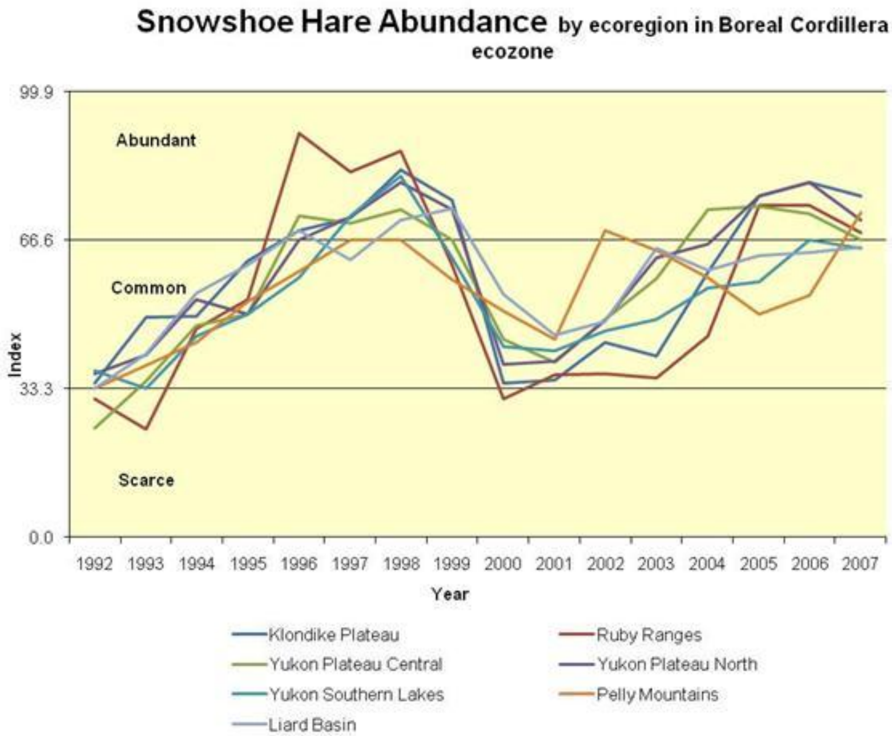
A Yukon Trappers' Perspective on Wildlife Populations:



A Preliminary Analysis of Trapper Questionnaires, 1992-93 to 2007-08

prepared for

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EXECUTIVE SUMMARY

Questionnaires on the population levels and trends of furbearers and some prey species have been mailed annually to all licensed trappers since 1977 in an effort to make use of local knowledge. Changes have been made to the questionnaire over the years to improve the information collected and analytical techniques. This report summarizes the analytical methods, presents the results of a preliminary analysis of Yukon Trapper Questionnaire data for the years 1992-93 to 2007-2008, and makes recommendations for further analysis and interpretation of the data.

Analyses included the calculation of species abundance and trend indices, trapper response rates to the questionnaire, the proportion of trappers who visited their traplines, trends in trapper effort, correlations and cross correlations among species indices, spatial analyses of abundance and trend indices by Yukon (all traplines combined), management regions and ecoregions. Marten indices were analyzed for the Marten Conservation Area, a special management region for the species. Some of the spatial results were mapped.

The response rate to the questionnaire is consistently around 50% of trappers contacted, and an average of 232 questionnaires is returned each year. Eighty- eight percent of respondents report visiting their traplines, an indication of good data quality. Trapping effort has been reported less or the same each year.

Spatial analyses of indices included the 5 management regions (Dawson, Mayo, Haines Junction, Southern Lakes and Watson Lake) and 9 ecoregions with adequate questionnaire returns (two in the Taiga Cordillera ecozone, Mackenzie Mountains (170) and Selwyn Mountains (171), and 7 in the Boreal Cordillera ecozone, Klondike Plateau (172), Ruby Ranges (174), Yukon Plateau-Central (175), Yukon Plateau-North (176), Yukon Southern Lakes (177), Pelly Mountains (178), and Liard Basin (181)).

Some of the data limitations include lack of standardization and verification with other data such as fur harvest and population surveys, the lack of standardization of trappers perceptions and animal behaviours independent of population densities which affect perceptions of abundance. Only some of the more notable and verifiable population changes are discussed. Some of these involve temporal and spatial variation in lynx, wolverine, coyote, marten, fisher, snowshoe hare, grouse and mouse populations.

Recommendations are made to improve the questionnaire and analytical methods. It is recommended that the entire time-series of data be analyzed, since it will be more informative than the 16-year time-series analyzed here.

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Slough, B.G. 2009. A Yukon Trappers' Perspective on Wildlife Population Trends: A Preliminary Analysis of Trapper Questionnaires, 1992-93 to 2007-08. Prepared for Fish and Wildlife Branch, Department of Environment, Whitehorse, YT. 61 pages.

INTRODUCTION

Questionnaires on the population levels and trends of furbearers and some prey species have been mailed annually, following the trapping season, to all licensed trappers since 1977 in an effort to make use of local knowledge. Trappers were requested to answer based on their own experience over the past season on each concession for which they were licensed (some trappers had “assistant trapping” licences on other concessions). The questionnaire used 2 mailings and, for a number of years in the 1980s, prizes, donated by local businesses, were offered as incentives. The removal of the prizes in 1986 did not affect the response rate (Slough 1987). The questionnaire responses are converted to numerical values which contribute to abundance and trend indices to provide a way to compare trappers’ interpretations of species abundance and trends in a given area over time. Questionnaires are also useful for determining species distribution (Gese 2001). Potential drawbacks of the technique are misidentification of tracks, low response rates, and concentrations of sightings in populated and accessible areas (Gese 2001). These concerns are mitigated by Yukon trappers who have intimate local knowledge of their traplines, which are often in remote areas.

In 1977, information was requested only for grouse and snowshoe hare populations (Table 1). In 1981 all 14 furbearer species were added, mice were added in 1986, and moose and caribou were added in 1993. Arctic fox and fisher were dropped in 1985 since very few trappers had first hand information on these species. Fisher was included again in 2001 at a time when the fisher populations appeared to be increasing and expanding.

Special questions on topics of biological interest were occasionally requested of the trappers. Some of these questions were on subjects of winter bear activity, lynx trapping effort, lynx population estimates, snowshoe hare and lynx habitat choices, least weasel sightings, fisher sightings, cougar sightings, and winter ticks - moose hair loss (Samuel 1989).

Questions are asked on whether or not they trapped or visited their trapline, and on changes to their trapping effort. The current questionnaire format is shown in Appendix 1. Previous reports and publications which have made use of questionnaire data or have described the methodology used are Jung et al. (2005, Appendix 2), Samuel (1989), Slough (1984, 1985, 1986a, 1986b, 1987), Slough and Jessup (1984), Slough and Smits (1985), Slough et al. (1987), Slough and Ward (1990) and Yukon Department of Renewable Resources (1985).

The purpose of this report is to summarize the analytical methods, to present the results of a preliminary analysis of Yukon Trapper Questionnaire data for the years

1992-93 to 2007-2008, and to make recommendations for further analysis and interpretation of the data.

ANALYSES

The analytical methods are based on those of Brand and Keith (1979) for estimating snowshoe hare densities from their own fieldwork in Alberta. They found a good relationship between the questionnaire responses and their estimates of hare densities. They developed an index of abundance from this relationship of observed vs. actual densities. These methods are also used in Alaska (Blejwas 2006), although the indices were not recalibrated for local populations.

The abundance index was modified in the Yukon in 1980 to accommodate a response category of ‘not present’, in addition to scarce, common and abundant. The algorithm was changed again in 1993 to even the spread between response categories.

Indices were calculated using Mainframe SAS (SAS Institute Inc.). In this study, SAS output was exported to Microsoft Excel (Microsoft Corporation). WinSTAT statistics add-in for Excel (R. Fitch Software) was used to calculate Pearson correlation coefficients and cross-correlations. The mathematical calculation of the indices is described below:

Species Abundance Index

The species abundance index is derived from an equation which expresses the cumulative response of trappers as a percentage of the range of possible values:

$$\mathbf{AI} = \left(\left(\sum_{i=1}^{i=n} R_i\right) - n\right) / 3n \times 100\%$$

Where AI = abundance index

R = numerical value (1 = not present, 2 = scarce, 3 = common, 4 = abundant)

n = number of trappers reporting

AI ranges from 0 to 100%, where 0% is not present, 33.3% is scarce, 66.7% is common, and 100% is abundant. Brand and Keith (1979) and Blejwas (2006) arbitrarily set ranges around those values; in our case these might be <16.7% is not present, 16.8%-50% is scarce, 51-83.3% is common, and >83.4% is abundant.[1]

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1 Before 1993 the index was calculated as:

Species Trend Index

The species trend index is calculated as follows:

$$\mathbf{TI} = \left(\sum_{i=1}^{i=n} R_i\right) / n \times 100\%$$

Where TI = trend index

R = numerical value (-1 = less, 0 = same, 1 = more)

n = number of trappers reporting

TI ranges from –100% to 100%, where –100% (<-33%) is less (i.e., declining), 0% (-33 to 33%) is same (i.e., stable), and 100% (>33%) is more (i.e., increasing). The trend index represents the difference between the percentage of respondents reporting an increase and the percentage reporting a decrease. The calculation of the trend index has not changed over the years.

It is not known if the ranges of percentages presented above are appropriate, however the indices are very useful when used in conjunction with other indicators such as fur harvest and population surveys.

Response Rate

The response rate is calculated as the proportion of trappers who received questionnaires (may be more than 1 per trapper and more than one trapper per trapline) that responded to at least one question.

Trapline Visits

The quality of the data is assessed based on the proportion of trappers who visited the trapline(s) for which they are licensed.

$$\mathbf{AI} = \left(\sum_{i=1}^{i=n} R_i\right) / 9n \times 100\%$$

Where R = numerical value (0 = not present, 1 = scarce, 5 = common, 9 = abundant). The index was modified to create a more even spread between response categories.

Trapping Effort

Trapping effort is calculated by the net number of respondents reporting 'more' or 'less' trapping effort by weighting each 'more' response as +1, each 'same' response as 0, and each 'less' response' as -1.

Correlations and Cross-correlations

In the 1986 trapper questionnaire report (Slough 1987), analyses showed that the snowshoe hare population level index was significantly correlated with estimated snowshoe hare densities at Kluane Lake for the period 1977 to 1984 ($r=0.84$, $P>0.0085$). The correlation gives us confidence in the validity of the population indices as measures of abundance and trend. A similar correlation was found between a regional trapper questionnaire index and hare population densities in Alberta (Brand and Keith 1979). No correlations were made with estimated populations in the present study.

Correlations or the degree of association, between abundance indices of all pairs of species were calculated. While significant correlations do not identify the cause of the association (which may be due to a third factor), some causes may be inferred from empirical evidence. The snowshoe hare is a key and critical component of northern ecosystems. They are a dominant part of the biomass in the boreal forest without which the vertebrate community (mammals and birds) would largely collapse (Boutin et al. 1995, Krebs et al. 2001). Boutin et al. (1995) found that density changes of at least 10 species of vertebrates, including lynx, coyote, muskrat, ptarmigan and grouse, were correlated with the snowshoe hare cycle.

Cross-correlations were calculated among pairs of species to determine if the correlations would be even higher if we shift the populations in time with respect to one another. For example, we know that lynx and hare cycles are correlated, but do lynx or wolverine populations lag behind hares by a year or more?

Spatial Analyses

Data was analyzed annually for the Yukon (all traplines). Additionally, traplines were grouped into management regions and ecoregions to examine spatial differences in population levels or trends. The regions were Watson Lake, Whitehorse, Haines Junction, Mayo and Dawson.

Traplines were also grouped into ecoregions (Appendix 3; Smith et al. 2004); however there were sufficient numbers of responses (at least 10 per year) for comparisons of only 9 of the 23 ecoregions of the Yukon. These are two in the Taiga Cordillera ecozone, Mackenzie Mountains (170) and Selwyn Mountains (171), and 7 in the Boreal Cordillera ecozone, Klondike Plateau (172), Ruby Ranges (174), Yukon Plateau-Central (175), Yukon Plateau-North (176), Yukon Southern Lakes (177), Pelly Mountains (178), and Liard Basin (181).

Marten population trends were analyzed in the Marten Conservation Area, 81 traplines in the southwest Yukon with quotas of 0 to 20 marten where a marten transplant was conducted in the 1980s (Slough 2006). The area is roughly between the Teslin River in the east, Haines Junction in the west, the BC border in the south and Carmacks in the north. The area contained some typical old growth marten habitat that was isolated from occupied habitats by burns, open forests and alpine tundra. One hundred and seventy-one marten were released at several sites scattered throughout the area between 1984 and 1987.

Indices for the Yukon, regions and ecoregions were converted back to the appropriate categories, using the ranges mentioned above (e.g., >83.4% is abundant) for the purposes of plotting maps.

RESULTS

In all previous reports, the year assigned to a questionnaire refers to the year in which the questionnaire was mailed, which is at the end of the trapping season. For example the 1986 questionnaire refers to the 1985-86 trapping season. In this report dates given in the tables and figures refer to the beginning of the trapping season, which was the data format provided to the author; i.e. 2007 is the 2007-08 trapping season.

Response Rate

The response rate has remained remarkably consistent throughout the years, averaging 51.4% between 1992 and 2007 (Figure 1). Initial response rates were low (10-20% prior to 1985) but increased to over 50% in 1985 (Slough 1987). The number of respondents averaged about 232 per year. The average numbers of responses per year by management region were Dawson, 40.5, Haines Junction, 34.2, Mayo, 47.6, Southern Lakes, 50.4 and Watson Lake, 57.3. Ecoregions selected for analysis had an average of as few as 10.5 responses per year (Mackenzie Mountains and Selwyn Mountains) to as many as 43 responses per year (Yukon Southern Lakes).

Trapline Visits

The proportion of respondents who visited their traplines during the trapping season each year averaged 88.2% (Figure 2). This high proportion suggests that the data quality is likely to be high, since most trappers are reporting recent knowledge for their traplines. Traplines which were not visited were not removed from the spatial analyses.

Trapping Effort

Net trapping effort has reportedly been the same or less than in previous years for the entire 1992-2007 period (Figure 3) indicating an overall decline in trapping effort.

Spatial Analyses

Selected regional wildlife population indices for the Yukon, the 5 management regions, 9 ecoregions and the Marten Conservation Area are presented in Figures 4 to 21. The changes in abundance of seven key species over the 16-year period by ecoregion are displayed on ecoregion maps (Figures 24 to 30).

Correlations and Cross-correlations

Significant correlations between pairs of species are summarized in Table 2 and Figure 22, and cross-correlations are shown in Table 3 and Figure 23. Since many dubious correlations were found to exist between species abundance indices, only the most significant are reported and discussed ($r \geq 0.70$, $P<0.0015$).

DISCUSSION and CONCLUSIONS

The interpretation of results must be considered preliminary, since trappers' perceptions are more relevant when considered in conjunction with other data such as fur harvest and other population surveys. There is no doubt that their perceptions are more accurate for species with obvious population cycles and fluctuations. Less common species which may not fluctuate perceptibly will show few observed changes in the trapper-estimated indices.

Perceptions of trappers in different areas are not standardized, and may differ, especially where population densities of species varies geographically. For example coyotes which are most abundant in the southwest Yukon, may be perceived as abundant elsewhere at densities considered common or scarce in the southwest. The dates of the observations within the trapping season are likewise not standardized. For example, snowshoe hares and some mouse or vole populations peak in the summer and then decline throughout the winter. October populations may be quite different from those in late winter or June (the following year) in the same area. Finally, perceptions of abundance may be affected by factors other than animal density. Increased animal movements occur during the fall-early winter dispersal of juveniles or during dispersal after prey populations crash. More captures and sightings of tracks or individuals occur at these times. Weather may also affect animal movements as some species seek shelter from cold weather.

Some of the more notable and verifiable population changes documented by the questionnaire will be discussed.

The lynx and snowshoe hare population cycles are well known and obvious to most observers and are highly correlated (Table 2, Figure 4a to 4e, Figure 9a to 9e, Figure 22c, Figure 24, and Figure 29). The data show synchrony among management regions and ecoregions in the Yukon, although the species are apparently less common and less cyclic in ecoregions of the Taiga Cordillera Ecozone as compared with ecoregions of the Boreal Cordillera Ecozone. Both species demonstrated clear population peaks in 1998. Hares peaked again in 2006, with lynx lagging behind by at least a year (the data series stops at 2007). The 2006 hare peak was also lower than the previous peak in the southern ecoregions, but not in the north. Hare cycles are not always the same length or of the same intensity.

Lynx populations also correlated with red squirrel populations in the Liard Basin although both species showed a strong trend (Table 2), and hare correlated with grouse/ptarmigan in the Klondike Plateau. The highest cross-correlations with hares are lynx, which lag by 1 year, and grouse/ptarmigan, which precede the hare populations by 1 year (Table 3, Figure 22a and 22c, Figure 23a and 23c). Muskrat populations also lagged a year behind hares (Figure 23a and 23b) and 2 years behind red squirrels (Figure 23h and 23j).

Marten abundance also shows wide variation across management regions and ecoregions, being least common in the Yukon Southern Lakes and Ruby Ranges ecoregions (Figure 5, Figure 25). Most areas showed a marked population decline in 2001, following mice/vole and snowshoe hare declines in 1999 and 2000. The Marten Conservation Area overlaps the Yukon Southern Lakes, Ruby Ranges, Yukon Plateau-Central and Yukon-Stikine Highlands ecoregions. The marten population is perceived as stable but scarce in the Marten Conservation Area, contrary to an increase noted by Hofer and Kenney (2006) for the Kluane area. Marten abundance was strongly correlated with red squirrel abundance in the Mackenzie Mountains ecoregion (Figure 22b).

Wolverines are relatively common and stable across the Yukon (Figure 6, Figure 26). There was a weak cross-correlation with snowshoe hares at a 3-year lag ($r=0.45$). Snowshoe hares are an important food source for wolverine in the Yukon (Banci 1987), and likely support the increased survival of juveniles and sub-adults when they are abundant. After the hares crash, many wolverine become transient, increasing their perceived abundance (B. Slough, unpublished track counts and wolverine live captures, 1986-1994). Coyotes (r=0.73) and wolves (r=0.63) also lagged 3 years behind hares.

Coyote abundance varies greatly across ecoregions, being scarce in the Liard Basin and common to abundant in Yukon Southern Lakes and Ruby Ranges (Figure 7, Figure 27). Figure 27d gives a dramatic representation of the coyote population differences among ecoregions of the Boreal Cordillera ecozone. Dependence on the snowshoe hare is evident in the latter 2 ecoregions (Table 2). Coyotes also have a strong correlation with mice/voles in the Ruby Ranges ecoregion (Figure 22e).

Grouse/ptarmigan populations are also cyclic (Figure 10). As found in Kluane studies (Krebs et al. 2001), grouse peak 1 year before hares and 2 years before lynx (Figure 22, Figure 23), although willow ptarmigan appear to decline synchronously with hares (Krebs et al. 2001). Grouse/ptarmigan and red fox population levels were strongly correlated in the Klondike Plateau ecoregion (Figure 22d). There was also an unexplained cross-correlation where grouse/ptarmigan lagged a year behind beaver (Figure 23e).

The mice/vole trends in abundance demonstrated a clear peak in 2002, a peak which was widespread across much of the Yukon (Figure 11, Figure 30).

Fisher appear to be stable but scarce in the Liard Basin ecoregion, where they are known to range and are most abundant in the Yukon (Figure 19c; B. Slough and T. Jung, unpubl. data). There may be evidence of a population increase, and perhaps range expansion, in the Pelly Mountains to the west, but not in the Yukon Southern Lakes ecoregion, where a few sightings and captures have occurred (Figure 19c; B. Slough and T. Jung, unpublished data). An apparent fisher increase in the Ruby Ranges is unexplained, as are reported occurrences in the Mackenzie Mountains ecoregion and northern regions. These occurrences may be false reports.

Other strong correlations (Table 2, Figure 22) were observed between beaver and otter (Figure 22a) and moose and wolves (Figure 22f) in the Pelly Mountains ecoregion, and between fisher and wolverine in the Liard Basin ecoregion (Figure 22g). Red fox lagged 1 year behind red squirrel population changes (Figure 23j).

RECOMMENDATIONS

- Yukon Fish and Wildlife staff biologists and technicians should review this report before proceeding with further trapper questionnaire analysis.
- Complete analysis of all historic trapper questionnaire data.

- Determine if duplicate returns and returns from trappers who didn't visit their traplines should be removed from analyses.

- Test correlations of population indices with other data such as population estimates (hares, small mammals), harvest, pelt price, lynx pelt sealing data (proportion of kits). There are some existing population data from several Yukon studies such as the Kluane studies (Krebs et al. 2001, being continued as KEMP (Kluane Ecological Monitoring Program) and CEMP (Community Ecological Monitoring Program), the 1986-1994 Snafu study area lynx/hare studies (Slough and Mowat 1996).

- Investigate other analytical methods. The 1986 abundance and trend response frequencies were compared between years with a log-likelihood ratio goodness of fit test, using the G-statistic (Slough 1986). Jung et al. (2005) used univariate and multiple linear regression to explore relationships in the dataset, and correlate the ranks with trapping activity variables (including: year, harvest, pelt price, and number of trapping licenses) and biological variables (including: reported abundance of wolves, red squirrels, grouse, snowshoe hare, and mice and voles). The abundance of snowshoe hare had the most predictive value of all variables.

- Send copies of trapper questionnaire reports to all trappers who returned the questionnaire (Blejwas 2006). This was achieved with a "Renewable Resource Bulletin" in the 1985, which coincided with a sharp increase in response rate.

- Develop a more detailed questionnaire, including definitions to aid in standardizing perceptions among individuals.

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Table 1 Trapper Questionnaire Summary, 1976 to 2007.

	Questions on Population Levels and Trends of these Species:							
Trapping Season Starting	**12 Furbearers**[1]	**Snowshoe Hare**	**Grouse / Ptarmigan**	**Arctic Fox**	**Fisher**	**Mice / Voles**	**Moose**	**Caribou**
1976 to 1979	No	Yes	Yes	No	No	No	No	No
1980 to 1984	Yes	Yes	Yes	Yes	Yes	No	No	No
1985 to 1991	Yes	Yes	Yes	No	No	Yes	No	No
1992 to 1999	Yes	Yes	Yes	No	No	Yes	Yes	Yes
2000 to 2007	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

1. The 12 furbearers are: beaver, muskrat, mink, otter, weasel, marten, wolverine, lynx, coloured fox, coyote, wolf and red squirrel.

Table 2 Correlations[1] between Abundance Indices, Yukon Combined and Ecoregions[2].

Species	Beaver	Muskrat	Mink	Otter	Weasel	Marten	Wolverine	Lynx	Red Fox	Coyote	Wolf	Red Squirrel	Snowshoe Hare	Grouse / Ptarmigan	Mice / Voles	Moose	Caribou
Muskrat	**178** r=0.74																
Mink	**170** r=0.71	**181** r=0.78															
Otter	**178** r=0.82		**175** r=0.70 **176** r=0.77														
Weasel			**178** r=0.71														
Marten			**YT** r=0.77 **178** r=0.73														
Wolverine	**176** r=0.71		**176** r=0.76	**176** r=0.76 **177** r=0.70													
Lynx																	
Red Fox		**YT** r=-0.91				**172** r=0.76											
Coyote							**176** r=-0.74										
Wolf		**171** r=0.73															
Red Squirrel		**178** r=0.80				**170** r=0.81		**181** r=-0.75									
Snowshoe Hare								**172** r=0.72 **174**	**181** r=-0.74			**171** r=0.76					

								r=0.91 **175** r=0.74 **176** r=0.71 **177** r=0.75									
Grouse / Ptarmigan			**YT** r=0.74			**172** r=0.70 **176** r=0.70	**170** r=0.78		**172** r=0.80 **174** r=0.71			**172** r=0.72	**172** r=0.74				
Mice / Voles				**177** r=0.75	**175** r=0.74					**174** r=0.81		**171** r=0.84					
Moose							**174** r=0.76				**178** r=0.83						
Caribou		**174** r=0.73															
Fisher	**172** r=0.84	**172** r=0.81					**181** r=0.91		**172** r=0.78					**172** r=0.84			

[1] **Pearson's *r* ≥0.70 P<0.0015.**
[2] **Ecoregions** are (see also Figure xx) **170 =** Mackenzie Mountains**, 171 =** Selwyn Mountains**, 172 =** Klondike Plateau**, 174 =** Ruby Ranges**, 175 =** Yukon Plateau-Central**, 176 =** Yukon Plateau-North**, 177 =** Yukon Southern Lakes**, 178 =** Pelly Mountains**, 181 =** Liard Basin**.**

Table 3 Time lag between population changes.

Based on cross-correlations (r ≥0.70) between abundance indices (e.g., grouse populations change 1 year in advance of hares, while those of lynx change 1 year after).

SPECIES	SNOWSHOE HARE	GROUSE / PTARMIGAN	RED SQUIRREL
Beaver		+1 (r=-0.74)	
Muskrat	-1 (r=-0.73)		-2 (r=-0.70)
Lynx	-1 (r=0.91)	+2 (r=-0.80)	
Red Fox			-1 (r-0.73)
Grouse / Ptarmigan	+1 (r=-0.76)		

Figure 1 Trapper Questionnaire Response Rate.

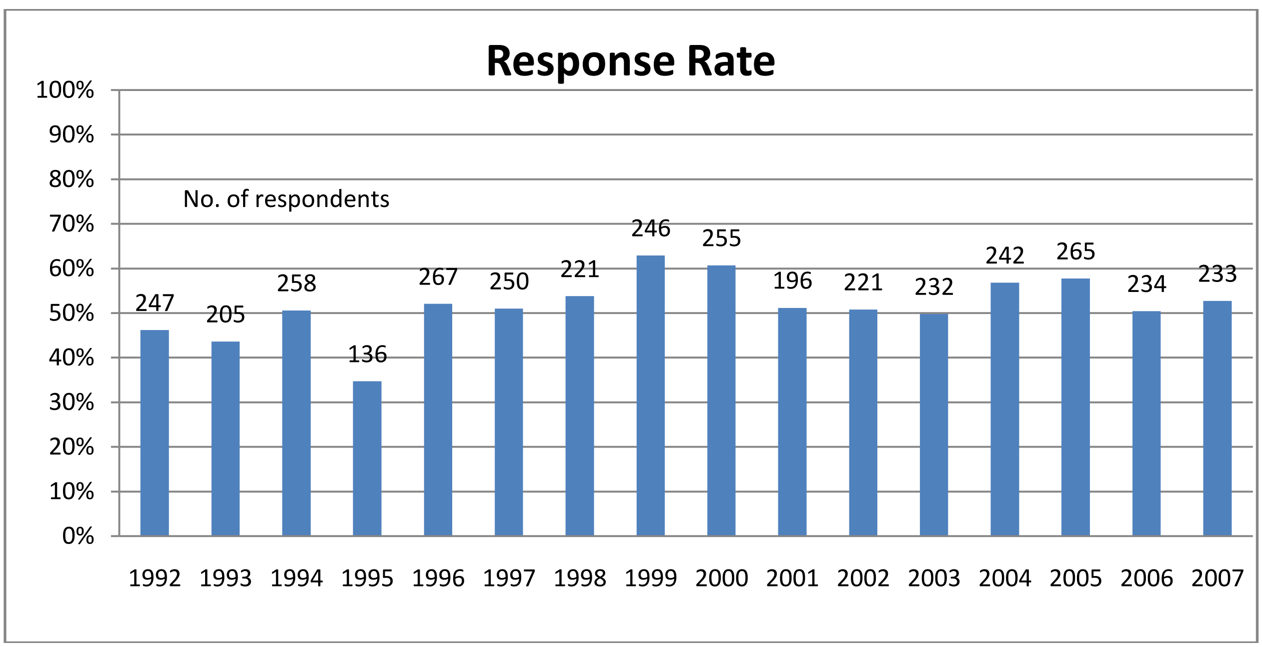


Figure 2 Proportion of Respondents Reporting Trapline Visits.

