey is the snowshoe rabbit or varying hare (*Lepus americanus* and subspecies), and that although it will eat other small animals and birds to some extent when it is starving, it is unable to exist successfully without snowshoe rabbit populations to prey upon. Seton (1912, ch. 14) gives some notes on the subject, remarking that 'It lives on Rabbits, follows the Rabbits, thinks Rabbits, tastes like Rabbits, increases with them, and on their failure dies of starvation in the unrabbited woods.' He describes the large numbers of lynxes roaming about in the MacKenzie River Valley in 1906–7 after the rabbits had crashed. Specimens examined contained various small rodents in their stomachs, but were starving and thin. There is not space here to review the scattered evidence on lynx food habits, but the observations of Sheldon (1930) will be cited as a particularly convincing example of the attachment of the lynx to one food. Sheldon was a first-rate field observer, who camped alone during the winter of 1907–8 on the north-east side of Mount Denali (or McKinley) in Alaska, an area now forming part of a National Park. 'In this region rabbits had been

scarce in 1906, and the year 1907 was the maximum of their periodic scarcity. Yet that year lynxes were common throughout the region...' (p. 329). A few still remained in the district that he camped in, but frequently when some rabbit tracks were seen a great horned owl would turn up almost at once, and they disappeared. Nearly all the lynxes he caught were starving. The only fat lynx seen that winter was an old female whose stomach was filled with mice and one ground squirrel—an exceptional event. 'I could discover no evidence that they were hunting mice; and mice were so abundant that if the lynxes had eaten them to any extent they must have been well fed. On the contrary all the lynxes that I examined were in a very starved condition' (p. 329). In one instance only, a lynx had killed a ewe mountain sheep weighing 130–150 lb.—presumably a rare event, as a lynx does not weigh more than about 20 lb.

Although the lynx cycle may be mainly explicable by the dependence of lynx on rabbits, it is also possible that the factor, at present unknown, which keeps the cycle in step over such large regions, may affect the lynx directly, e.g. through its rate of reproduction of physiological condition in other ways.

That the snowshoe rabbit itself has a persistent cycle averaging about 9·6 years can be shown by a large amount of evidence, part of which remains to be published.

The 206 years of lynx cycle are good evidence of the existence of a similar one in snowshoe rabbits during that period. The most promising line of research on the ten-year cycle is an intensive study of snowshoe rabbit fluctuations, recent work on which is summarized by MacLulich (1937), by Chitty & Chitty (1942) in the ninth of a series of annual reports on the cycle, and in the publications of Green and his associates (Green, Larson & Bell, 1939).

The ten-year cycle generally. The long run of figures now available proves conclusively that the hypothesis put forward by Elton (1924) of control of this cycle by sunspots, acting through climatic cycles, is not true. The 200-year record shows the short cycle getting quite out of phase with the curve for sunspot numbers, which have an average period of about 11·2, with a rather wide variation. This point has been thoroughly established by MacLulich (1937), and the hypothesis was abandoned by Elton some years ago in the light of Hudson's Bay Company records. We have at present no clue at all to the nature of the factor controlling this enormous wild-life rhythm in the northern forests, except that it seems almost certain that climatic fluctuations must play a controlling part. The cycle operates exactly parallel on both sides of the Rockies; we have unpublished notes suggesting that the introduced snowshoe rabbits on Anticosti have developed a cycle corresponding to the mainland one; the whole of Canada keeps in step without ever getting right out of phase; there is a similar cycle in the muskrat, with peaks several years before the lynx (Elton & Nicholson, 1942); also in salmon catches on the Restigouche River, New Brunswick (Phelps & Belding, 1931).

Trapping and market factors. It is frequently suggested that the cycles shown in fur returns might be caused by changes in prices acting as incentive or deterrent to the trapping of particular species. We have given reasons in our paper on the muskrat why this is not an important factor, and these reasons apply to the lynx just as strongly. In the early days, and still to a great extent, trappers brought in any valuable skin they could catch, and for long periods at a time received the same tariff rates at the posts, although in London the prices did vary inversely with the supplies sold at auction (Innis, 1927). There is also a great deal of direct evidence, both for rabbits and lynx, in the

Hudson's Bay Company Journals, etc., about fluctuations observed by trappers in the field, using evidence from tracks in the snow and other signs. The chief respect in which the fur returns fail to give an entirely reliable picture of peak years in the lynx numbers is that the predators tend to come into the traps in greater numbers when they are starving, and so there is often a lag between the real peak of rabbits and lynx, and the lynx fur peak. This subject has been discussed in relation to foxes and mice in Quebec Peninsula (Elton, 1942), and it was shown that there was sometimes no lag, but at other times a lag of a year. For the main purpose of this paper, determining the persistence and periodicity of the lynx cycle, such small differences in the peak years cannot make very much difference, though they may be of the greatest importance practically in the fur trade at a particular place and year.

7. SUMMARY

1. Hudson's Bay Company and some other records provide a record of lynx (*Lynx canadensis*) fur collections in Canada for 206 years. Details for smaller regions have been obtained for 1821–1934 or 1937. The regions have been constructed from the original fur trade districts, in such a way as to give fairly standard areas for comparing catches over long periods.

2. The cycle in lynx furs is very violent and regular and has persisted unchanged for the whole period. Its average period is about 9·6 years.

3. This cycle is a real one in lynx populations, which are dependent upon the snowshoe rabbit (*Lepus americanus*) for food, and which starve when the rabbits disappear periodically. It is therefore strong evidence of a similar cycle in snowshoe rabbits for the last 206 years.

4. The wide synchronization of the cycle in different parts of Canada for at least 100 years, its parallel occurrence both west and east of the Rockies, and its independent occurrence in aquatic species such as the muskrat (*Ondatra zibethica*) and the salmon (*Salmo salar*), strongly suggest the existence of a climatic factor partly controlling it.

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