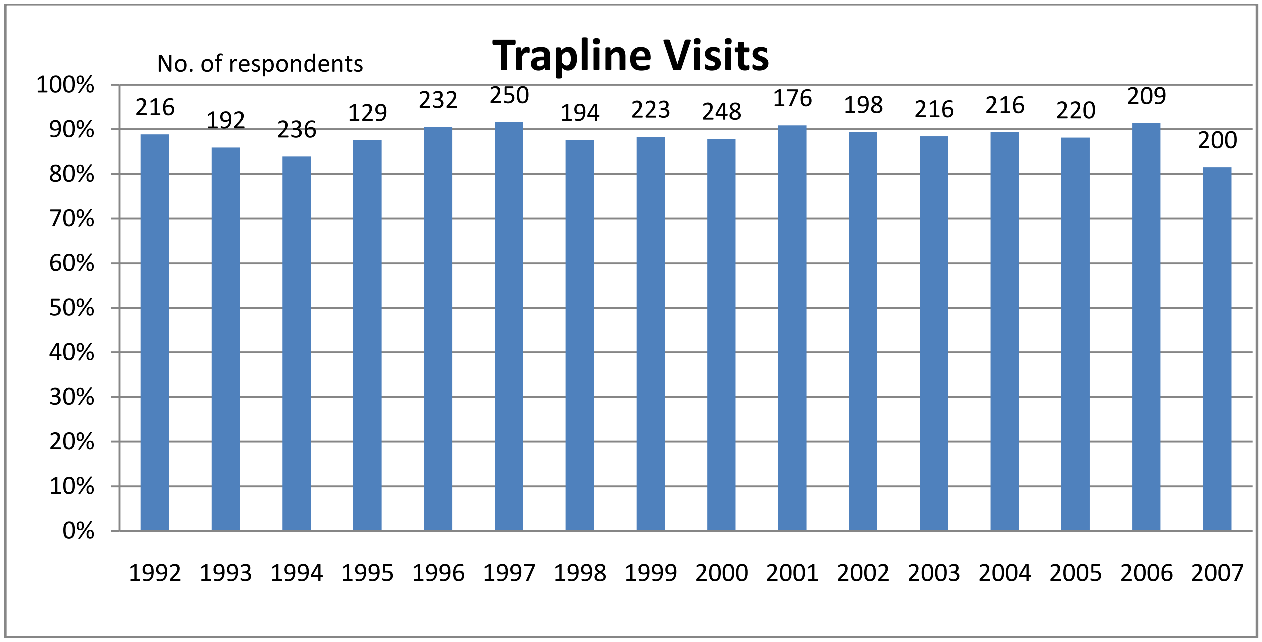


Figure 3 Net Number of Respondents Reporting More, Same or Less Trapping Effort.

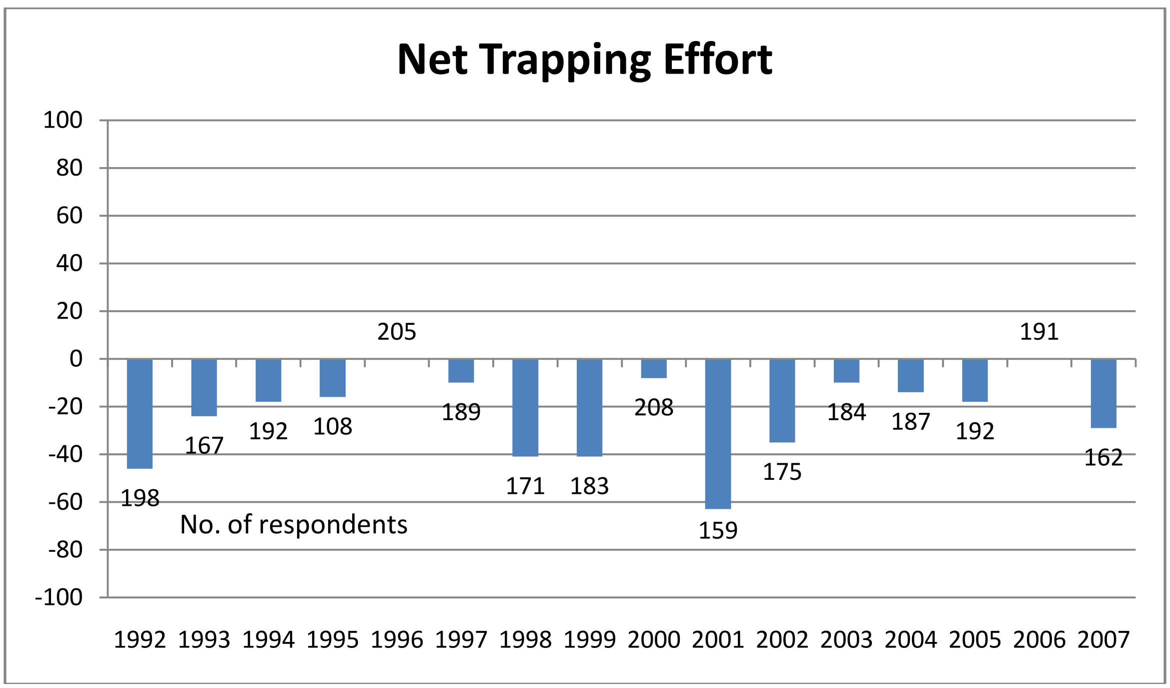


Figure 4 Population Indices for Lynx by Region and Ecoregion.

Figure 4a

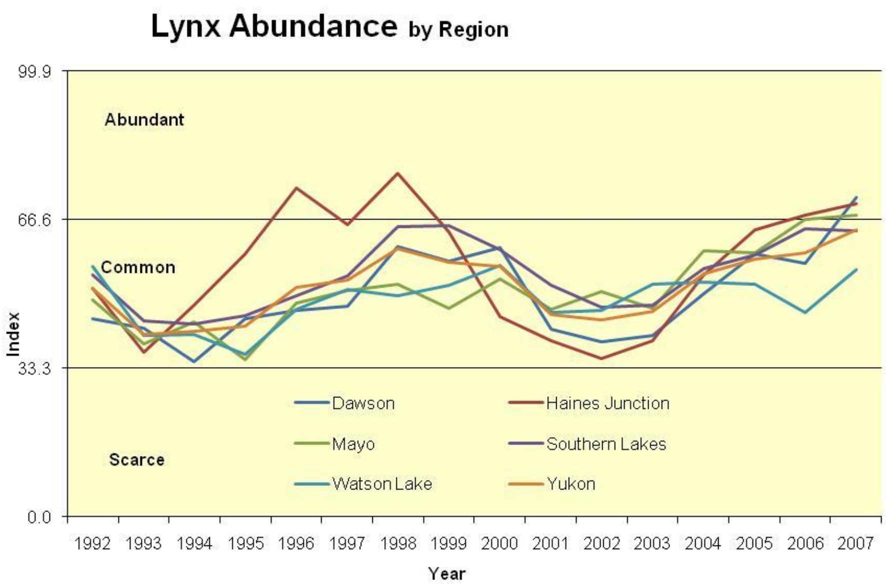


Figure 4b

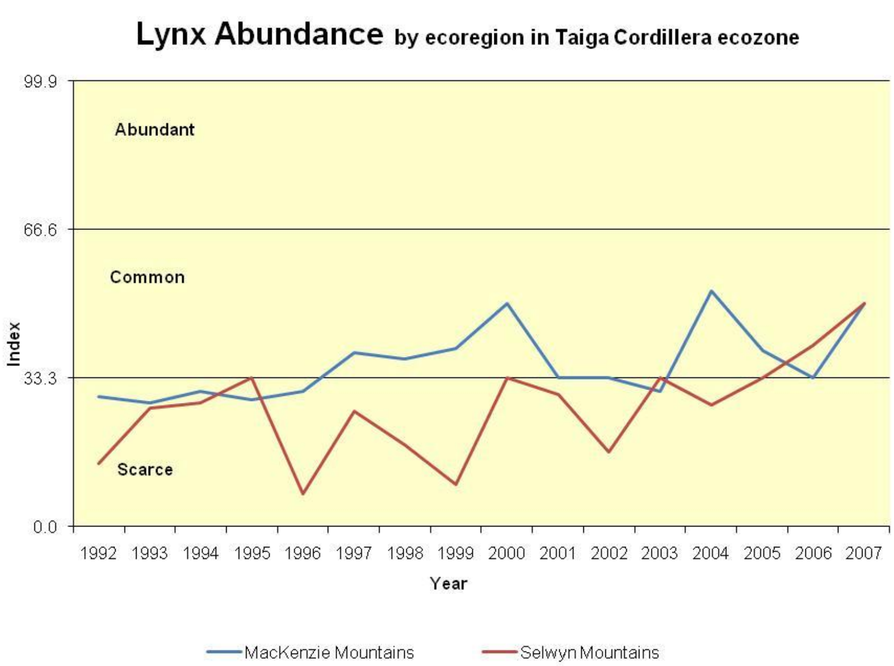


Figure 4c

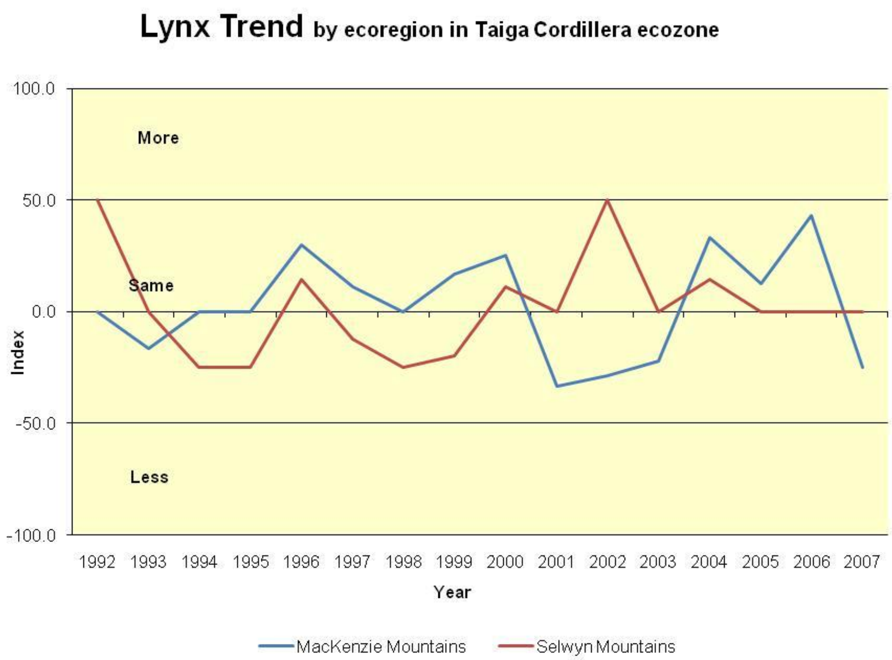


Figure 4d

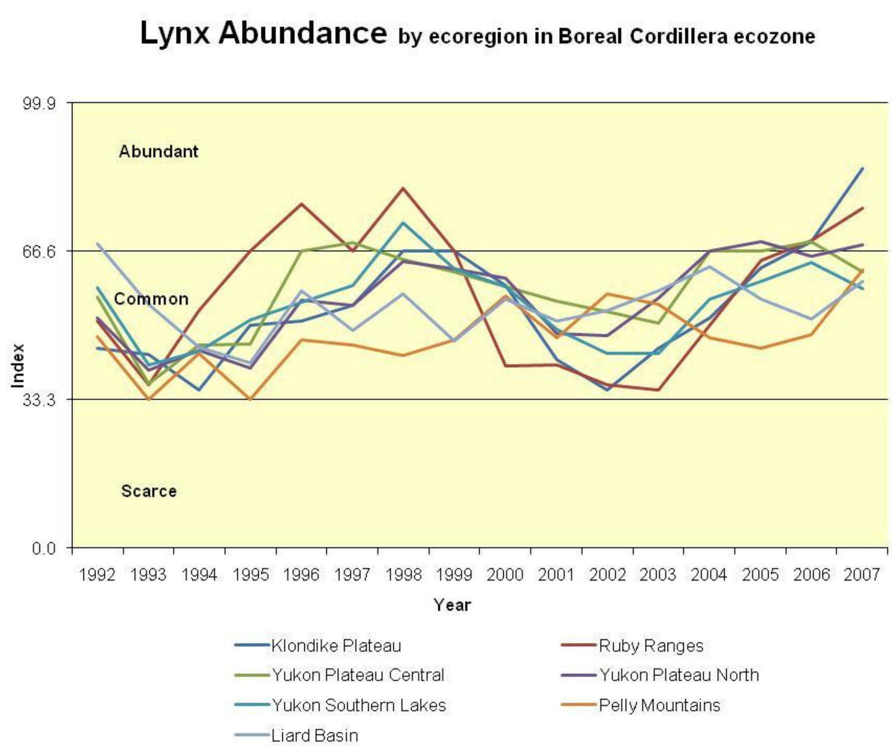


Figure 4e

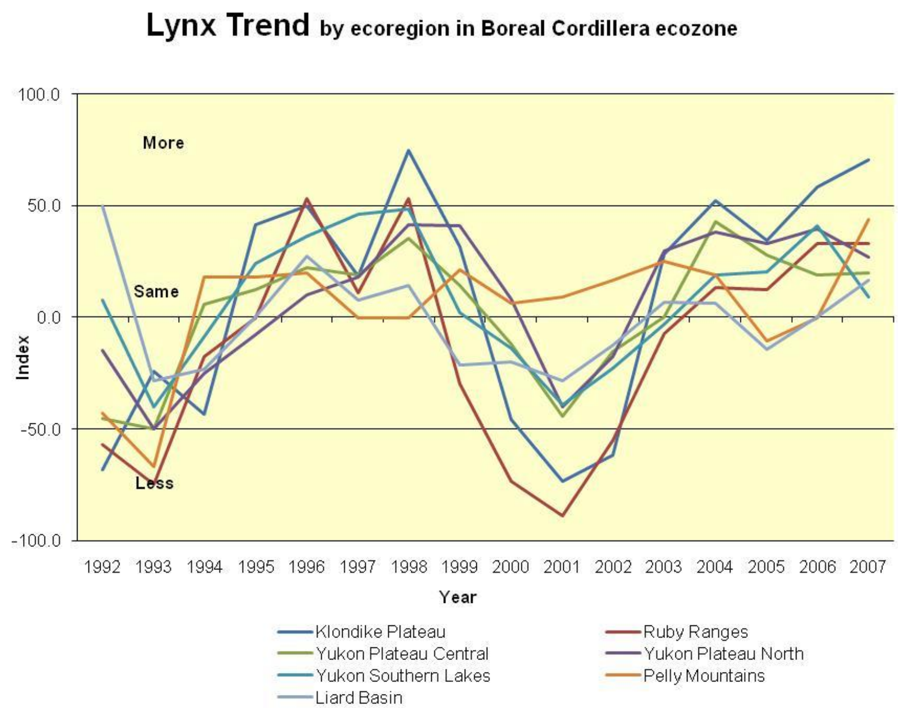


Figure 5 Population Indices for Marten by Region, Ecoregion and Marten Conservation Area.

Figure 5a

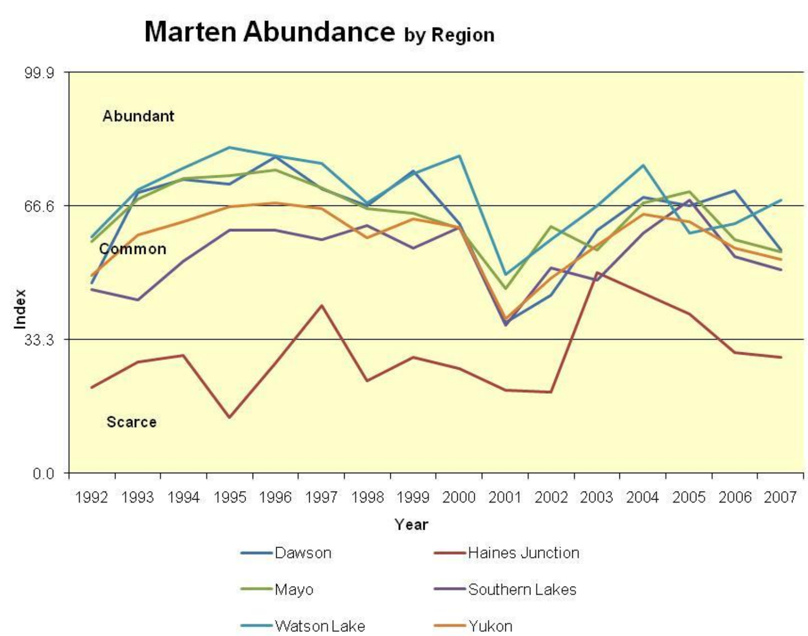


Figure 5b

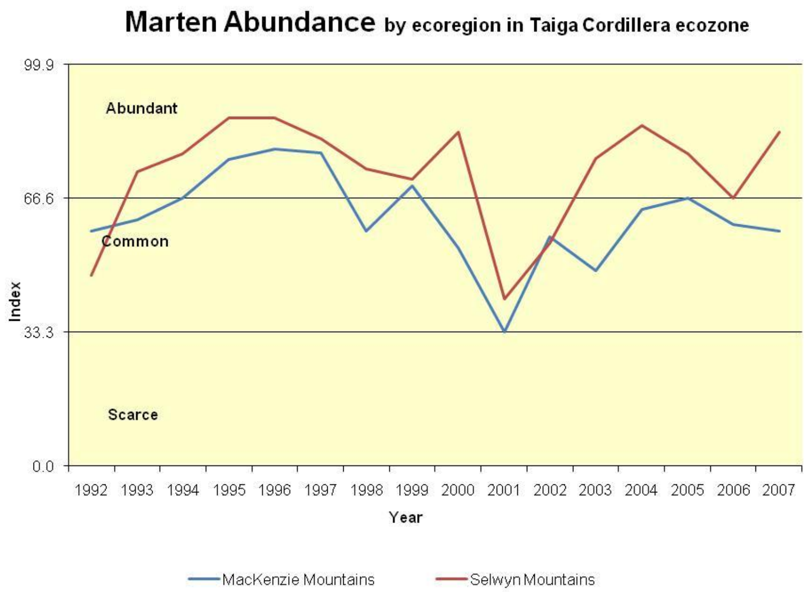


Figure 5c

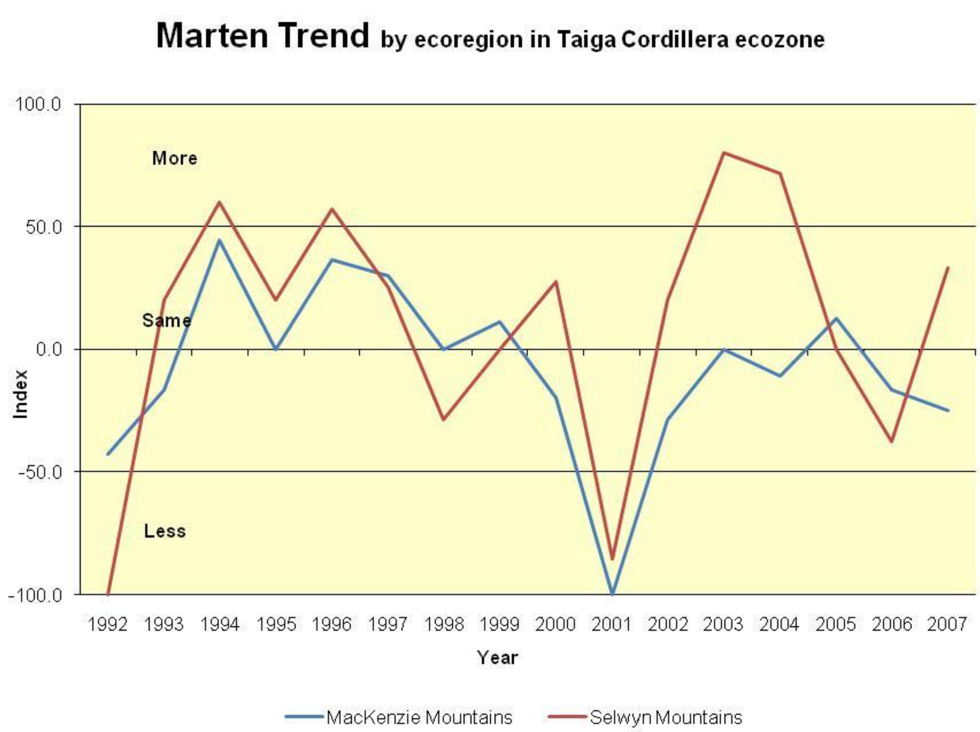


Figure 5d

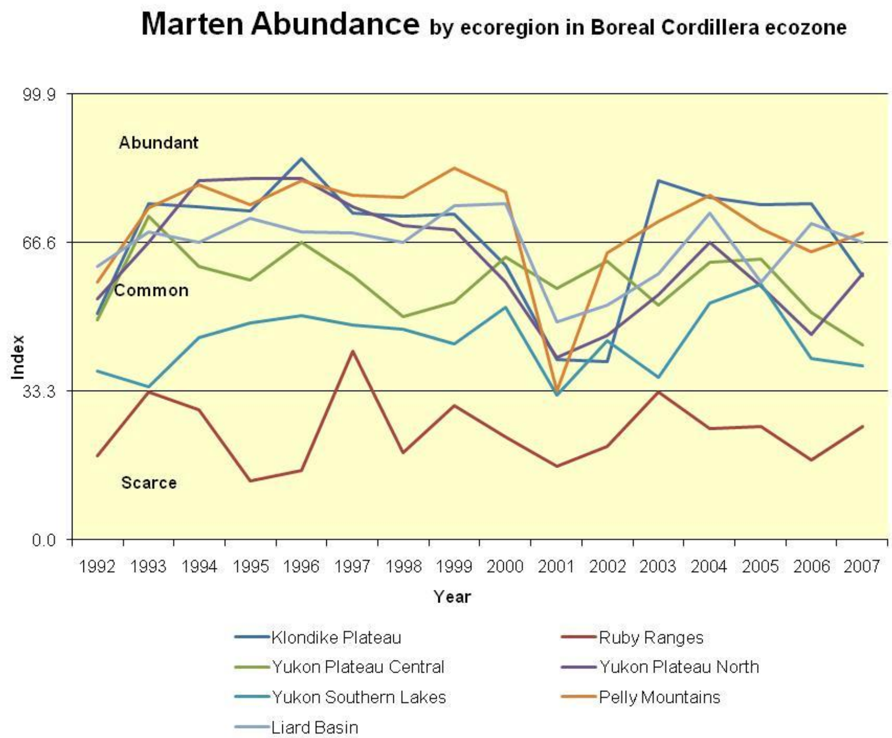


Figure 5e

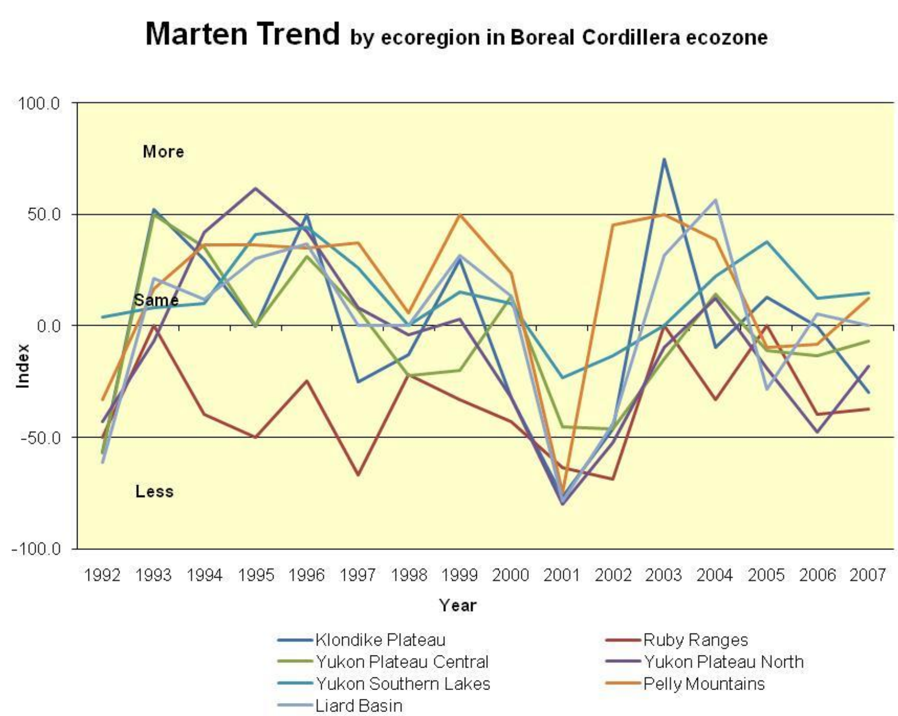


Figure 5f

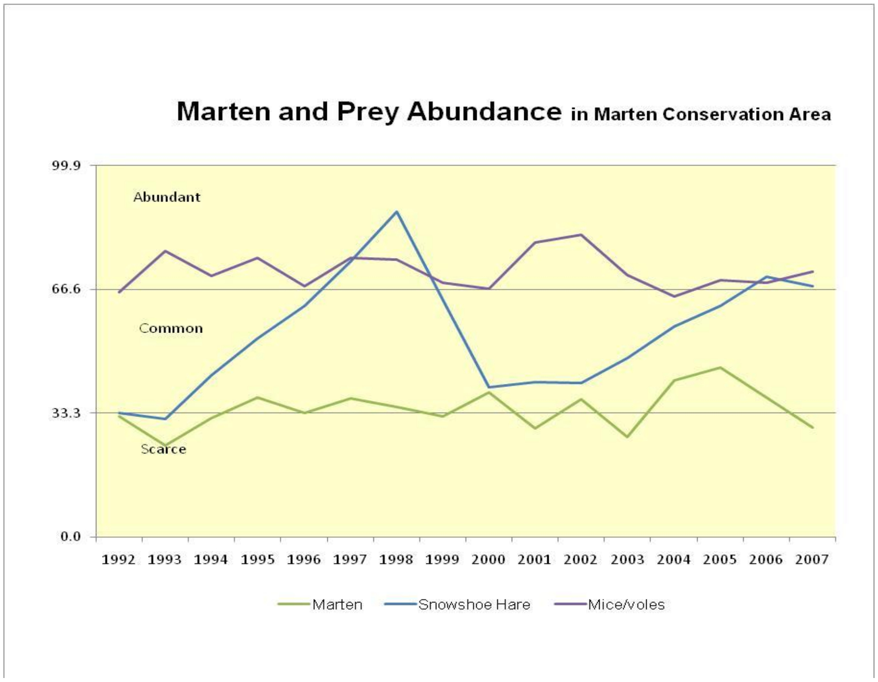


Figure 5g

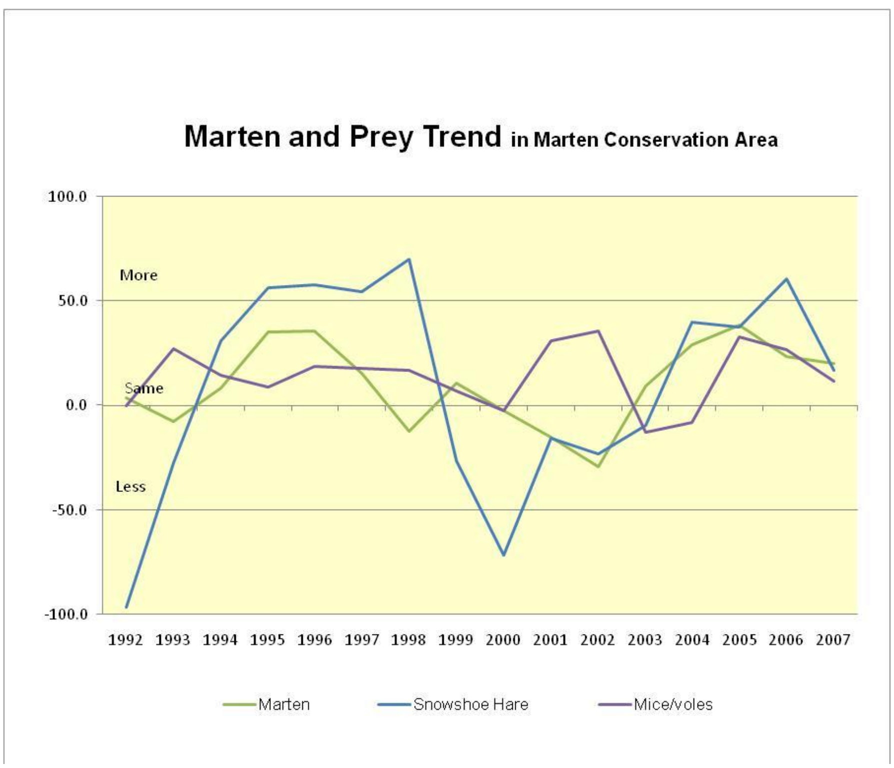


Figure 6 Population Indices for Wolverine by Region and Ecoregion.

Figure 6a

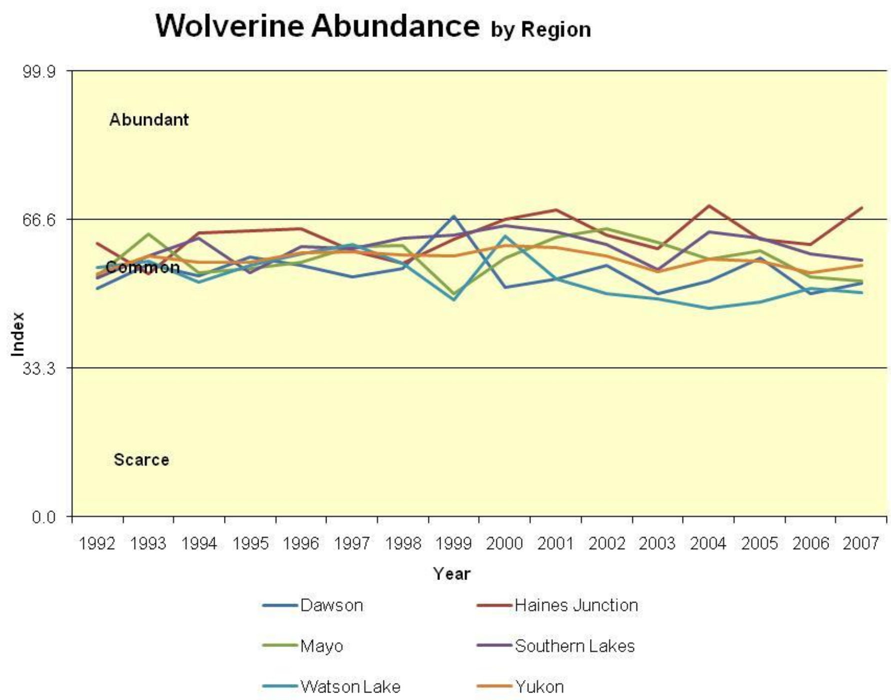


Figure 6b

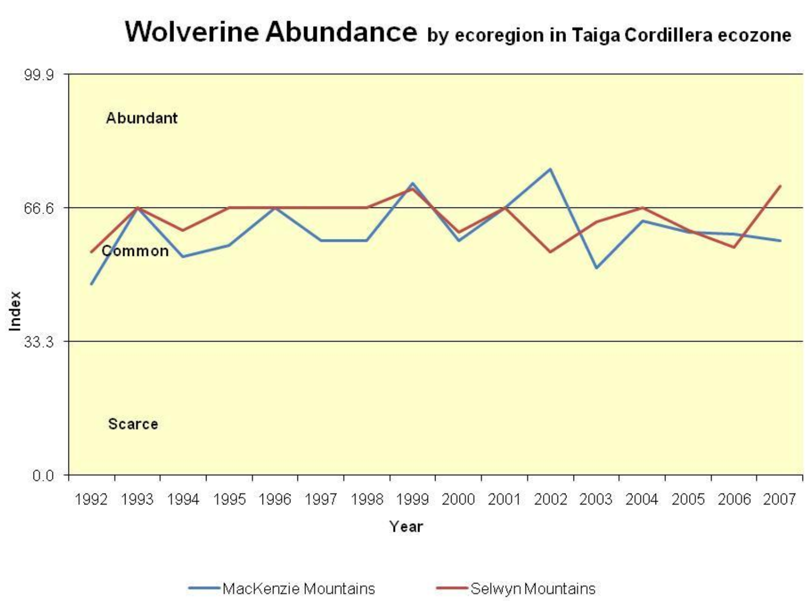


Figure 6c

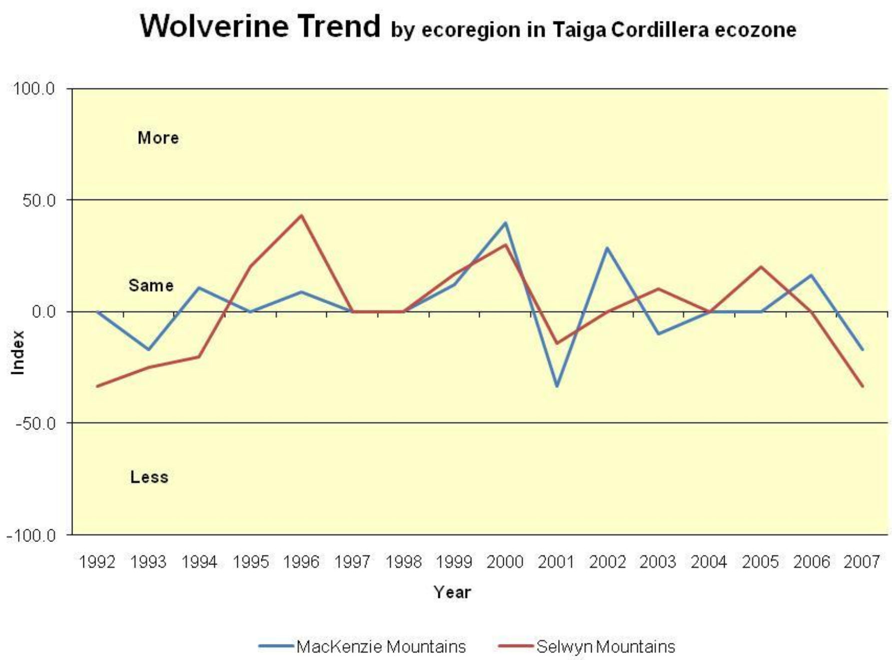


Figure 6d

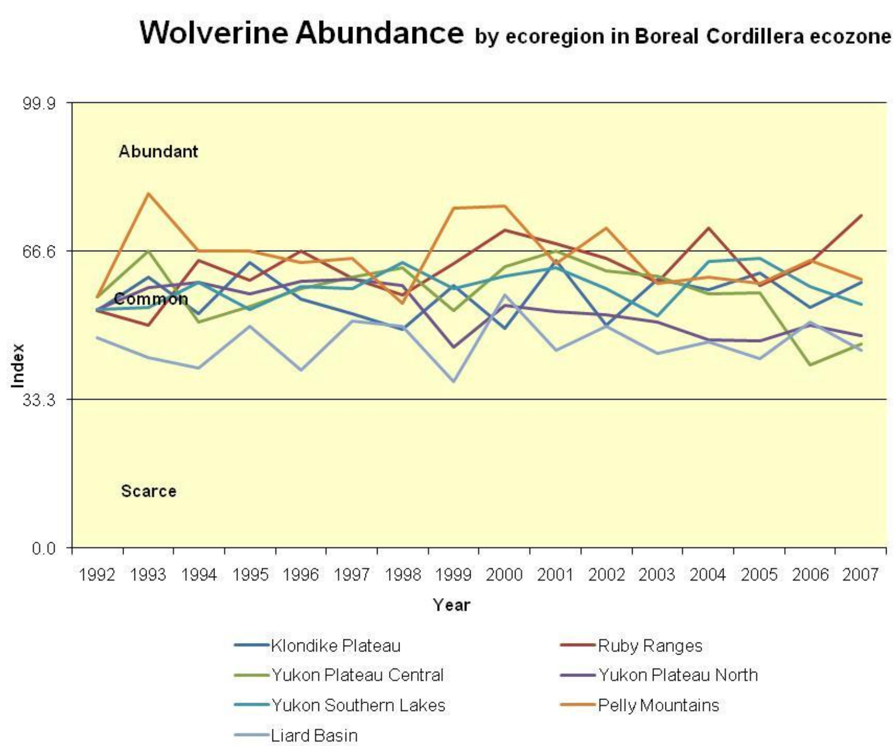


Figure 6e

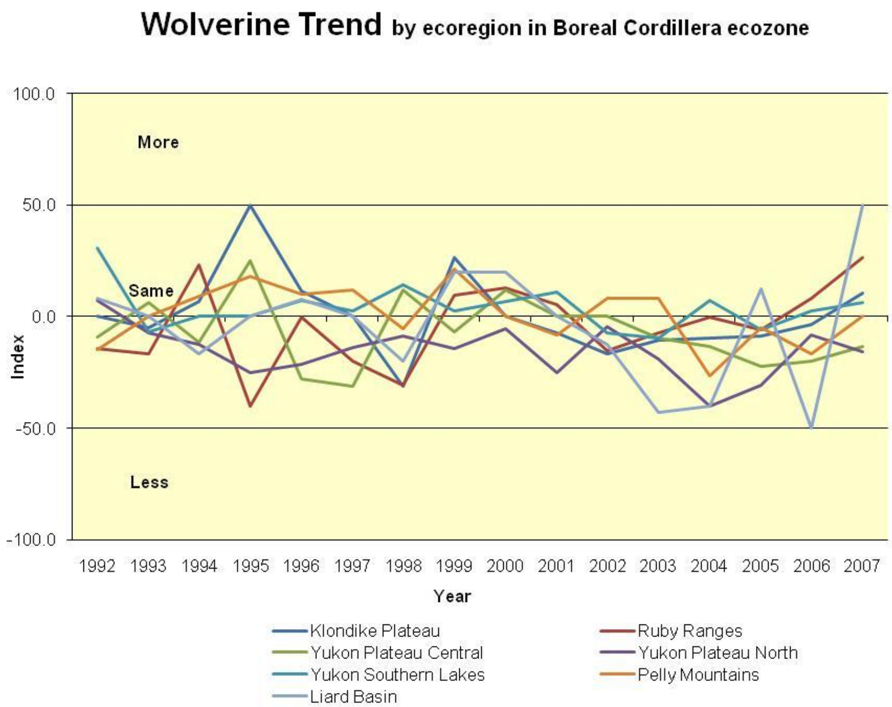


Figure 7 Population Indices for Coyote by Region and Ecoregion.

Figure 7a

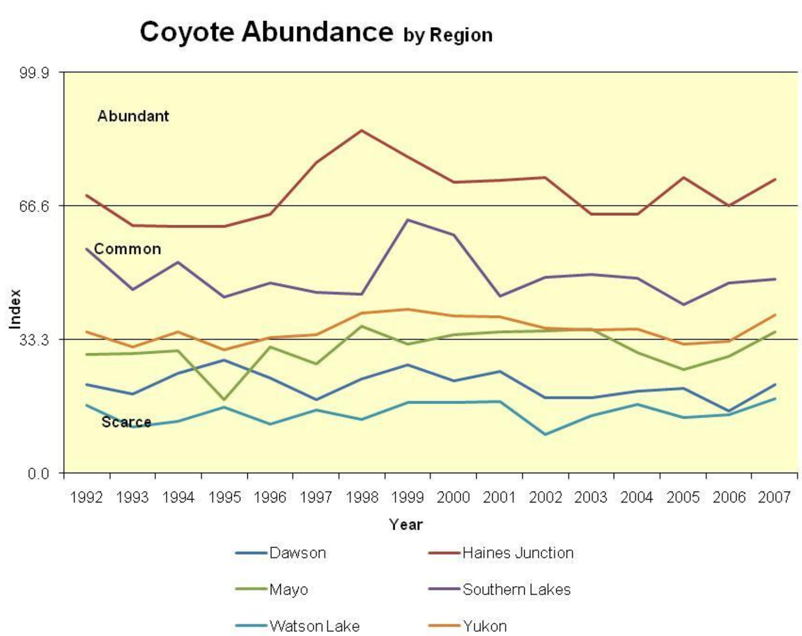


Figure 7b

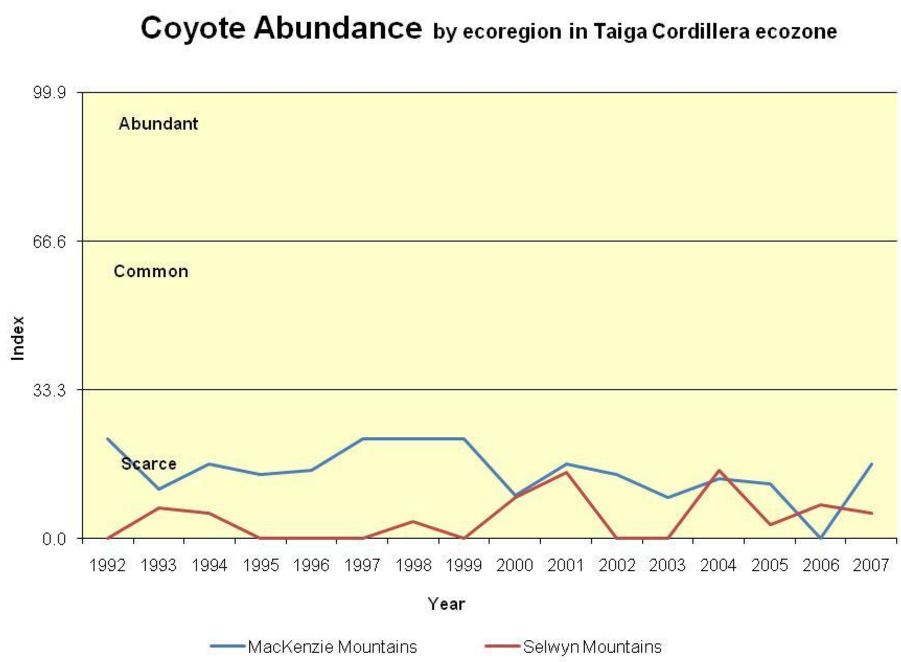


Figure 7c

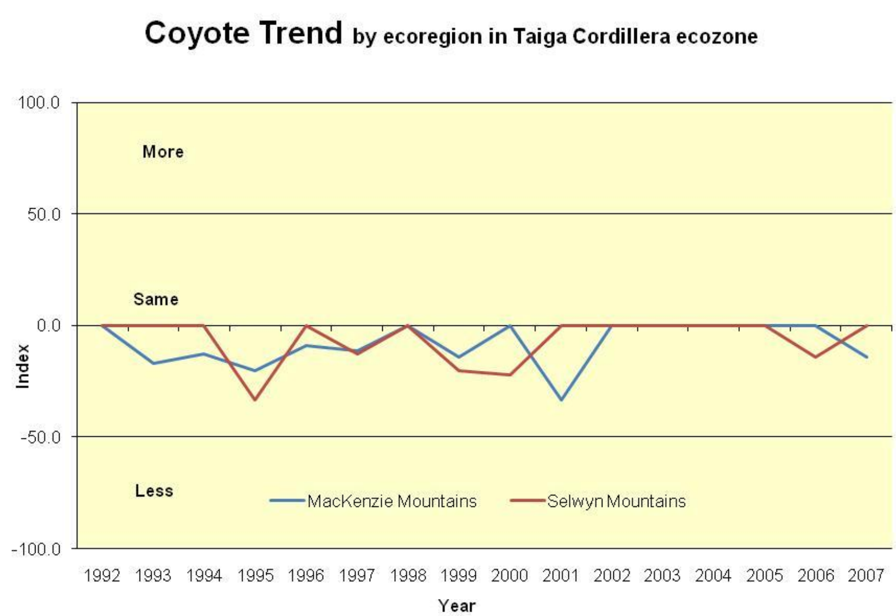


Figure 7d

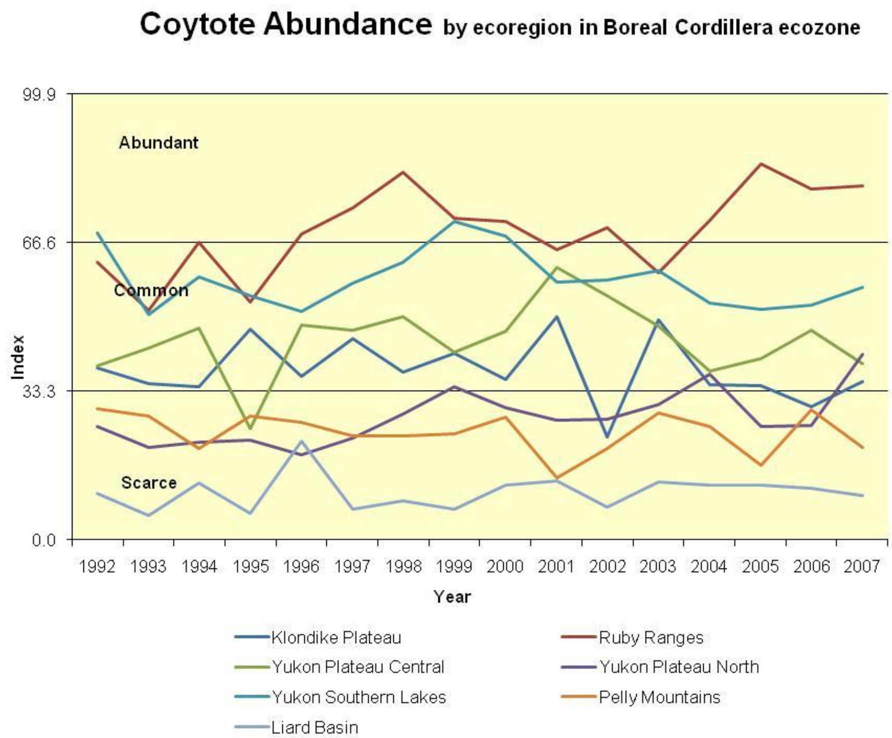


Figure 7e

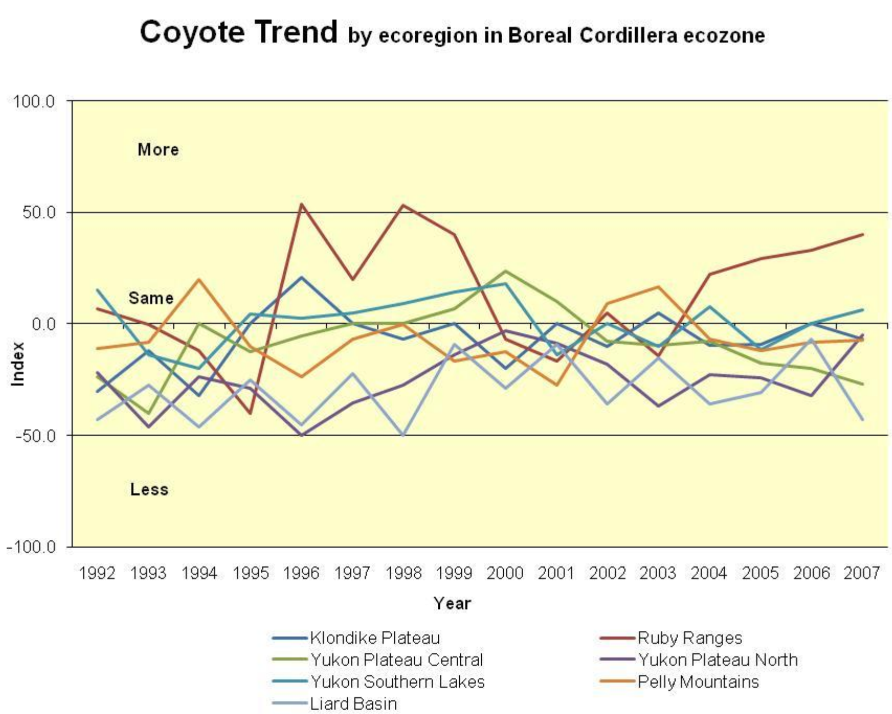


Figure 8 Population Indices for Red Squirrel by Region and Ecoregion.

Figure 8a

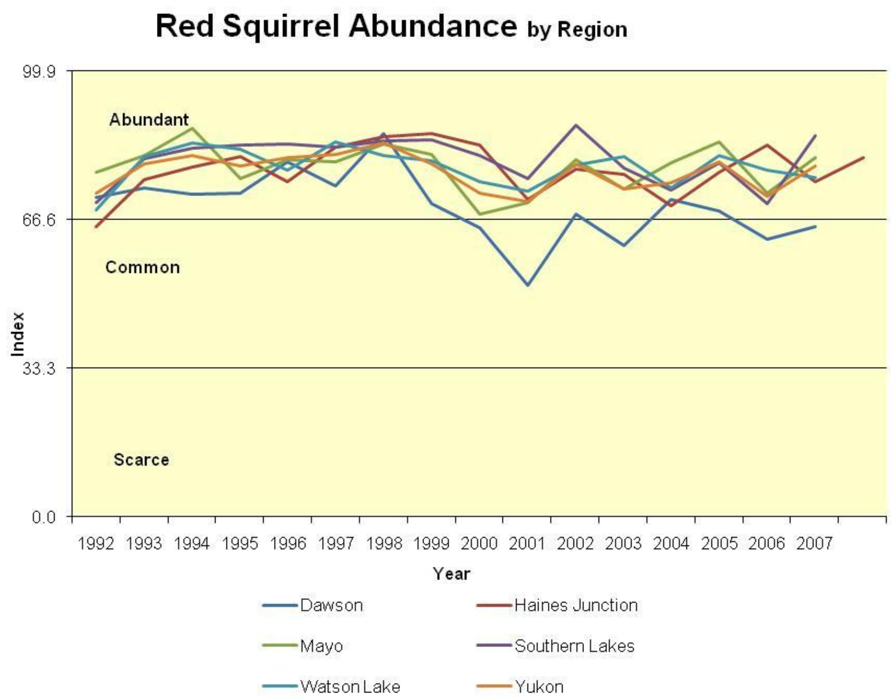


Figure 8b

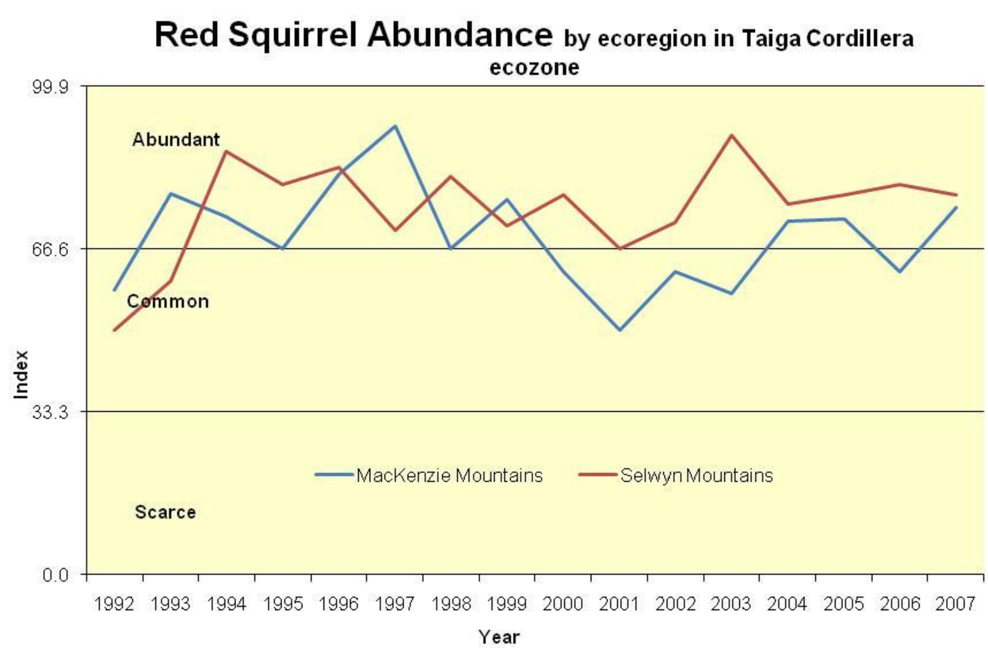


Figure 8c

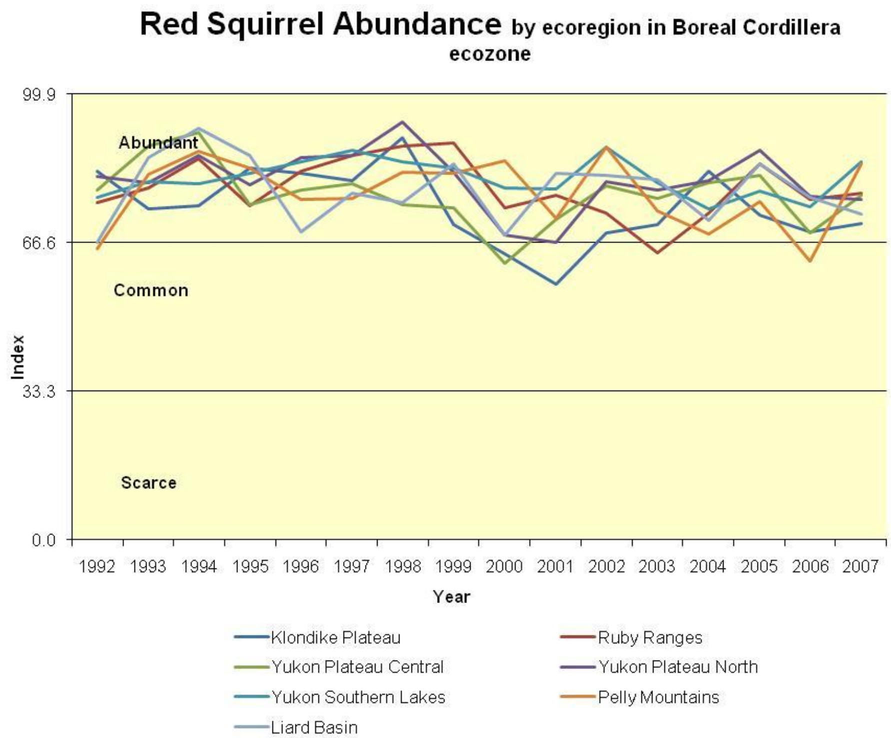


Figure 9 Population Indices for Snowshoe Hare by Region and Ecoregion.

Figure 9a

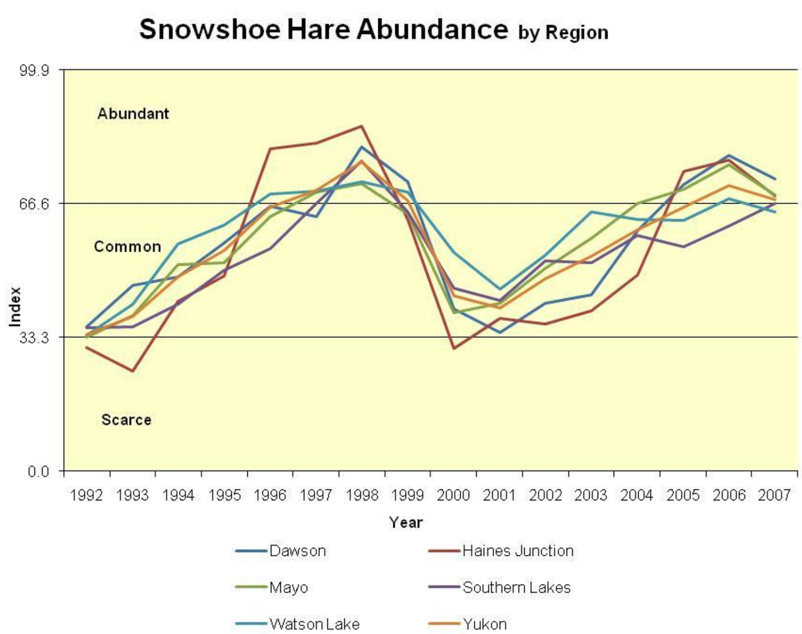


Figure 9b

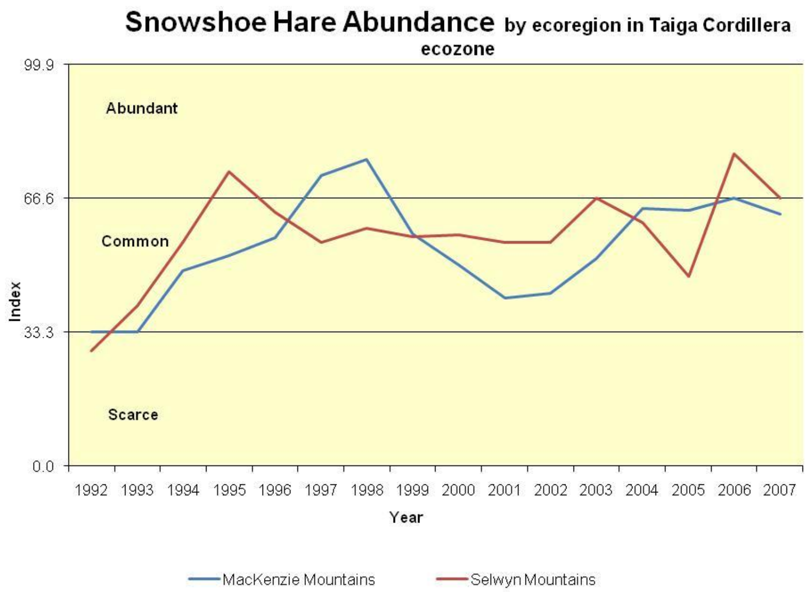


Figure 9c

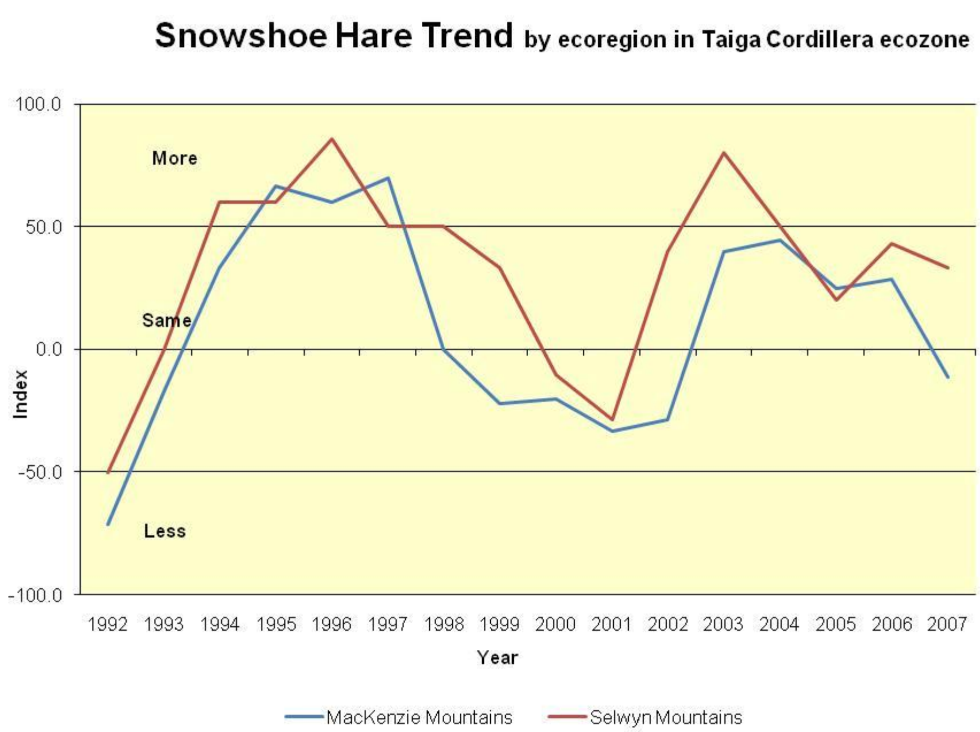


Figure 9d

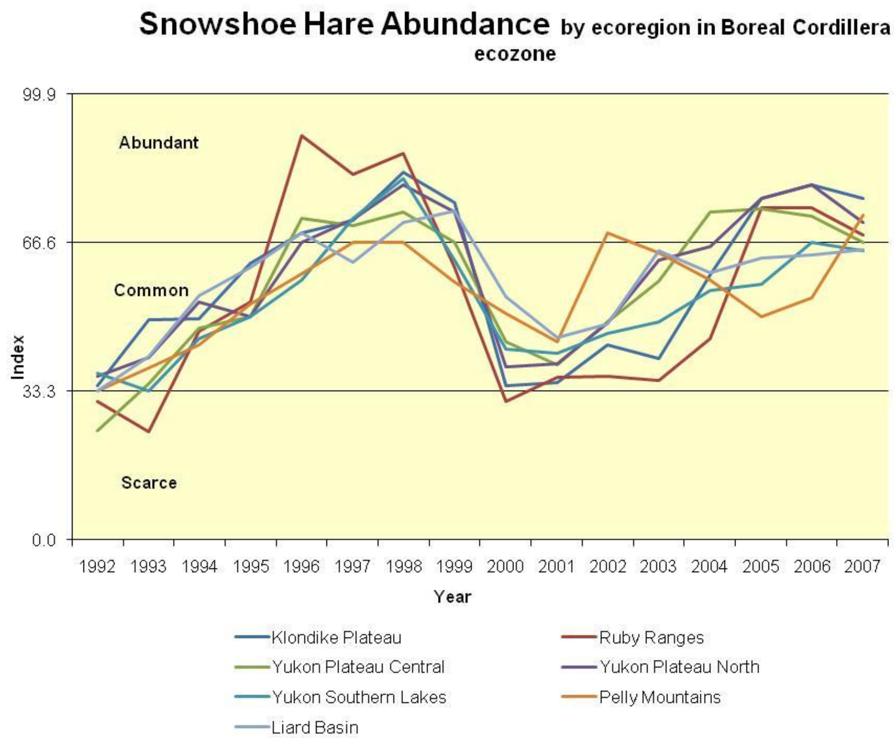


Figure 9e

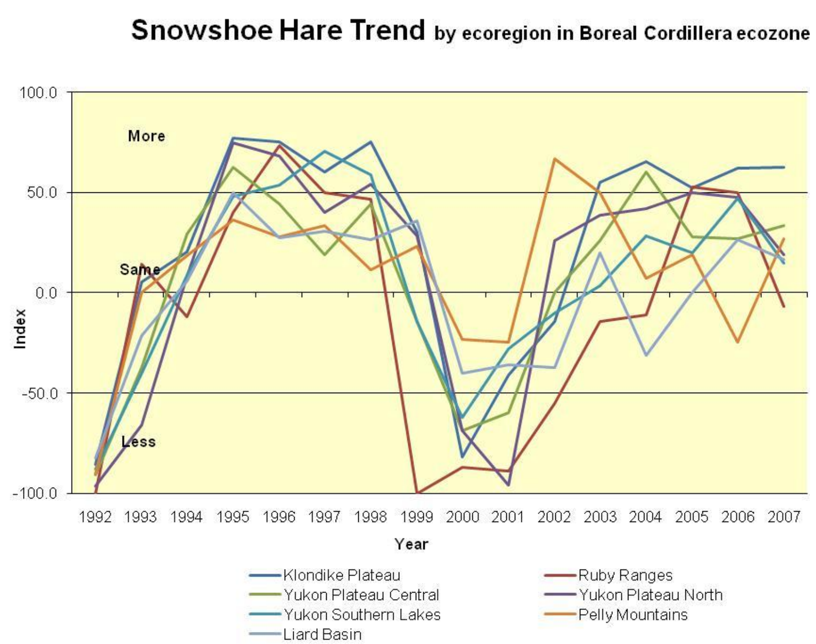


Figure 10 Population Indices for Grouse/Ptarmiganl by Region and Ecoregion.

Figure 10a

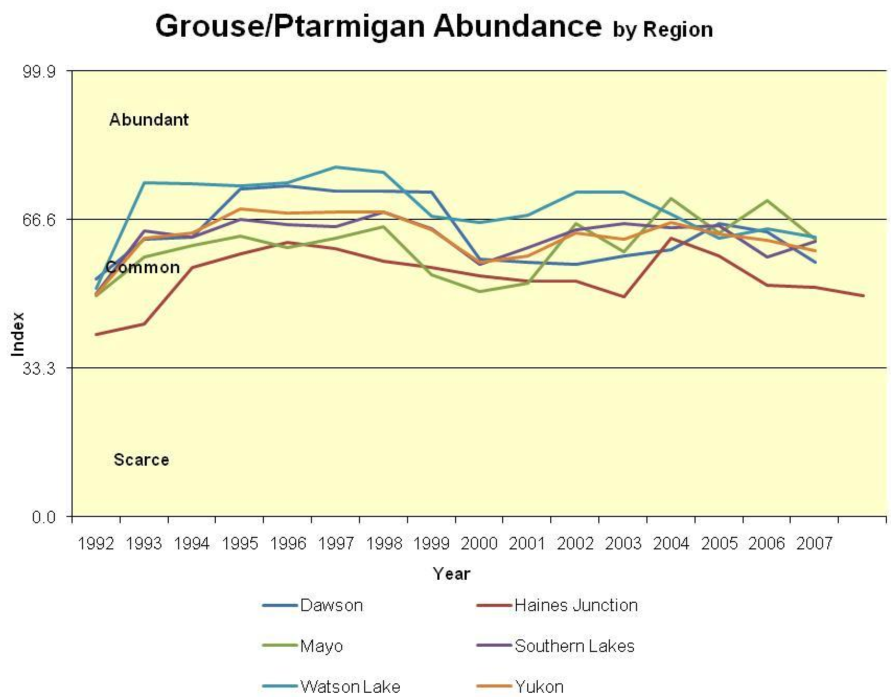


Figure 10b

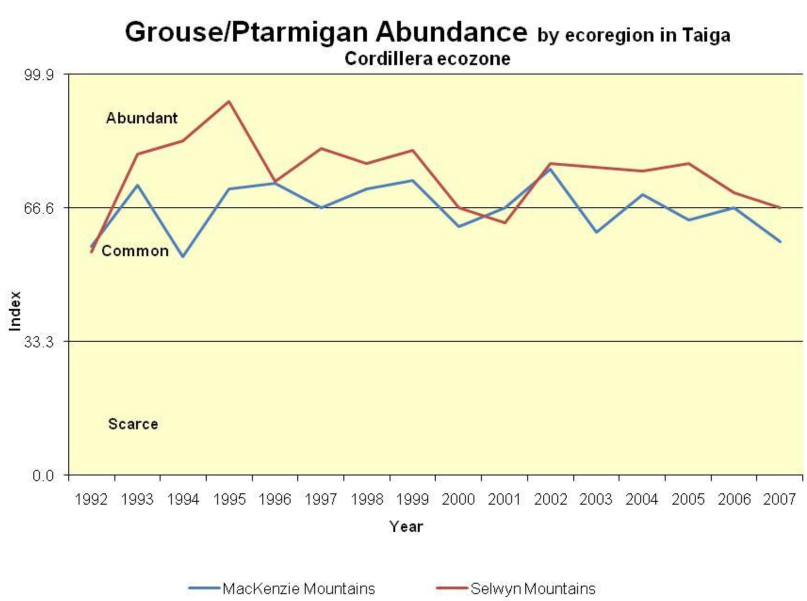


Figure 10c

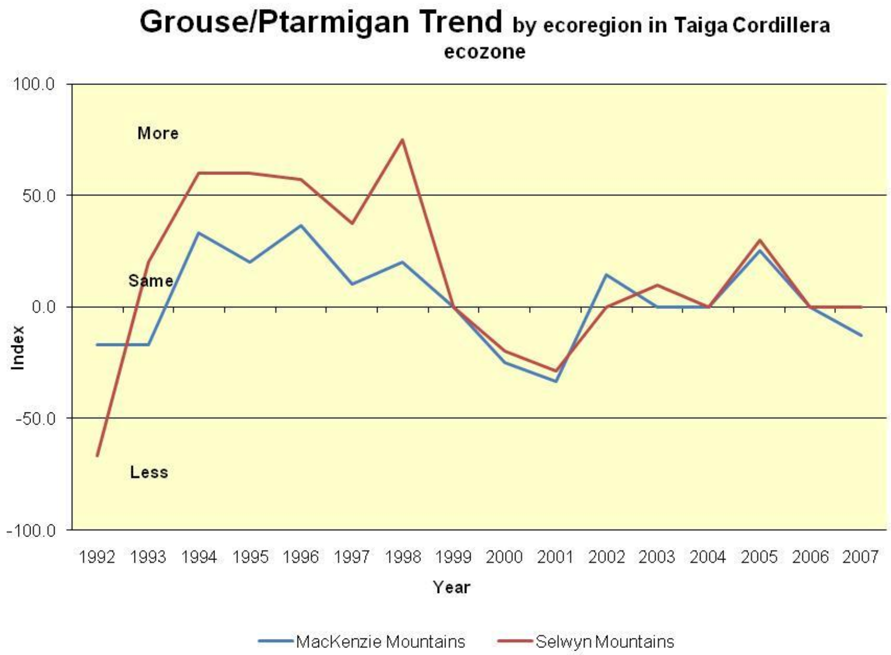


Figure 10d

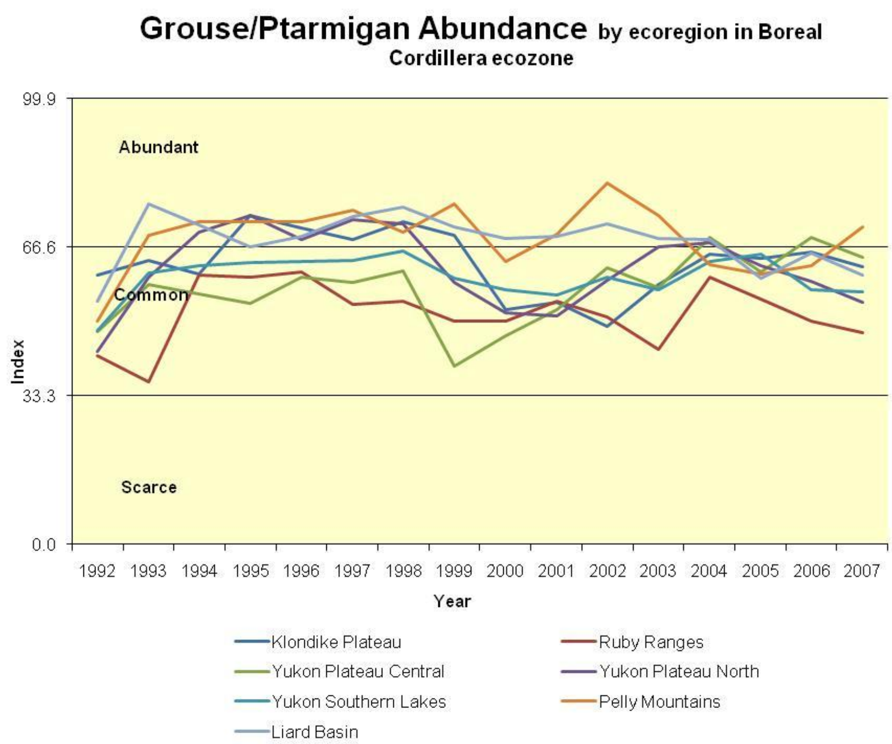


Figure 10e

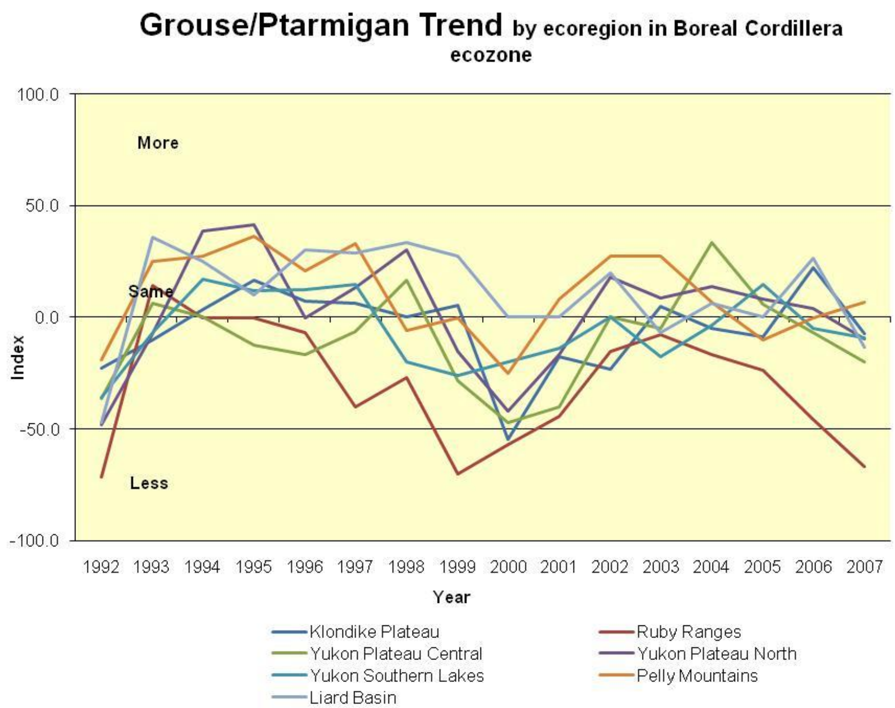


Figure 11 Population Indices for Mice/Voles by Region and Ecoregion.

Figure 11a

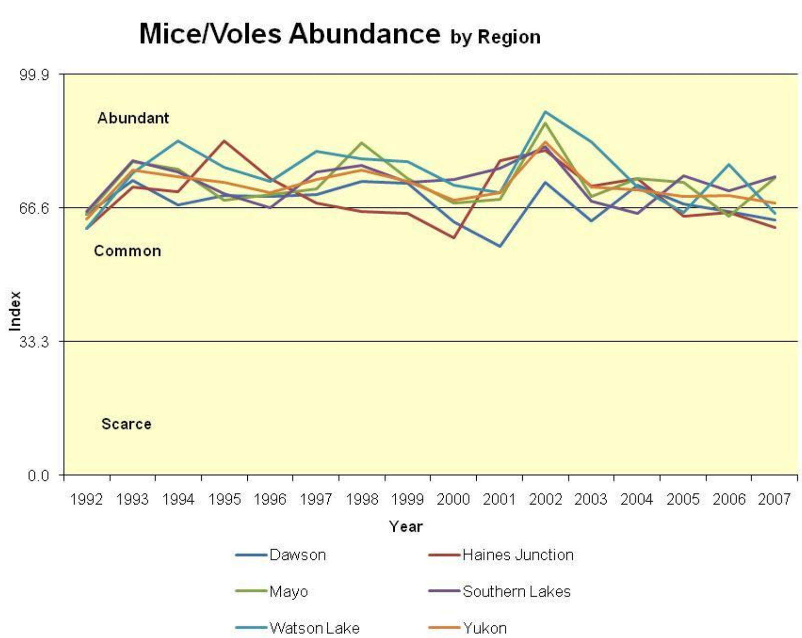


Figure 11b

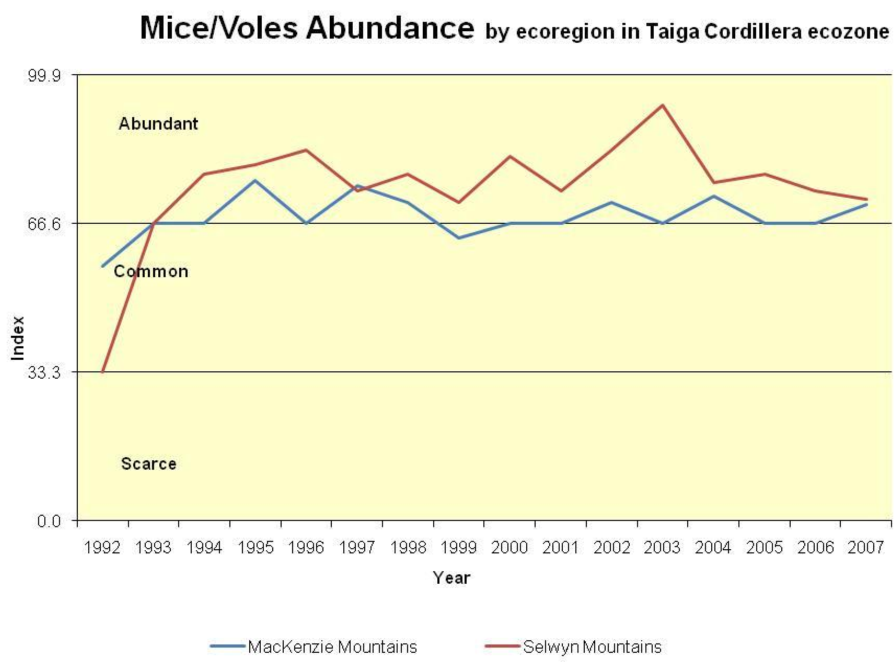


Figure 11c

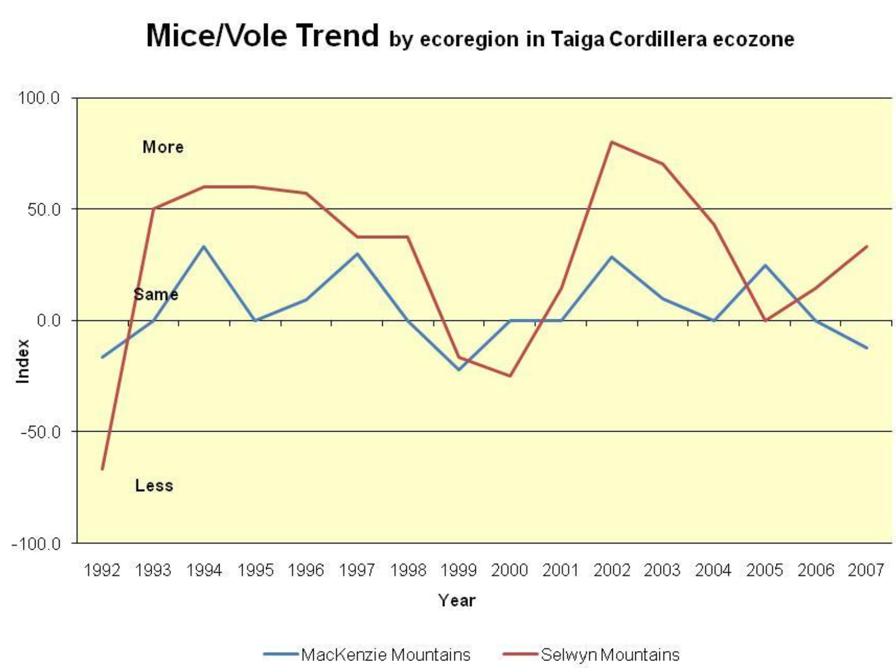


Figure 11d

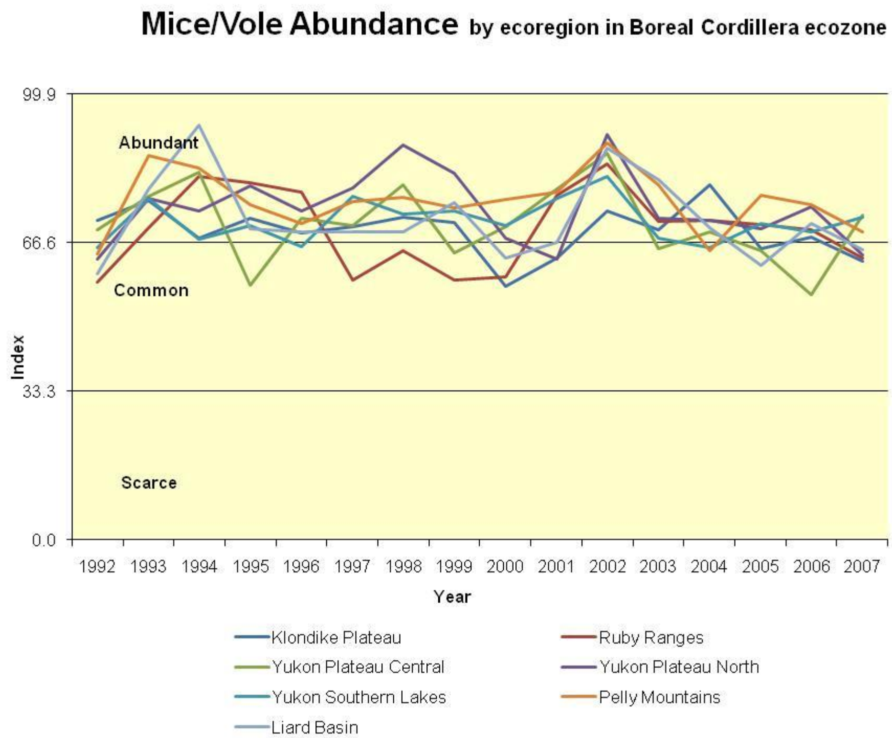


Figure 11e

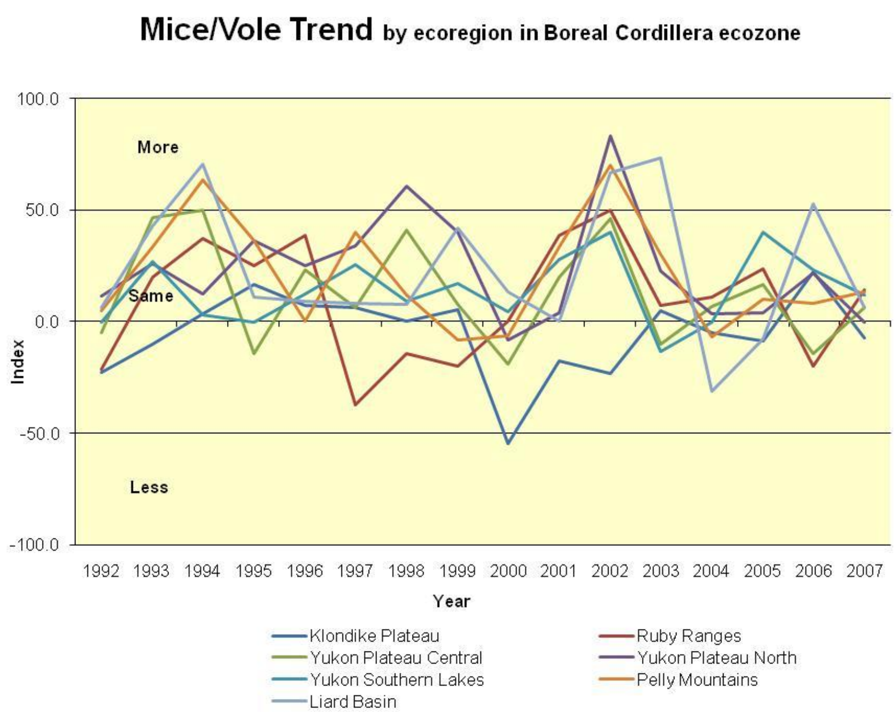


Figure 12 Population Indices for Beaver by Region and Ecoregion.

Figure 12a

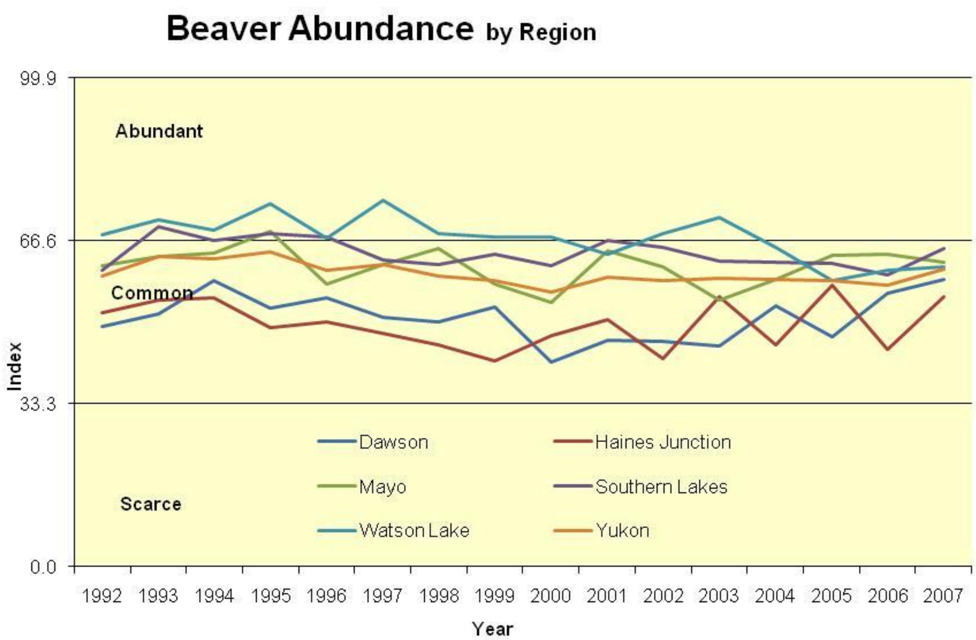


Figure 12b

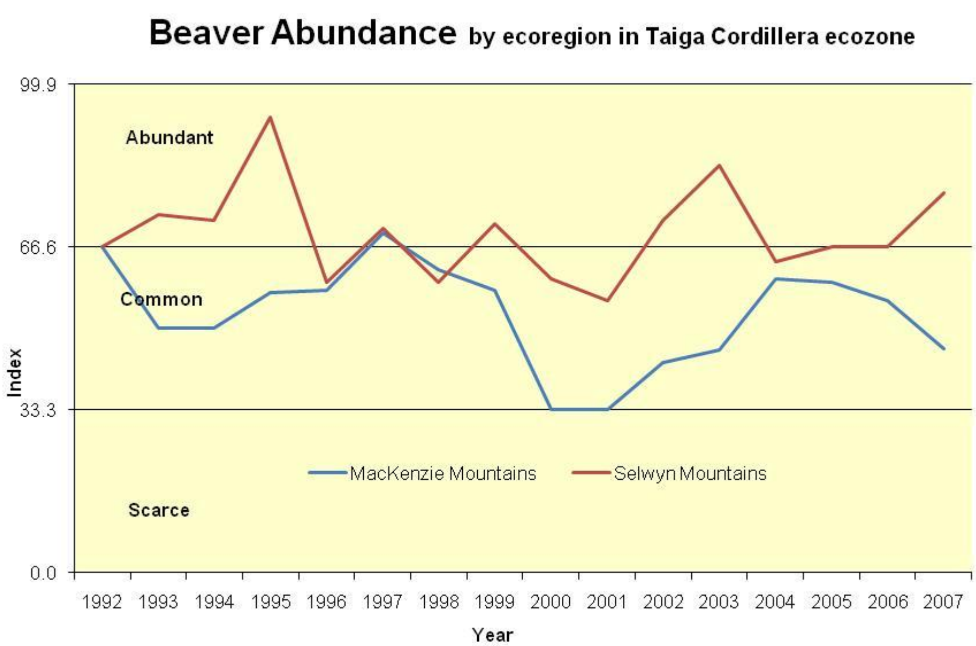


Figure 12c

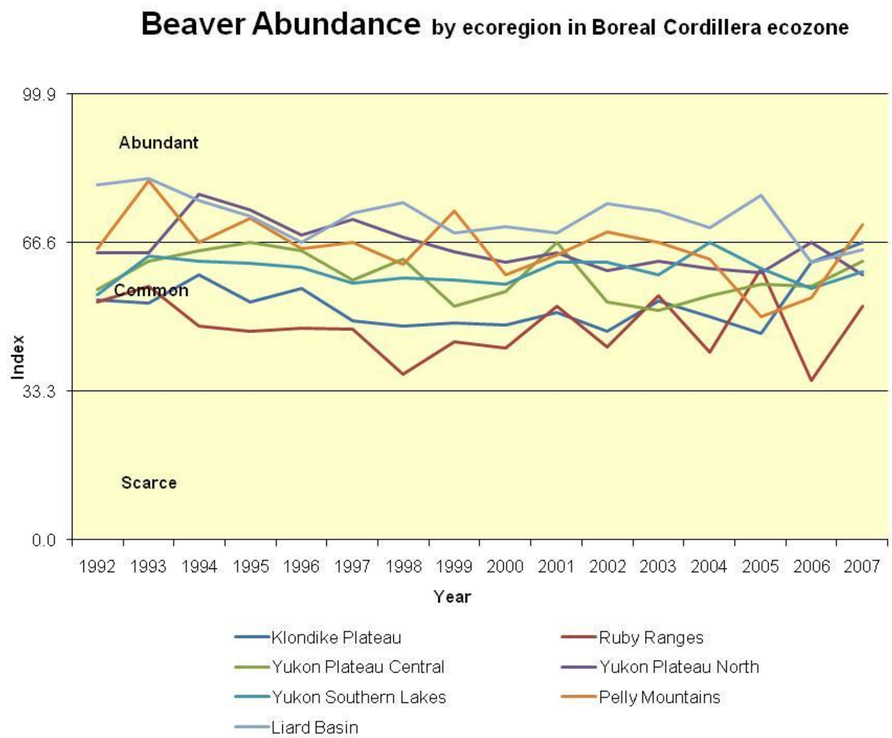


Figure 13 Population Indices for Muskrat by Region and Ecoregion.

Figure 13a

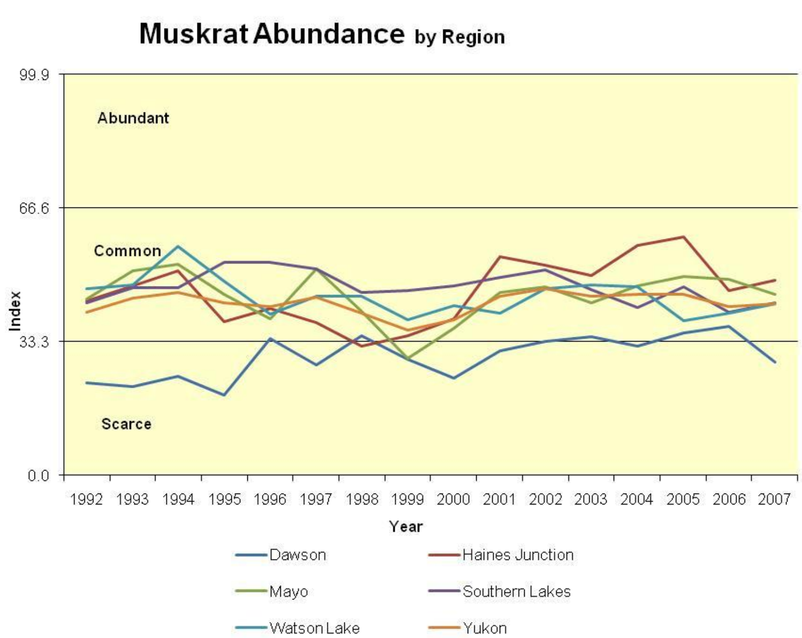


Figure 13b

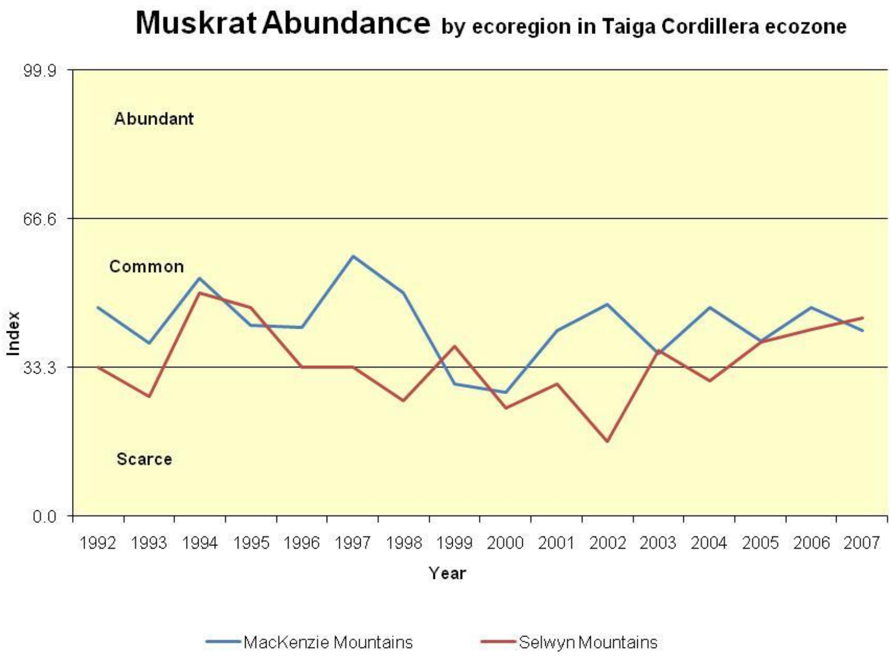


Figure 13c

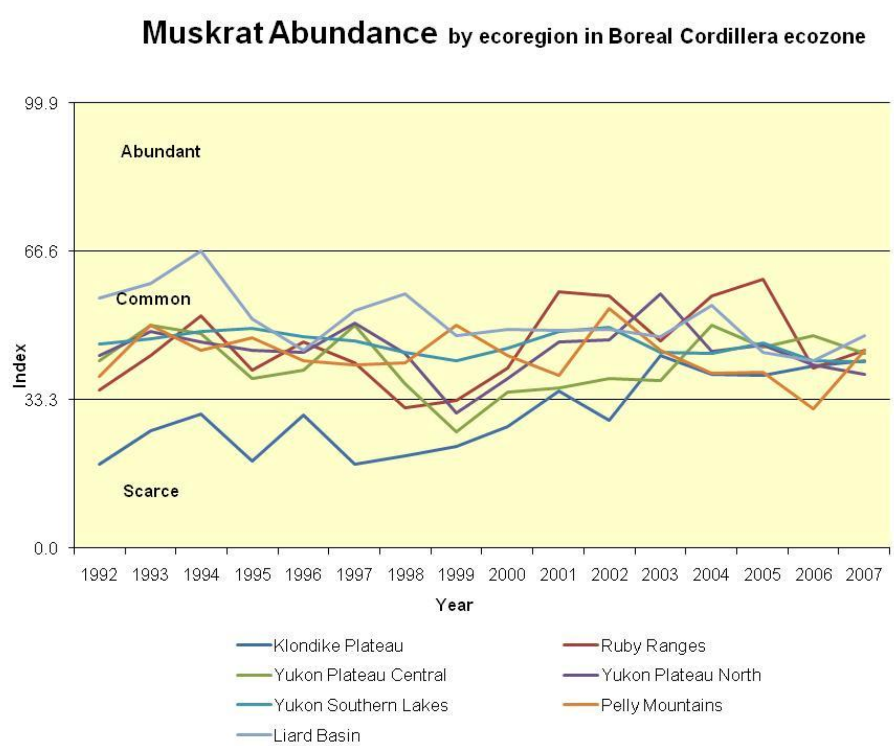


Figure 14 Population Indices for Mink by Region and Ecoregion.

Figure 14a

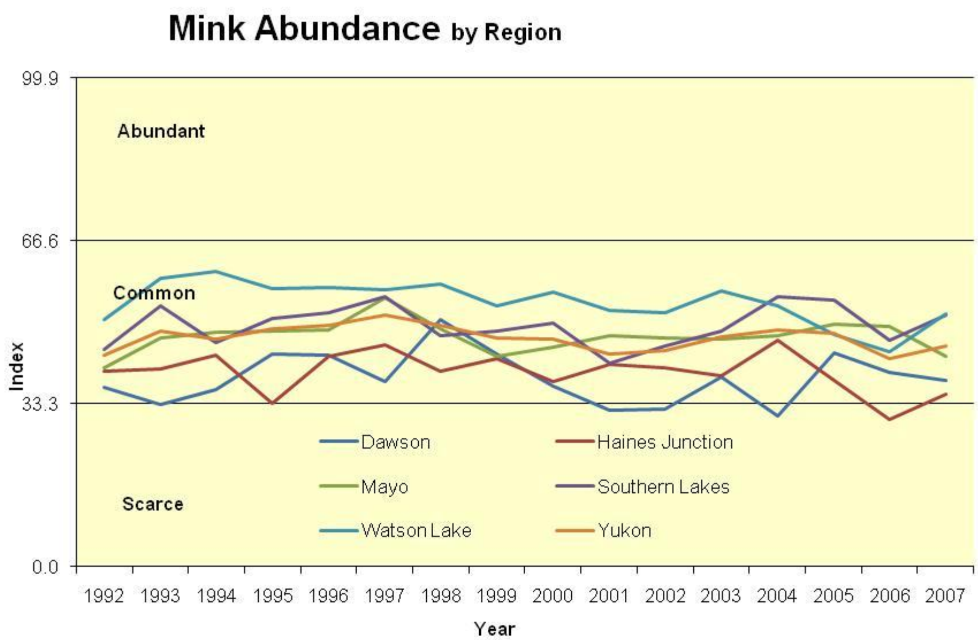


Figure 14b

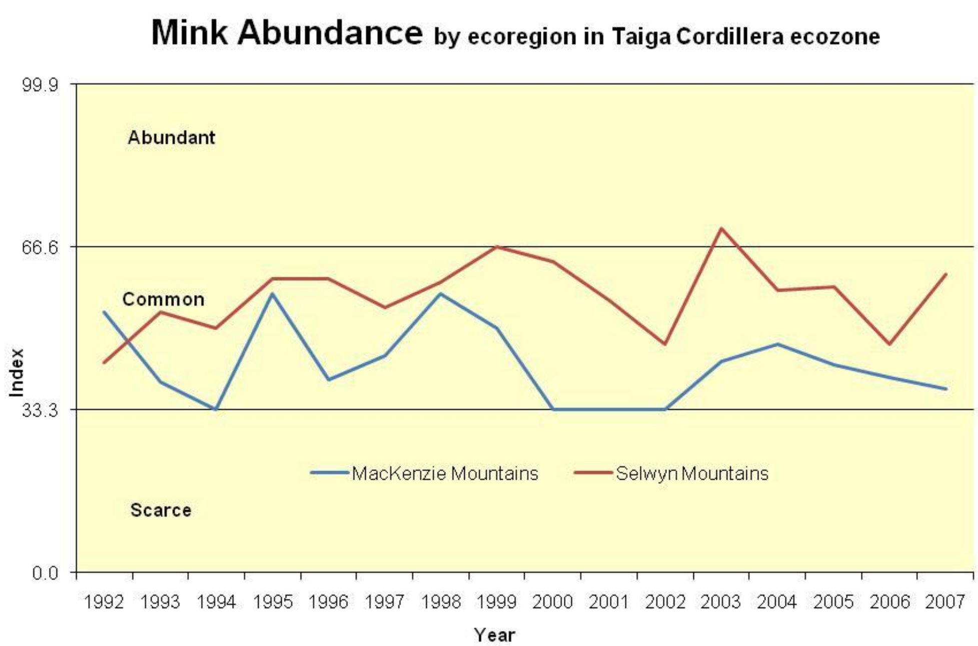


Figure 14c

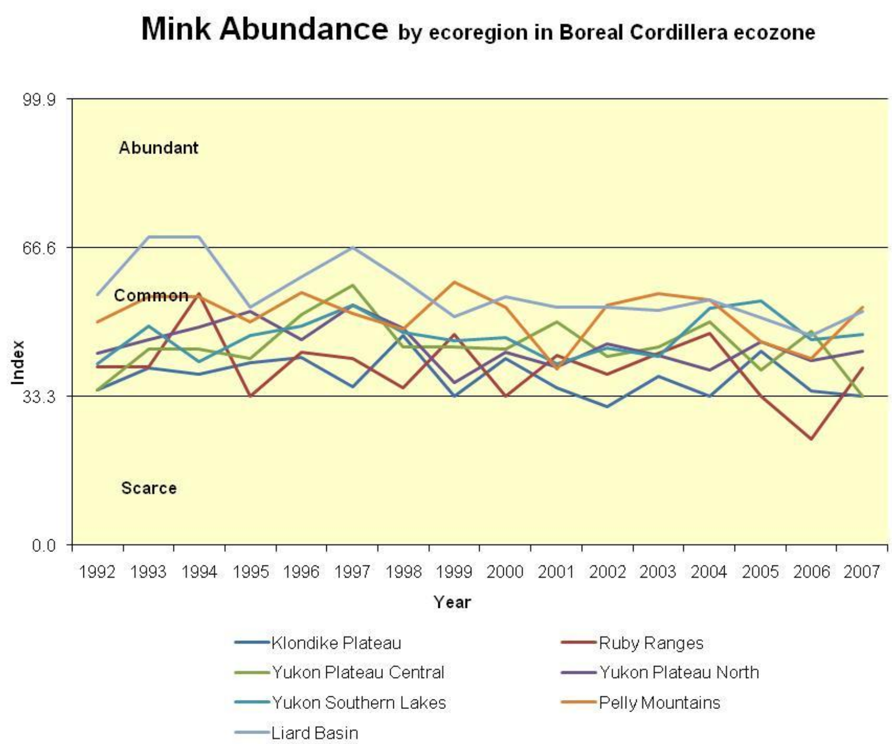


Figure 15 Population Indices for River Otter by Region and Ecoregion.

Figure 15a

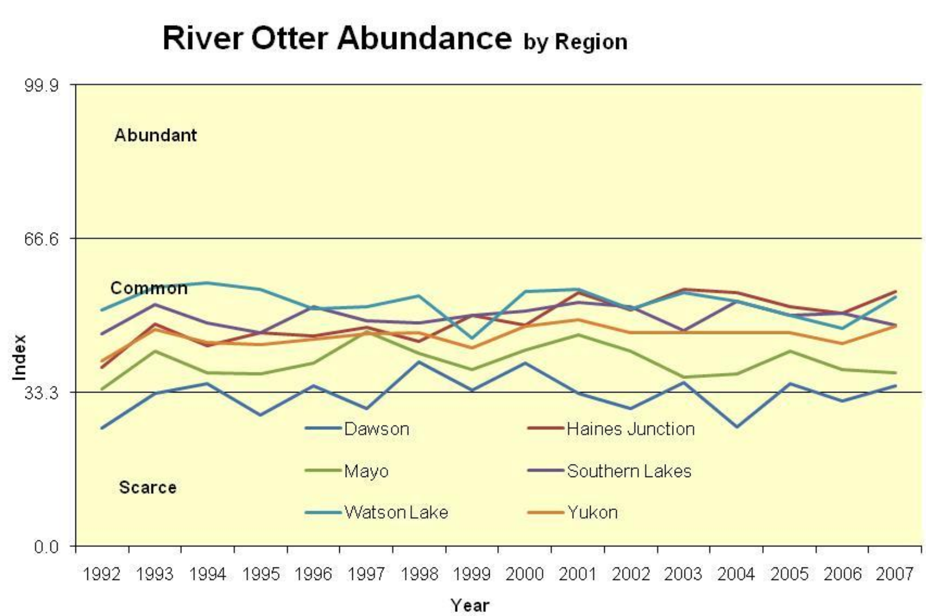


Figure 15b

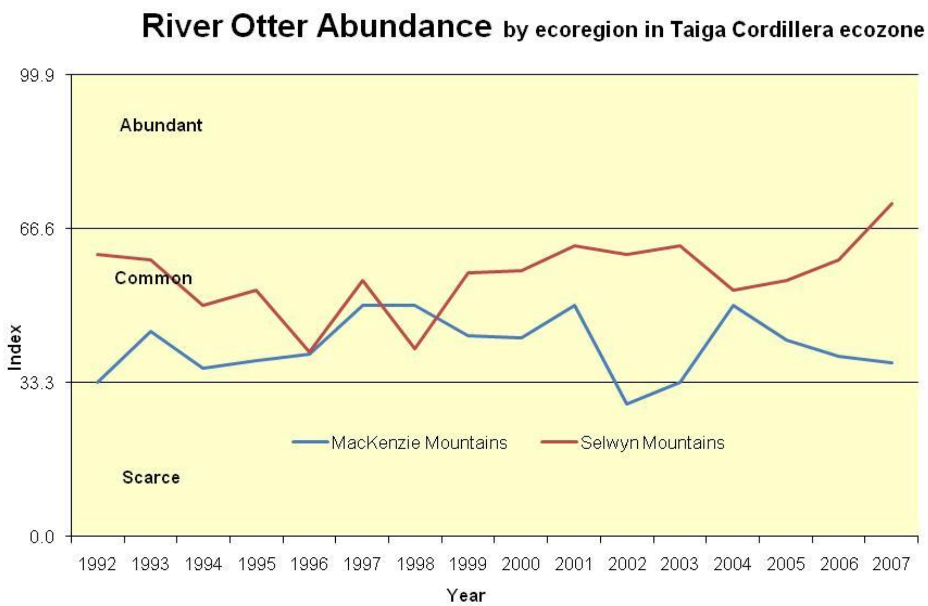


Figure 15c

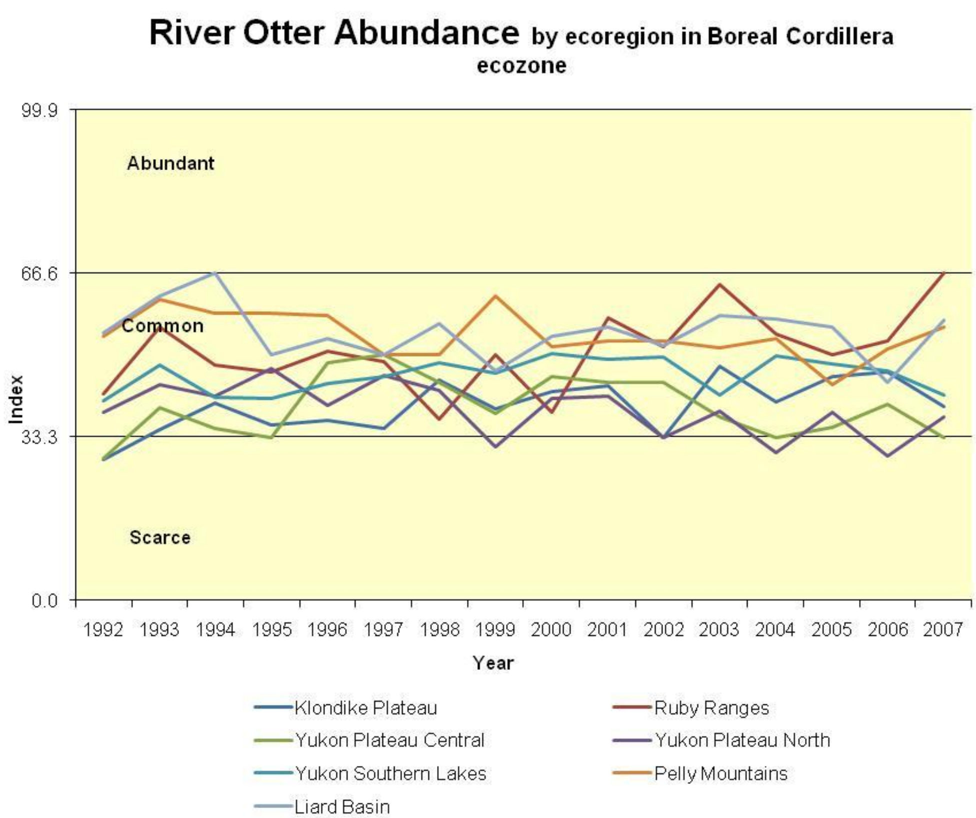


Figure 16 Population Indices for Weasel by Region and Ecoregion.

Figure 16a

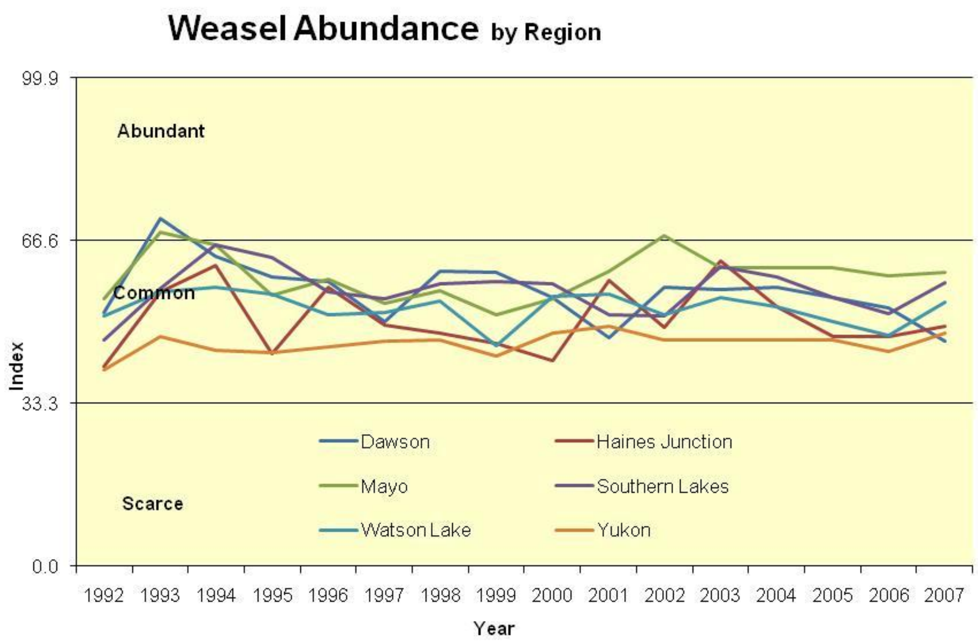


Figure 16b

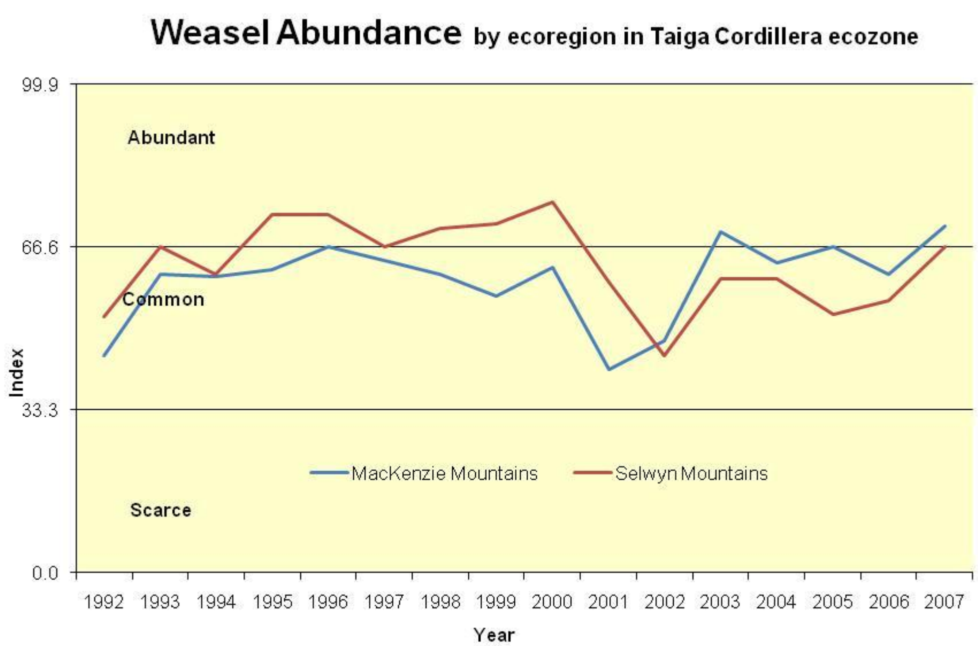


Figure 16c

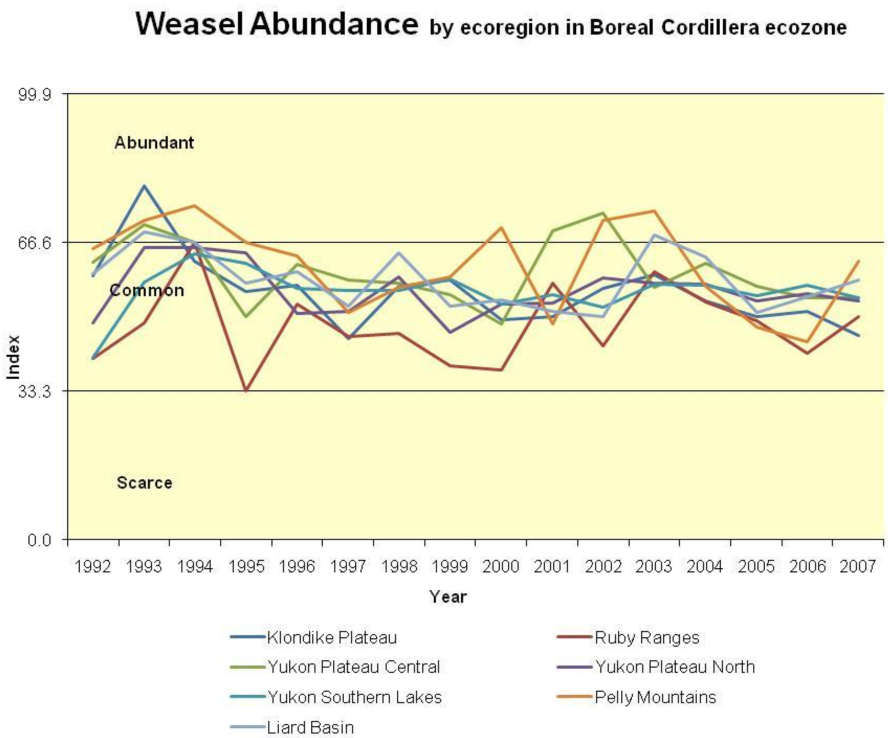


Figure 17 Population Indices for Red Fox by Region and Ecoregion.

Figure 17a

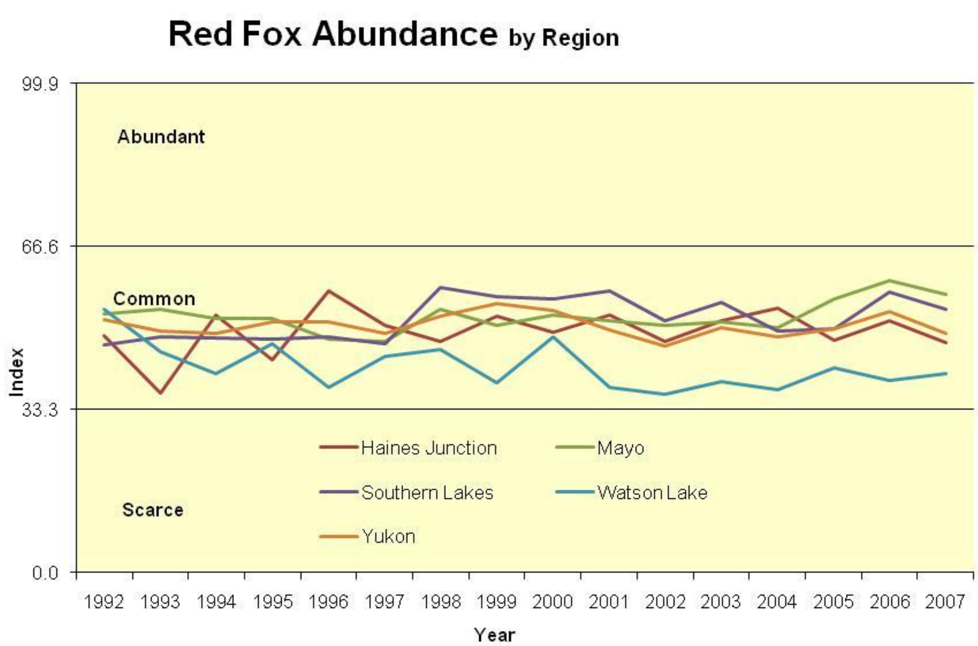


Figure 17b

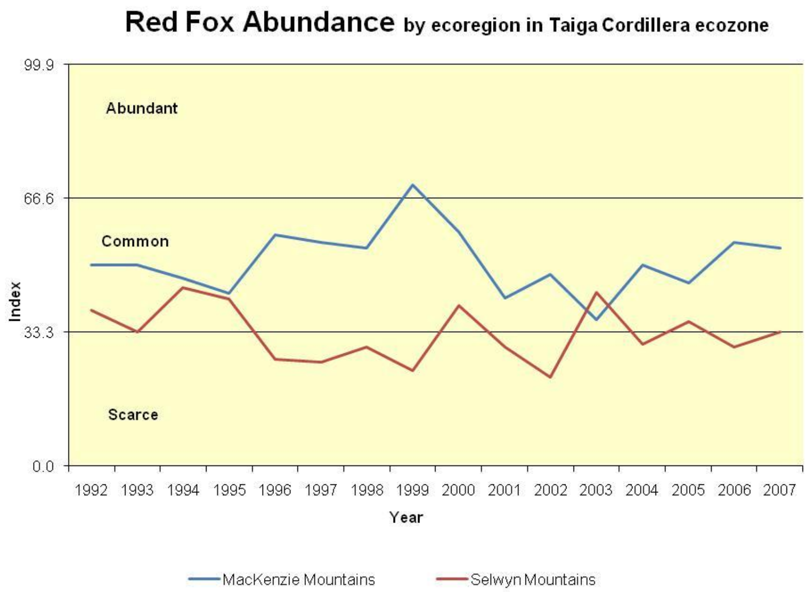


Figure 17c

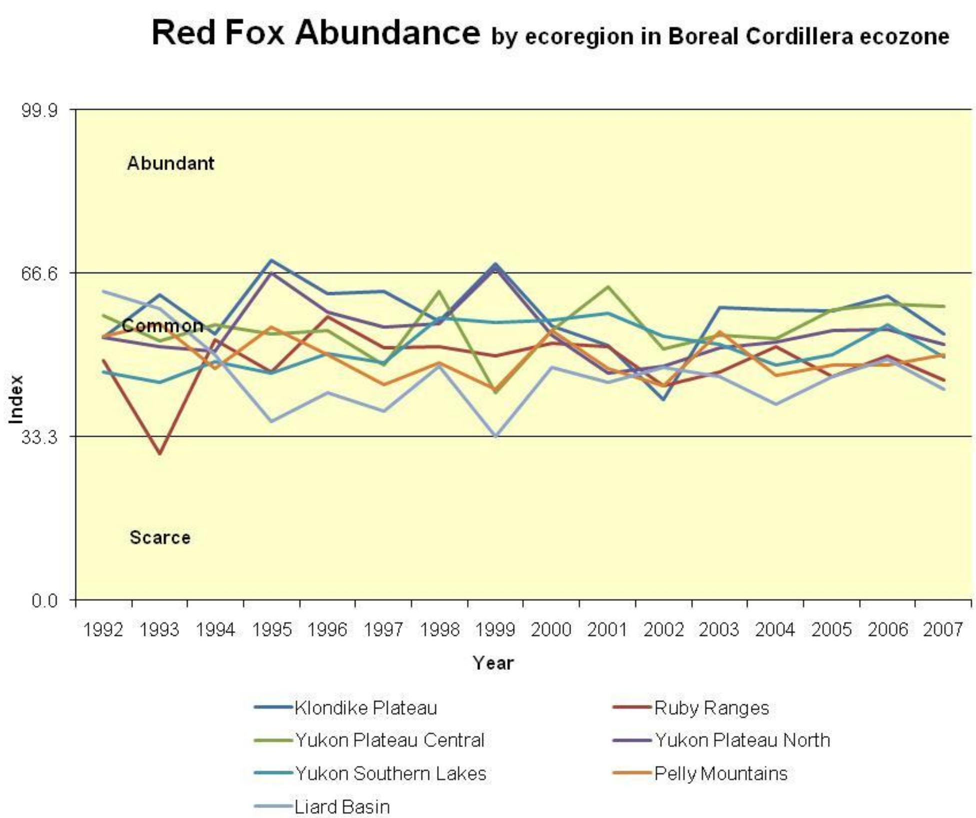


Figure 18 Population Indices for Wolf by Region and Ecoregion.

Figure 18a

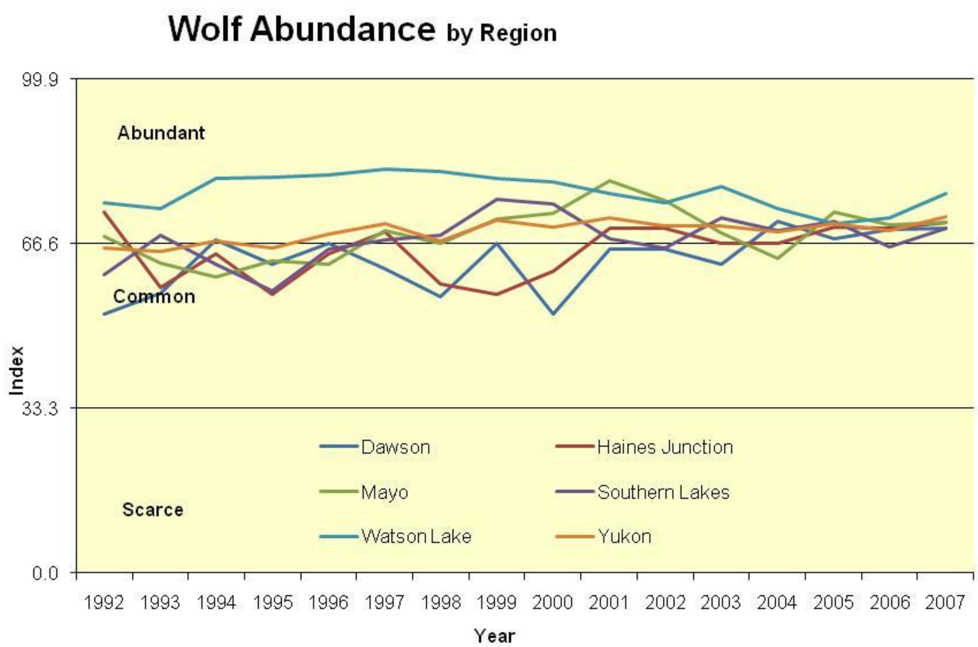


Figure 18b

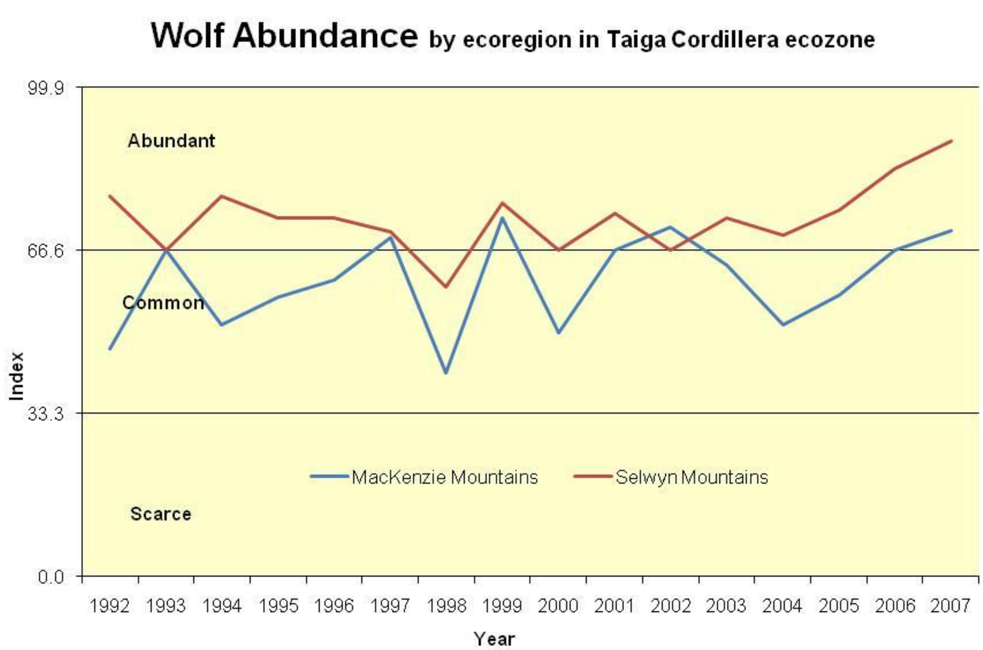


Figure 18c

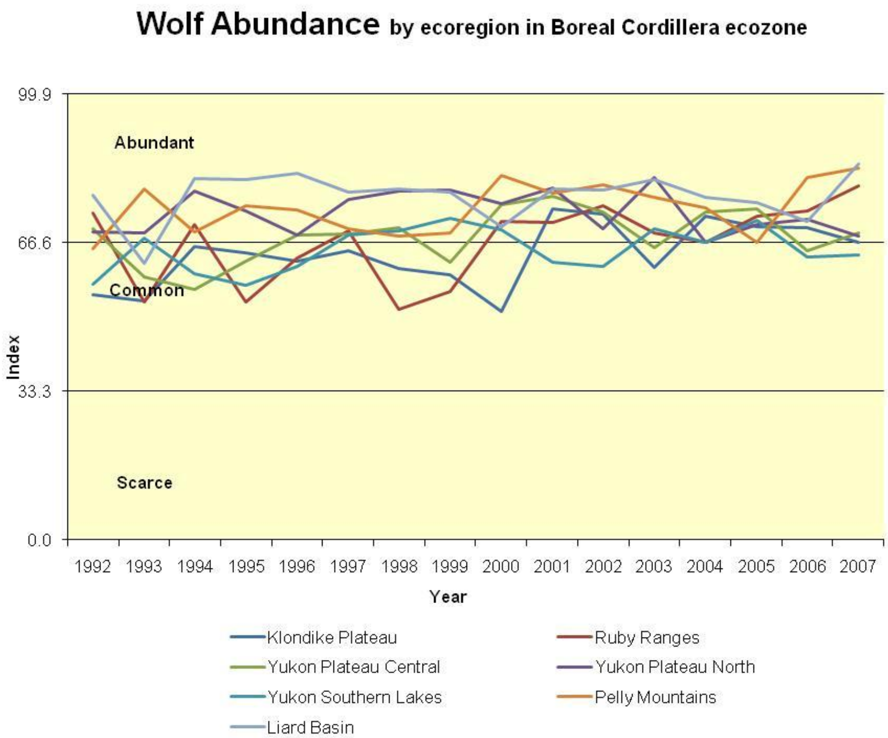


Figure 19 Population Indices for Fisher by Region and Ecoregion.

Figure 19a

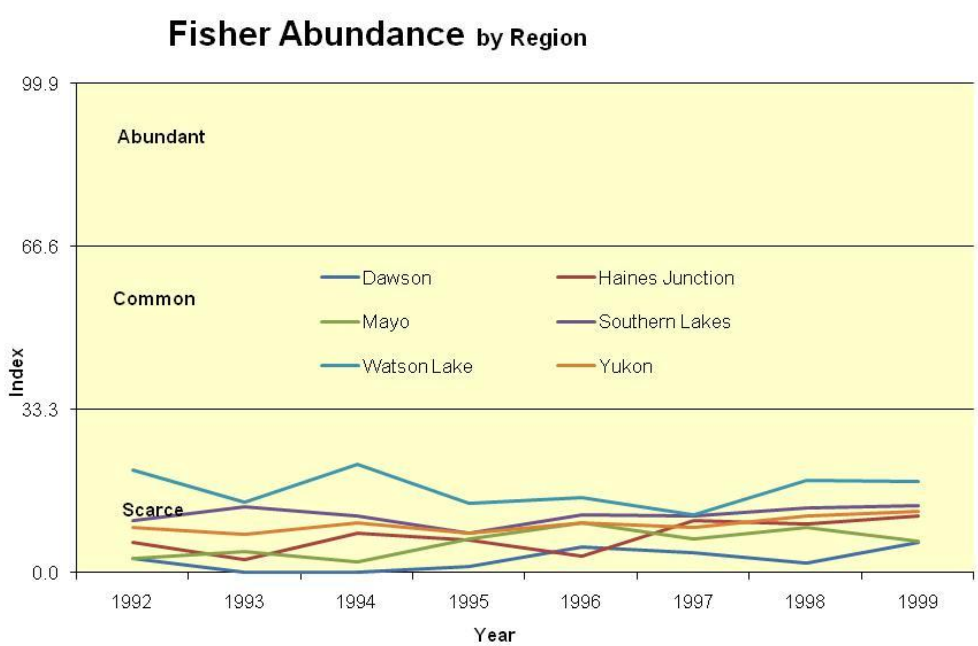


Figure 19b

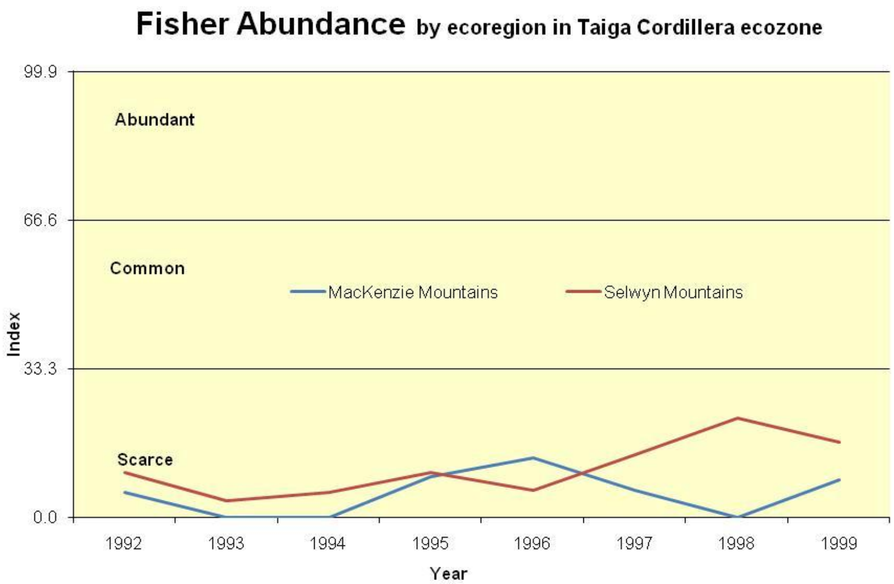


Figure 19c

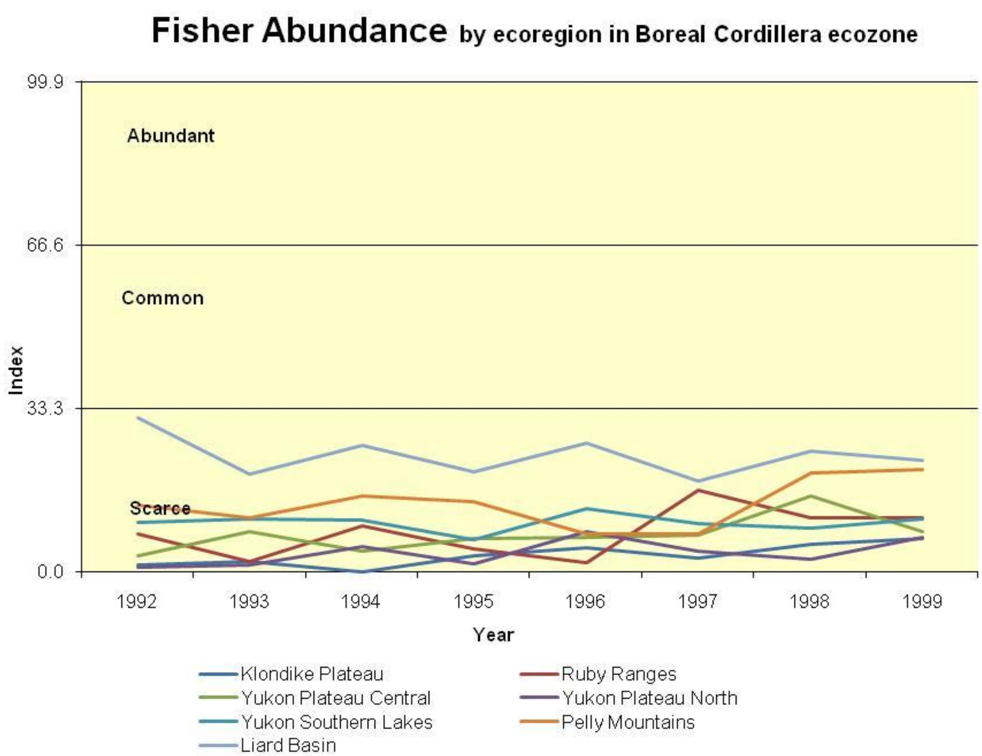


Figure 19d

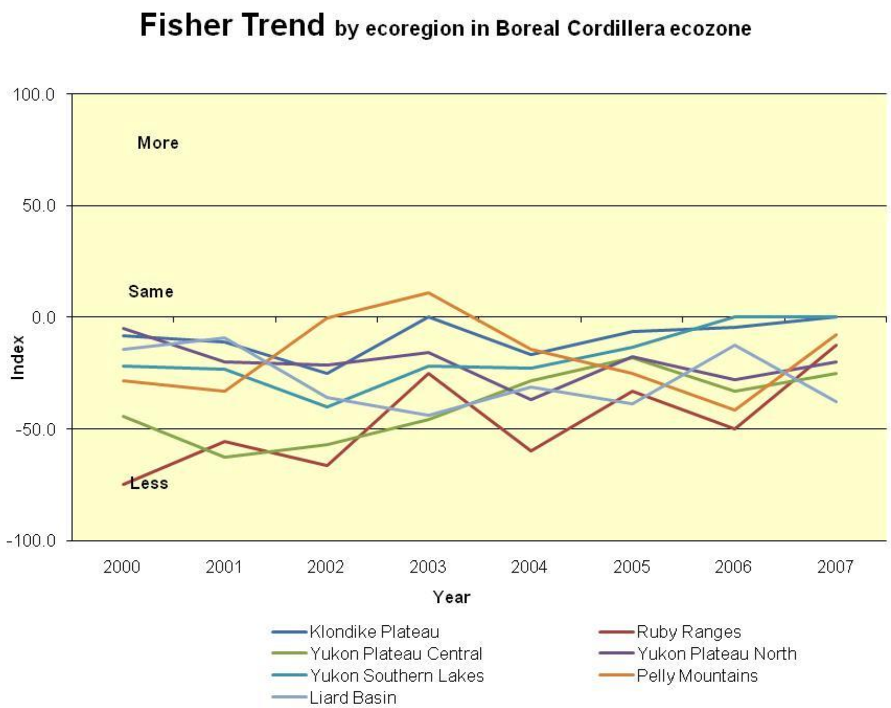


Figure 20 Population Indices for Moose by Region and Ecoregion.

Figure 20a

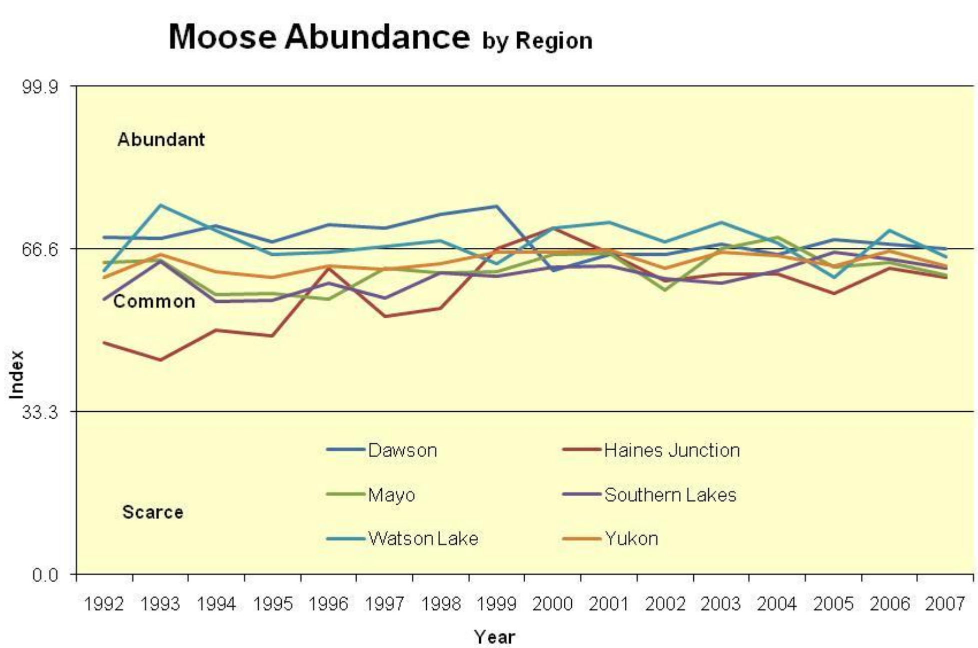


Figure 20b

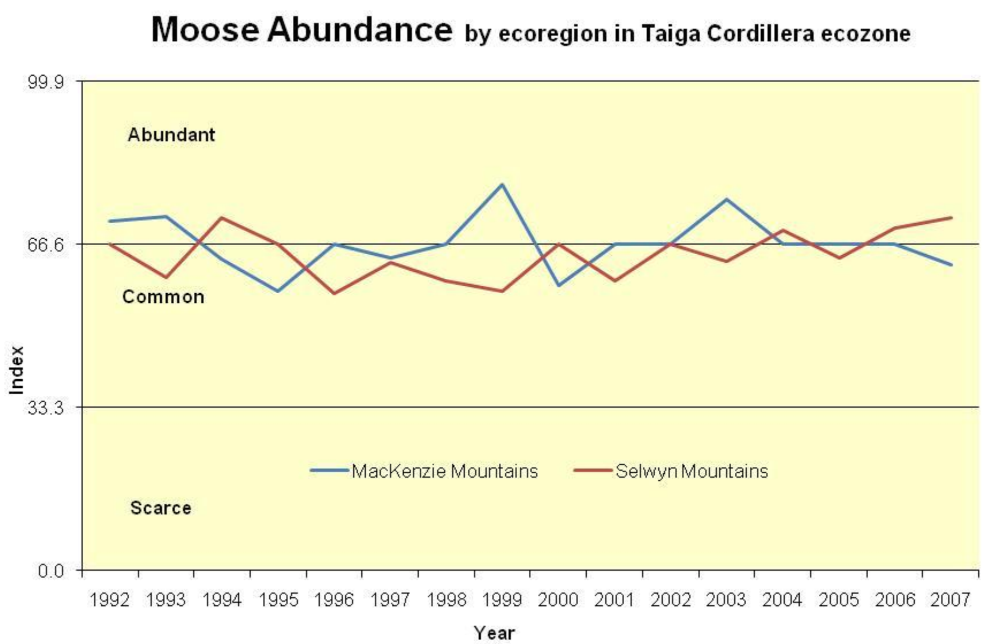


Figure 20c

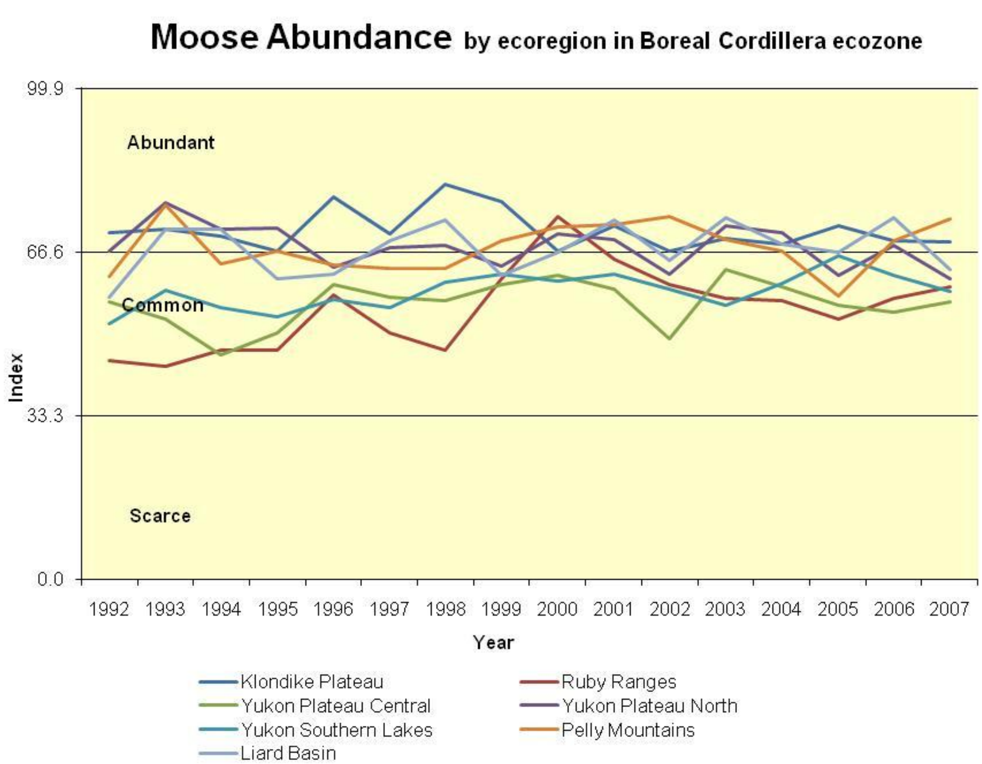


Figure 21 Population Indices for Caribou by Region and Ecoregion.

Figure 21a

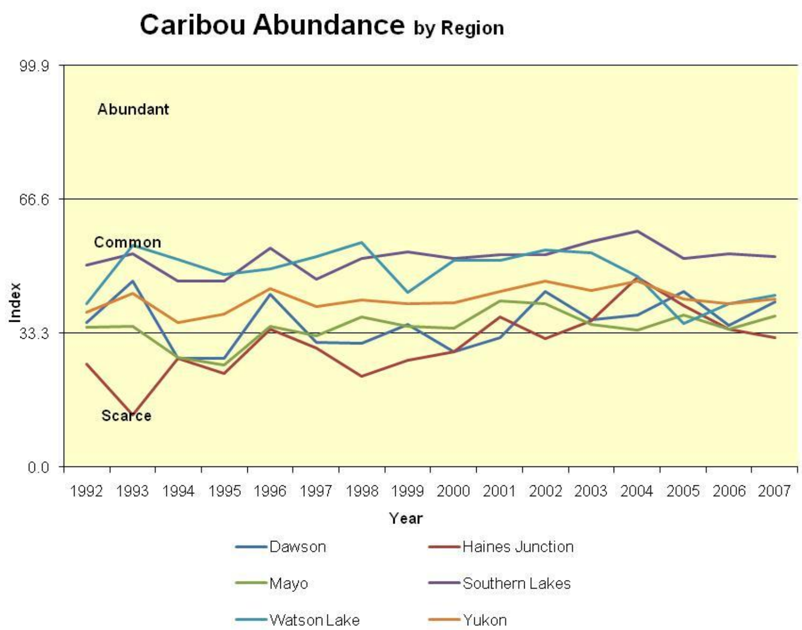


Figure 21b

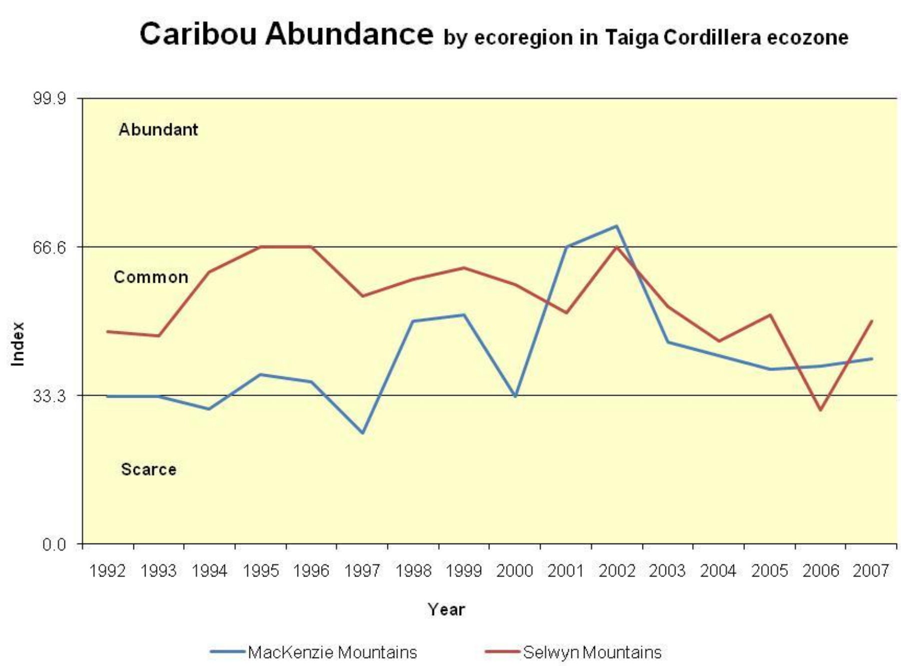
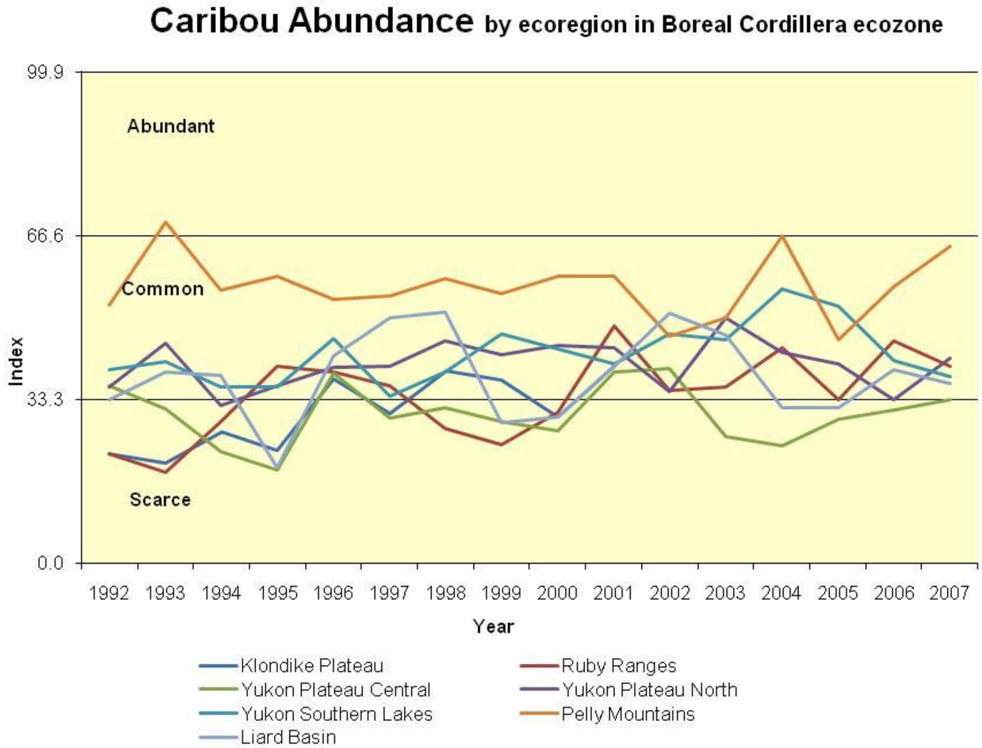


Figure 21c



Caribou Abundance by ecoregion in Boreal Cordillera ecozone
99.9
66.6
33.3
0.0
Abundant
Common
Scarce
Index
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Klondike Plateau
Ruby Ranges
Yukon Plateau Central
Yukon Plateau North
Yukon Southern Lakes
Pelly Mountains
Liard Basin

Figure 22 Correlations between species.

Figure 22a

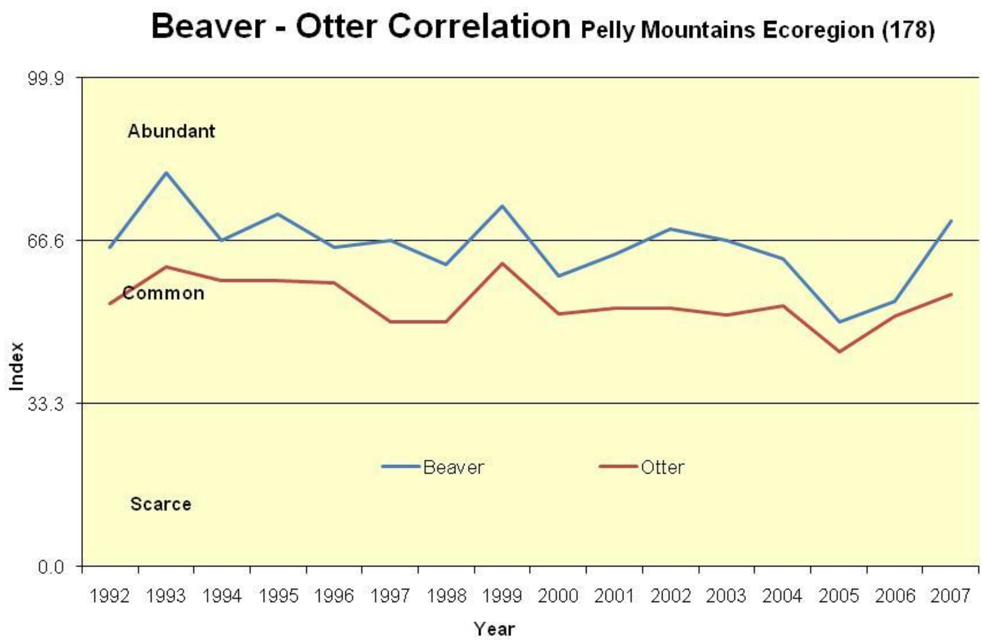


Figure 22b

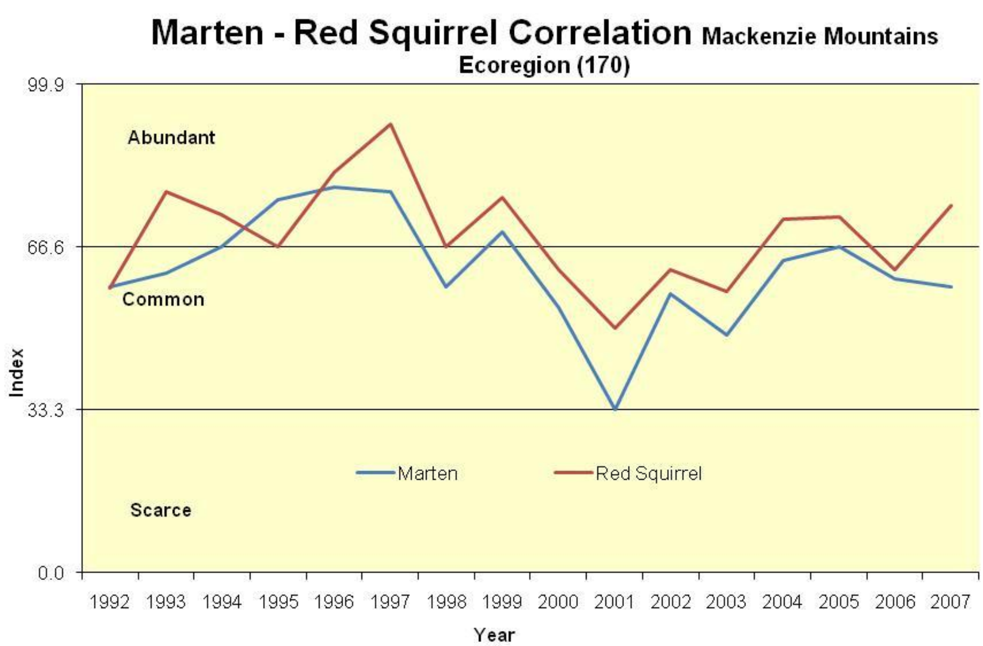


Figure 22c

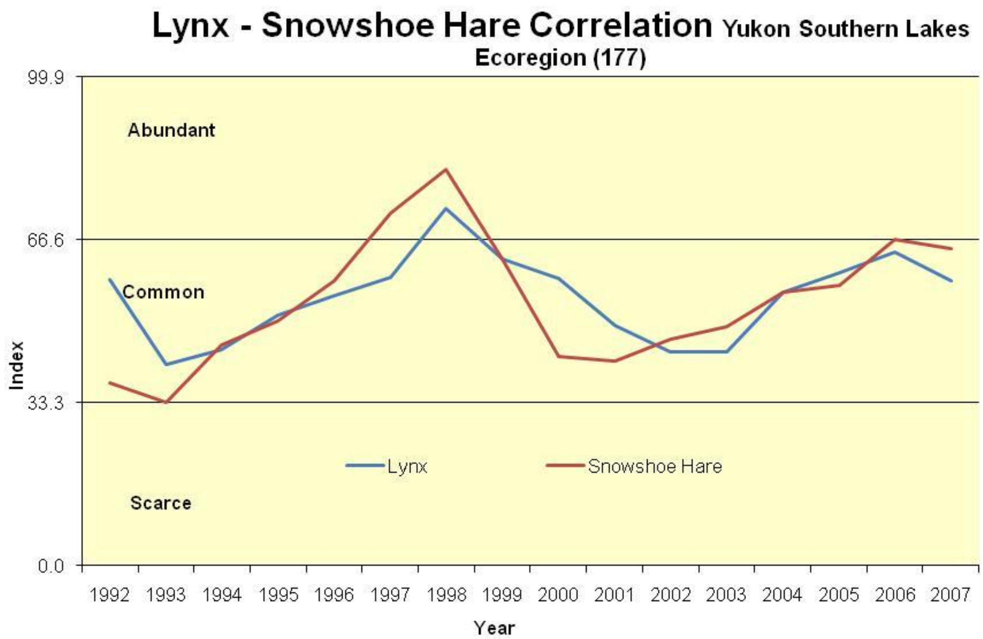


Figure 22d

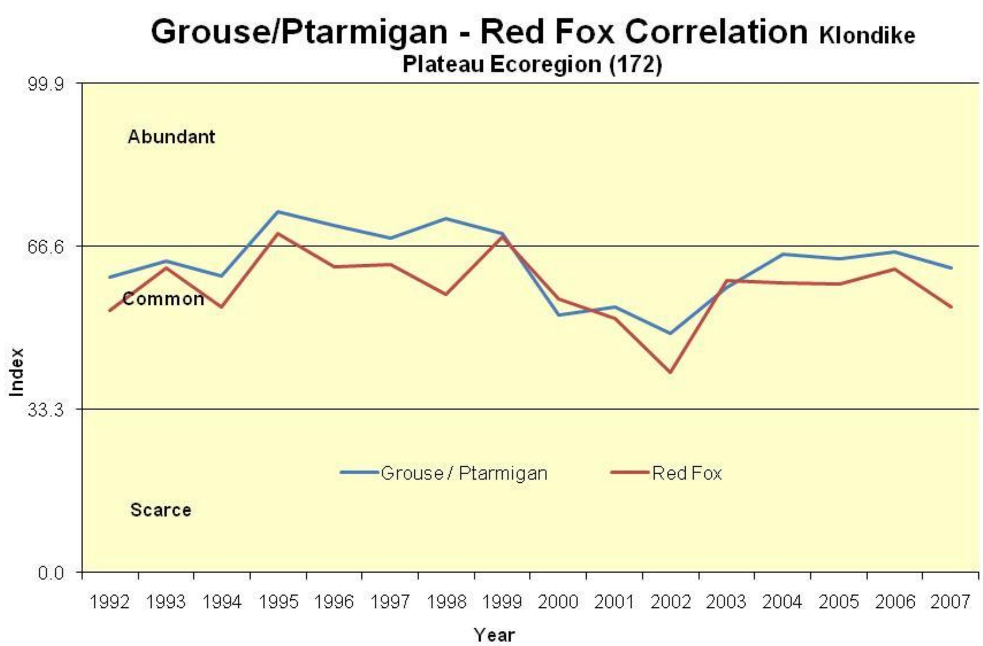


Figure 22e

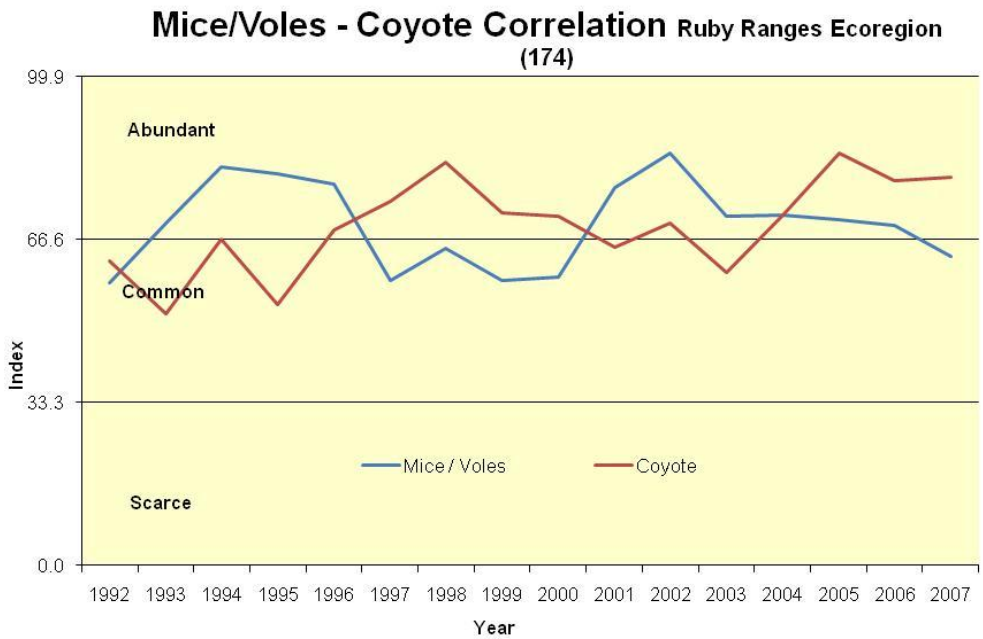


Figure 22f

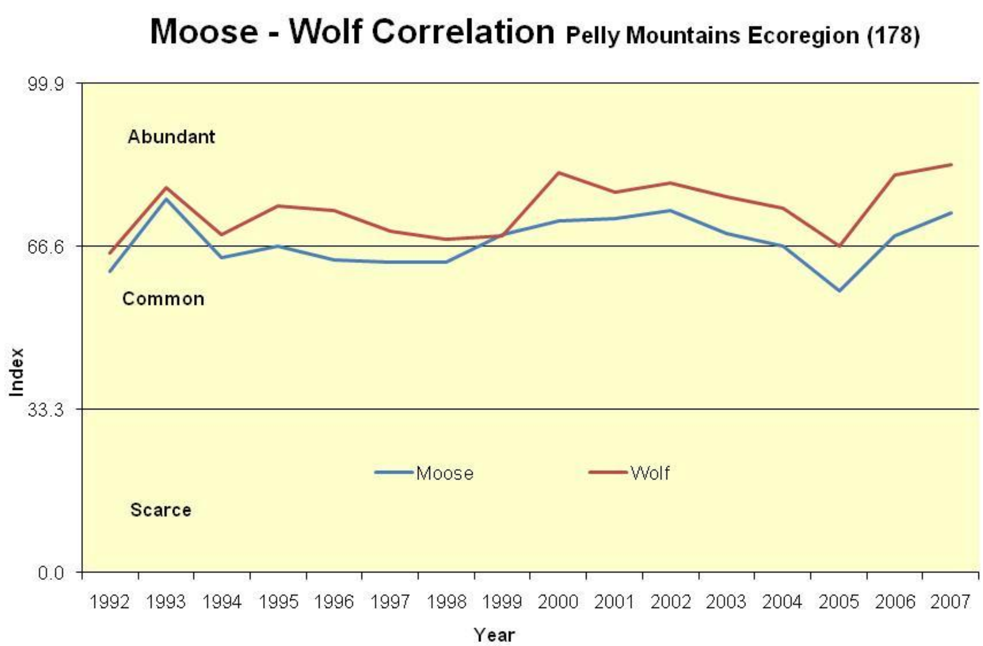


Figure 22g

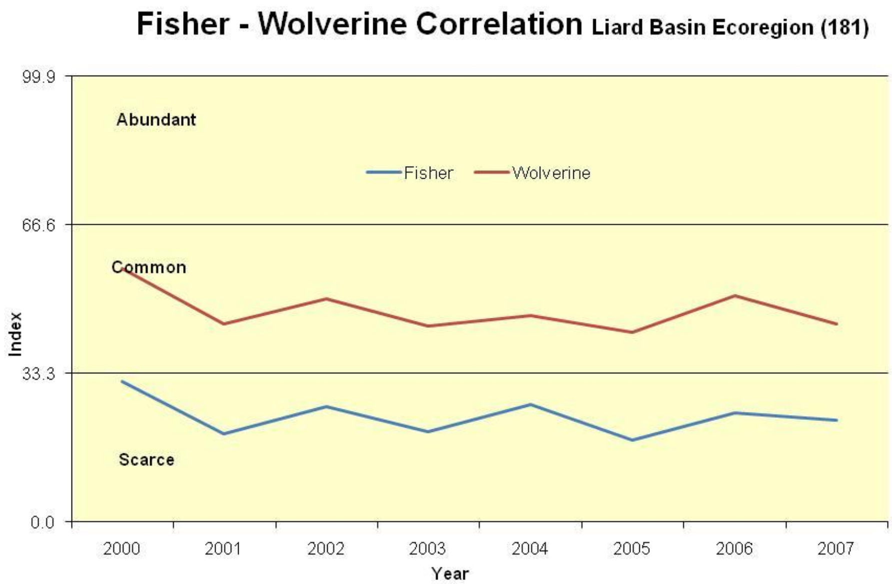

Fisher - Wolverine Correlation Liard Basin Ecoregion (181)
99.9
66.6
33.3
0.0
Abundant
Common
Scarce
Fisher
Wolverine
Index
2000
2001
2002
2003
2004
2005
2006
2007
Year

Figure 23 Population lags based on cross-correlations.

Figure 23a

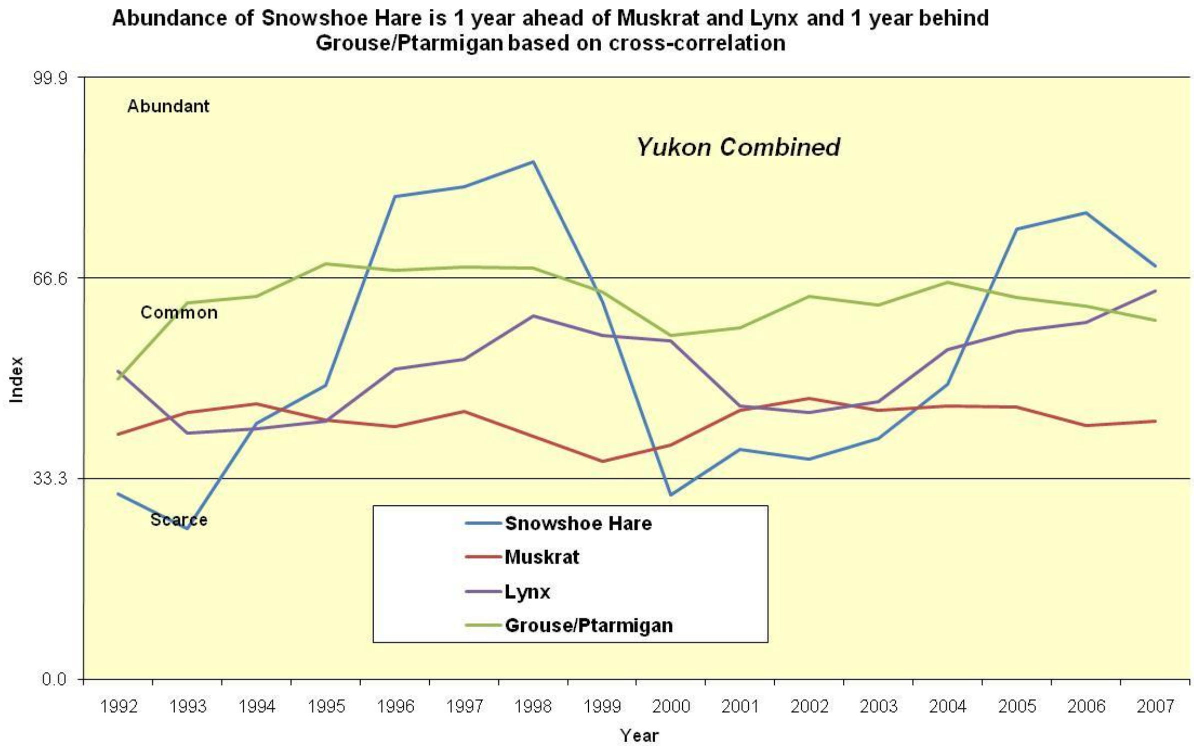


Figure 23b

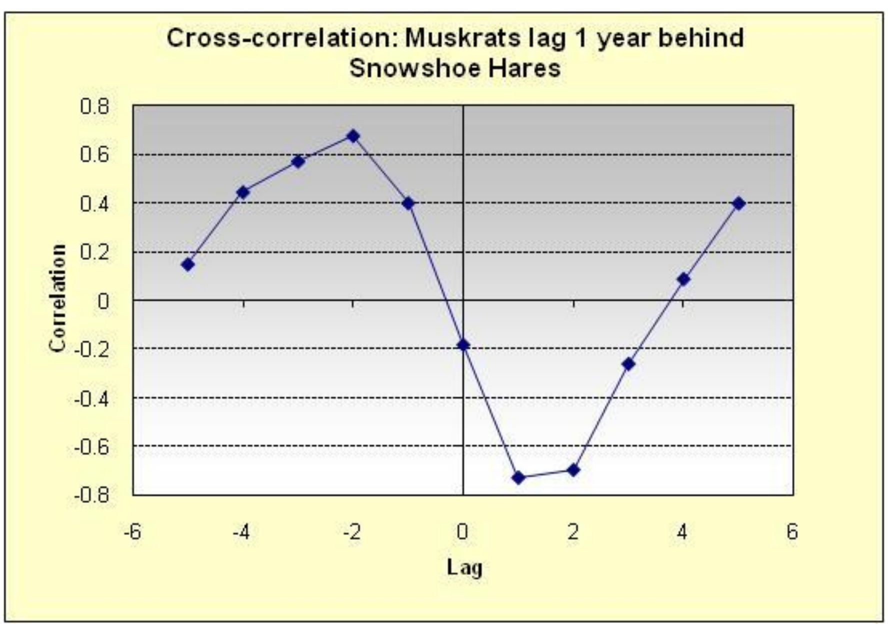


Figure 23c

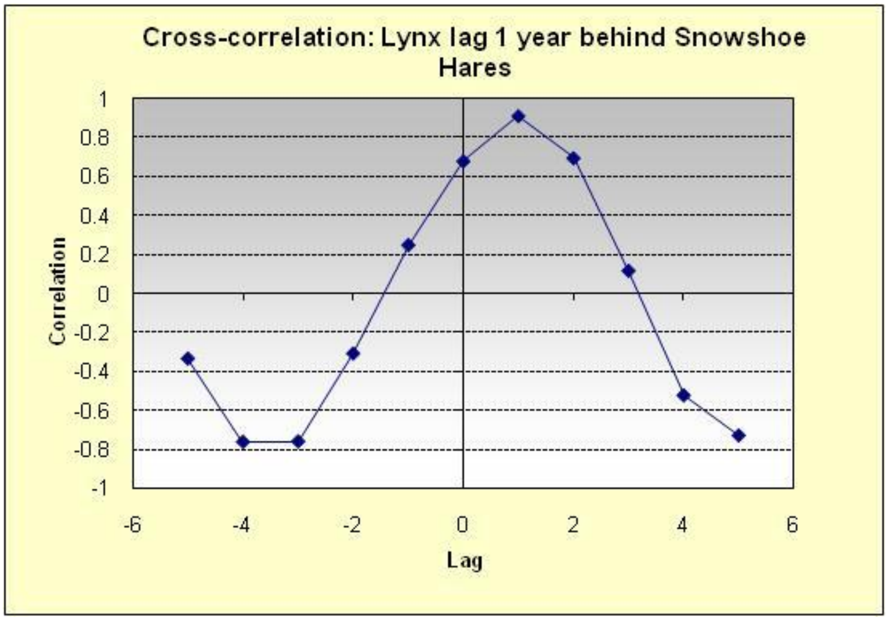


Figure 23d

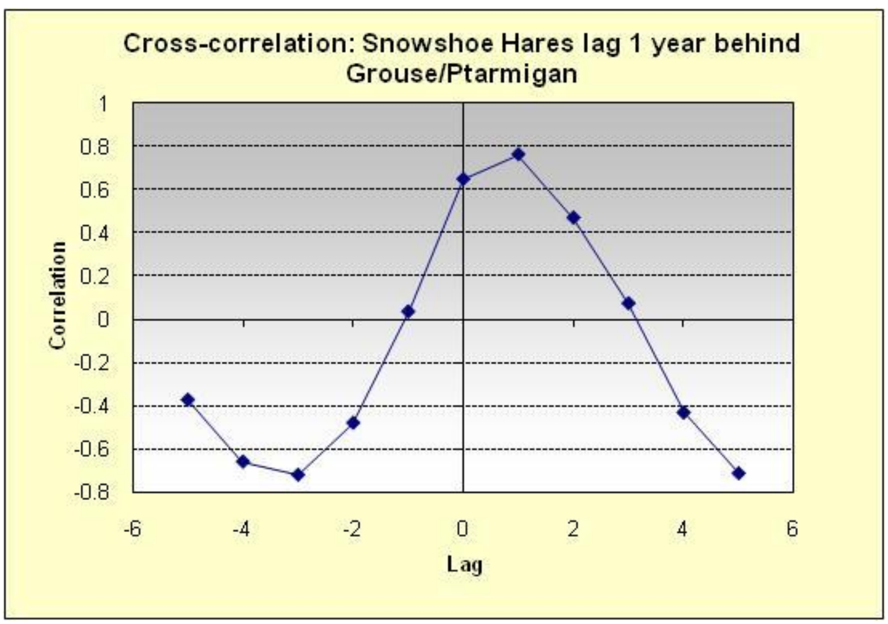


Figure 23e

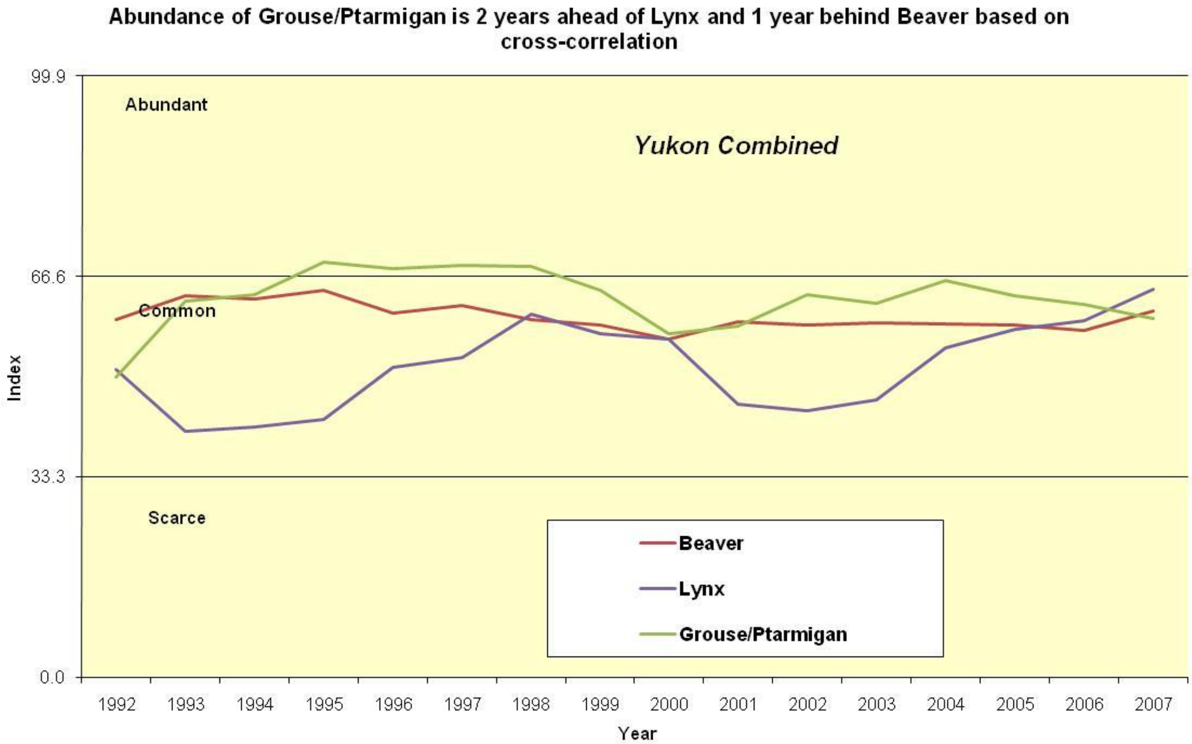


Figure 23f

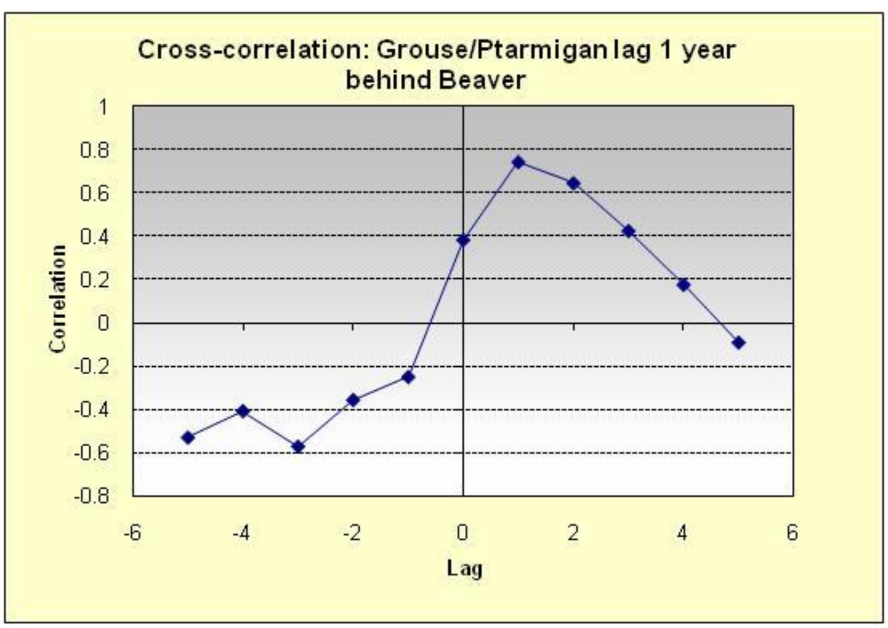


Figure 23g

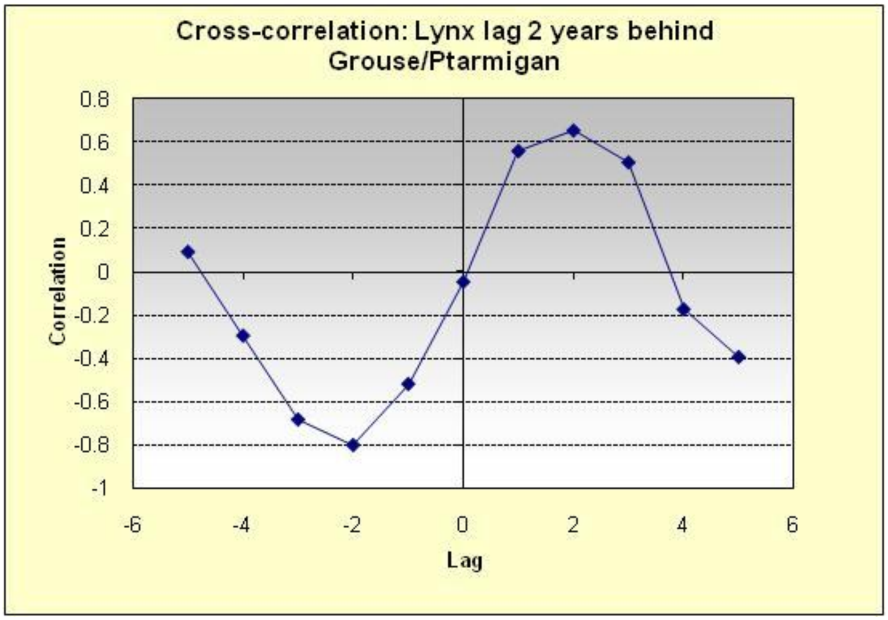


Figure 23h

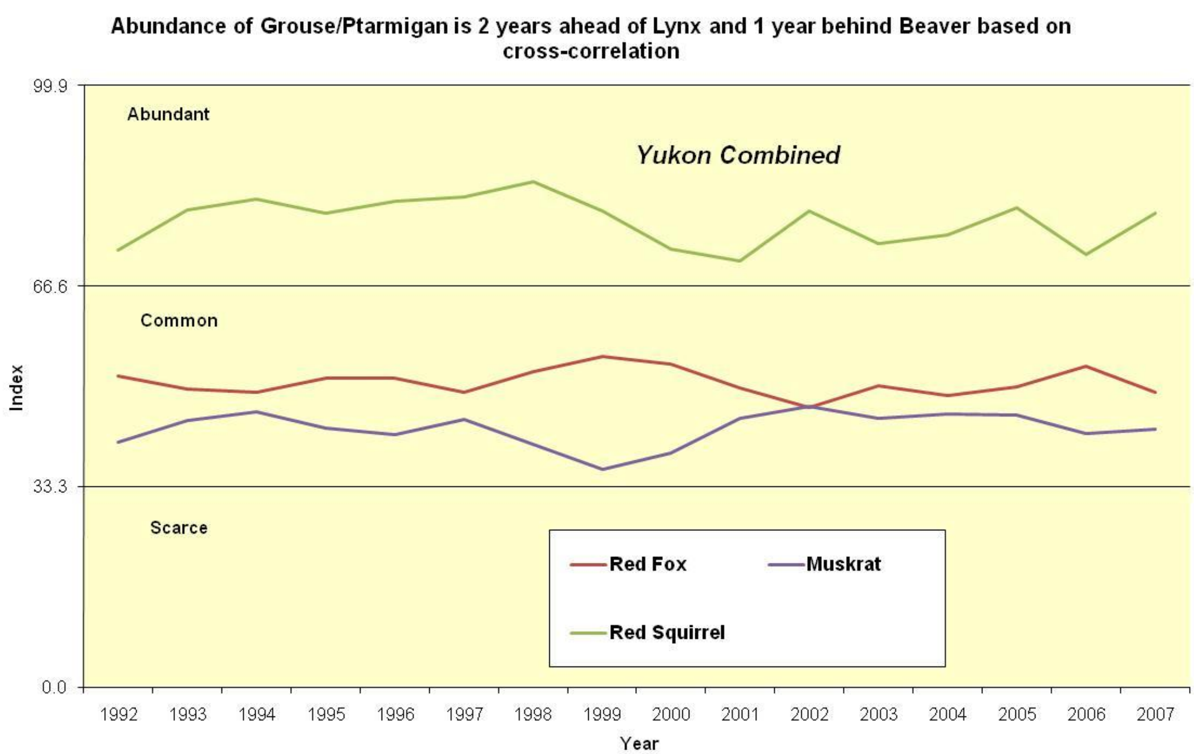


Figure 23i

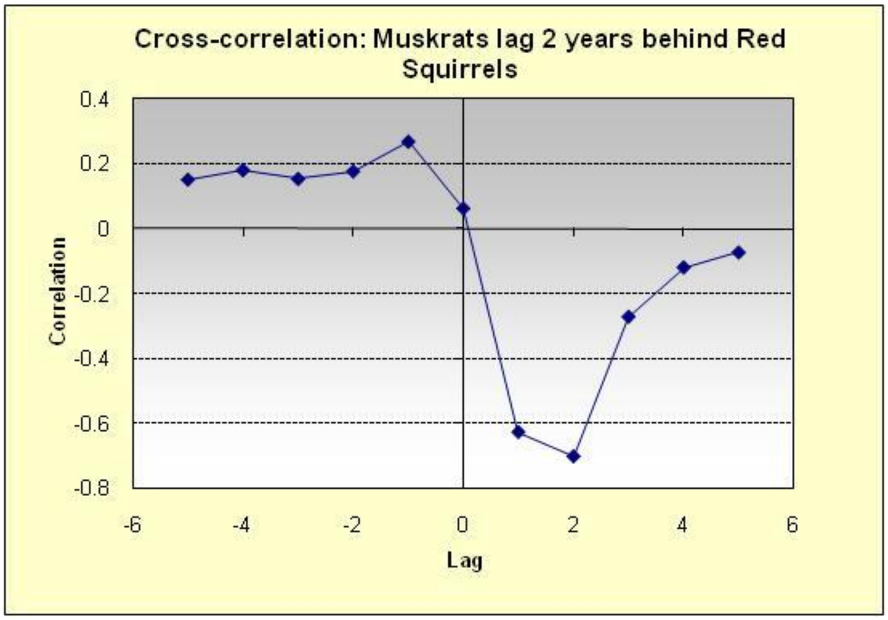


Figure 23j

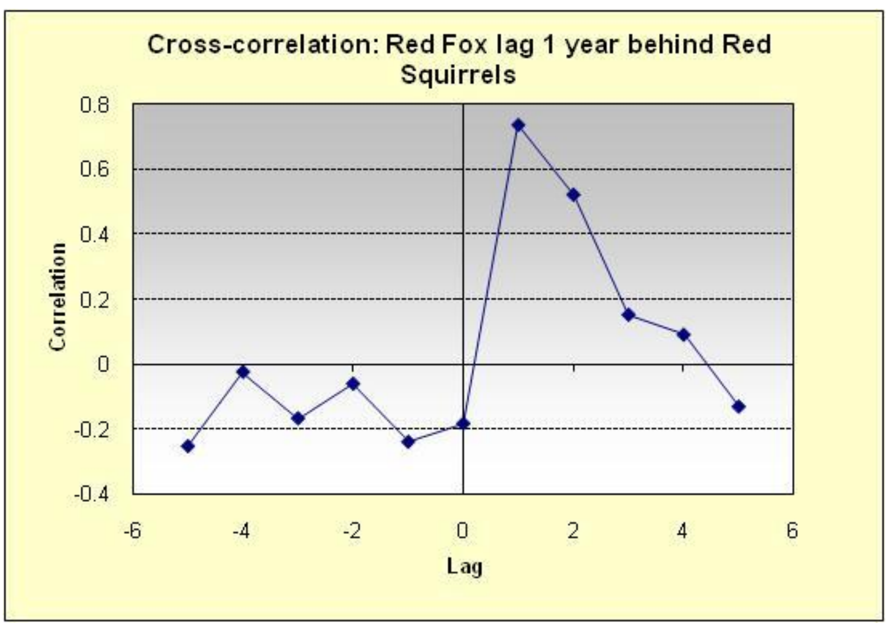


Figure 24 Lynx Population Abundance by Ecoregion.

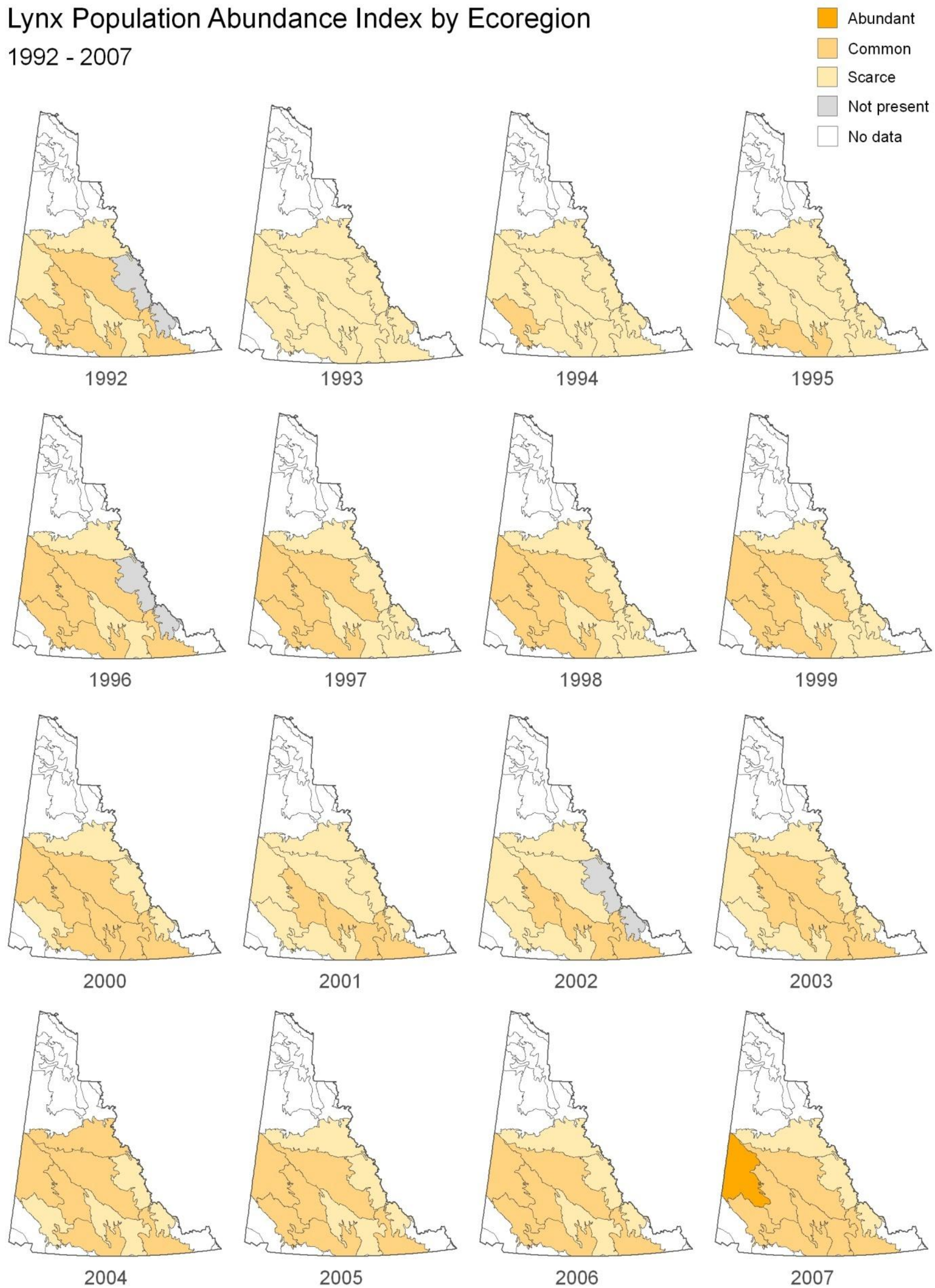


Figure 25 Marten Population Abundance by Ecoregion.

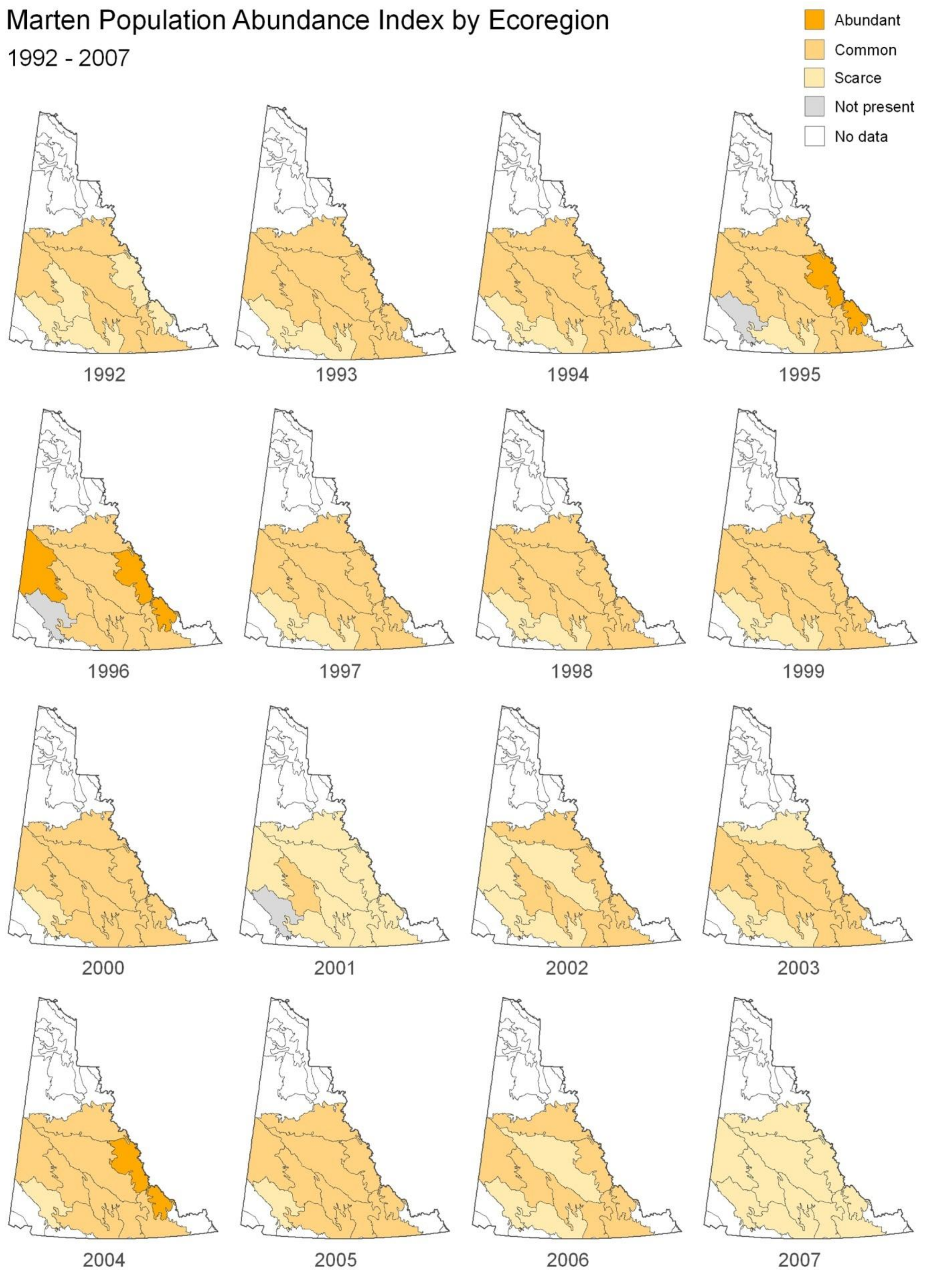


Figure 26 Wolverine Population Abundance by Ecoregion.

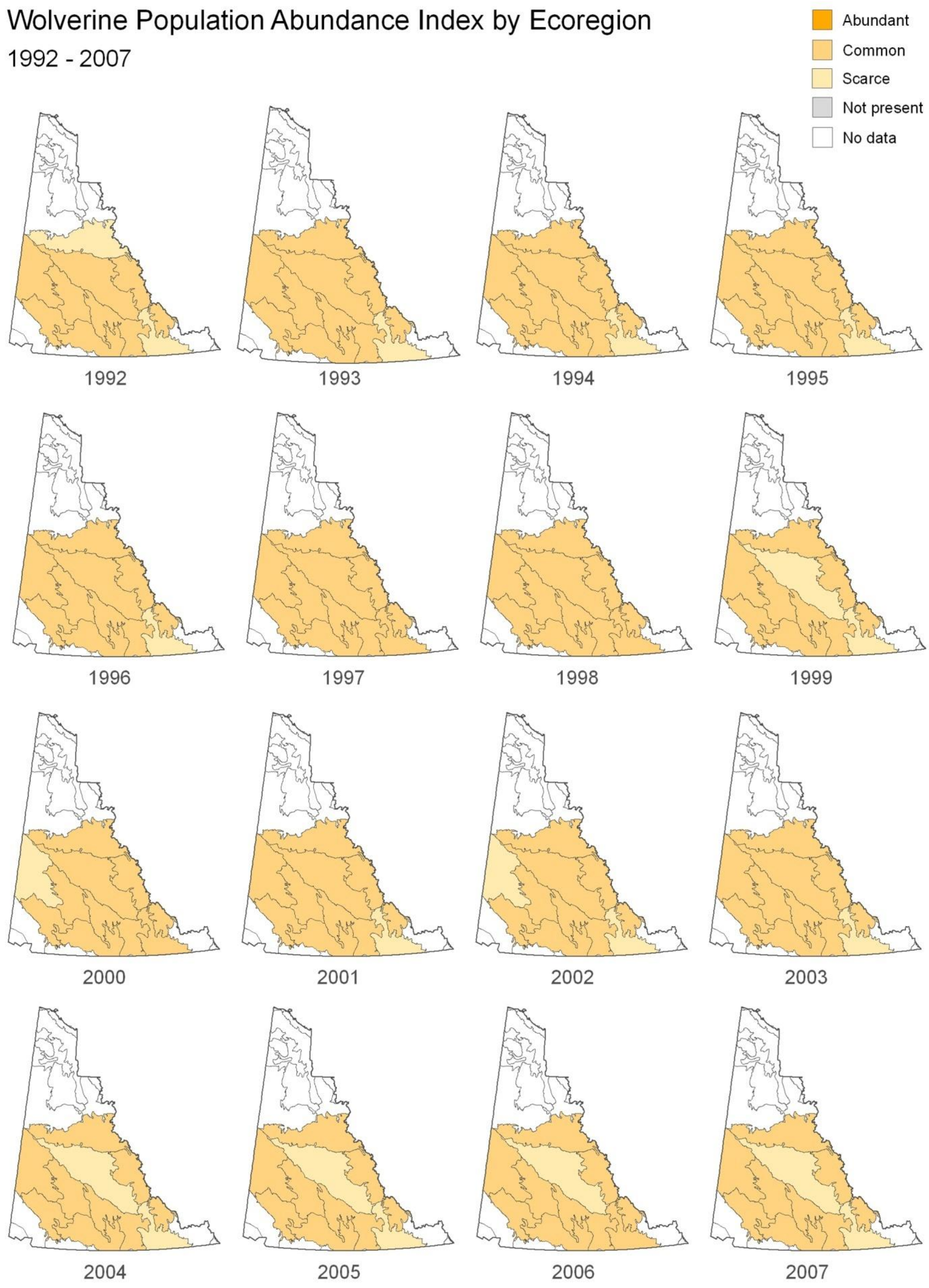


Figure 27 Coyote Population Abundance by Ecoregion.

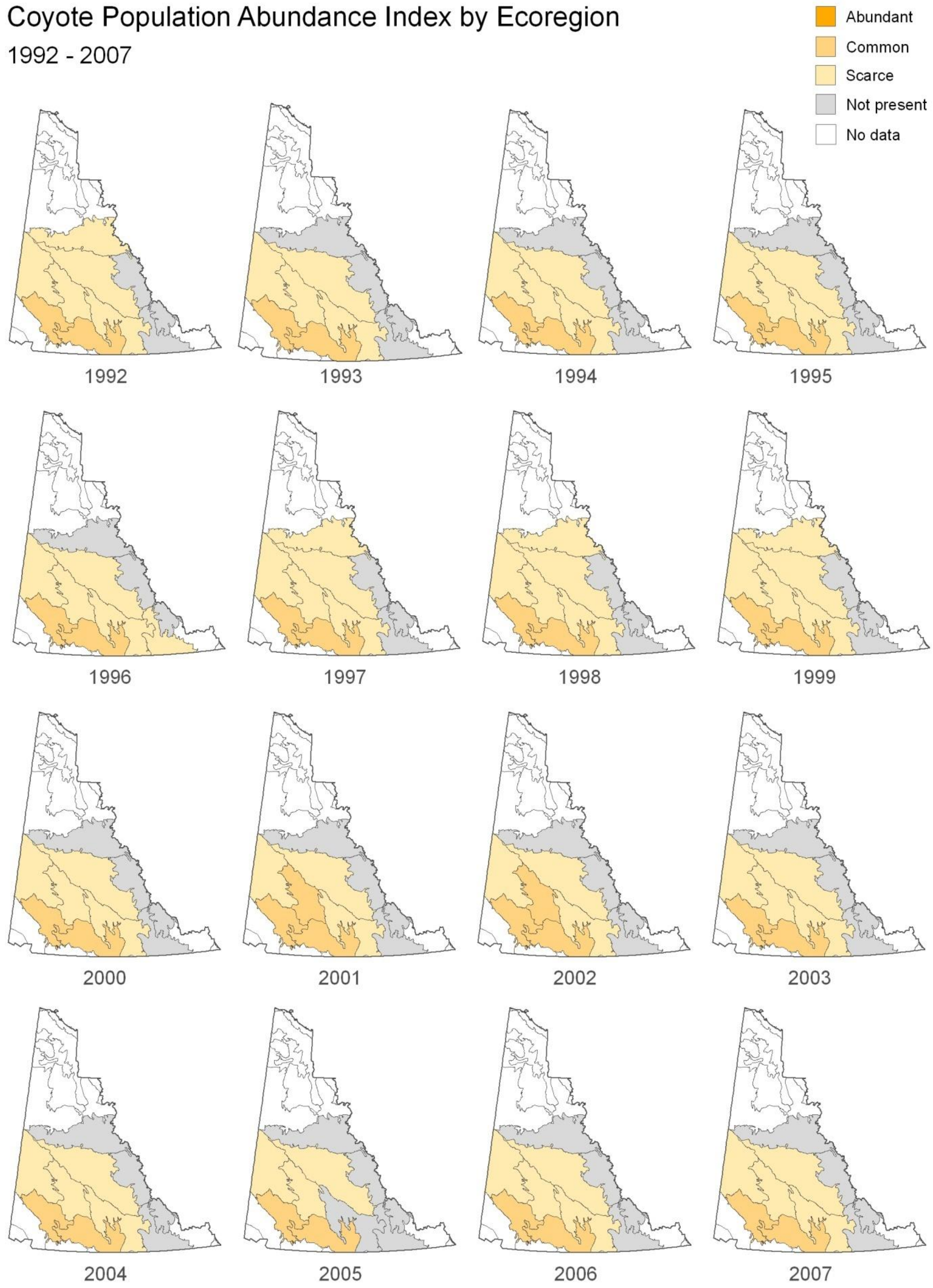


Figure 28 Red Squirrel Population Abundance by Ecoregion.

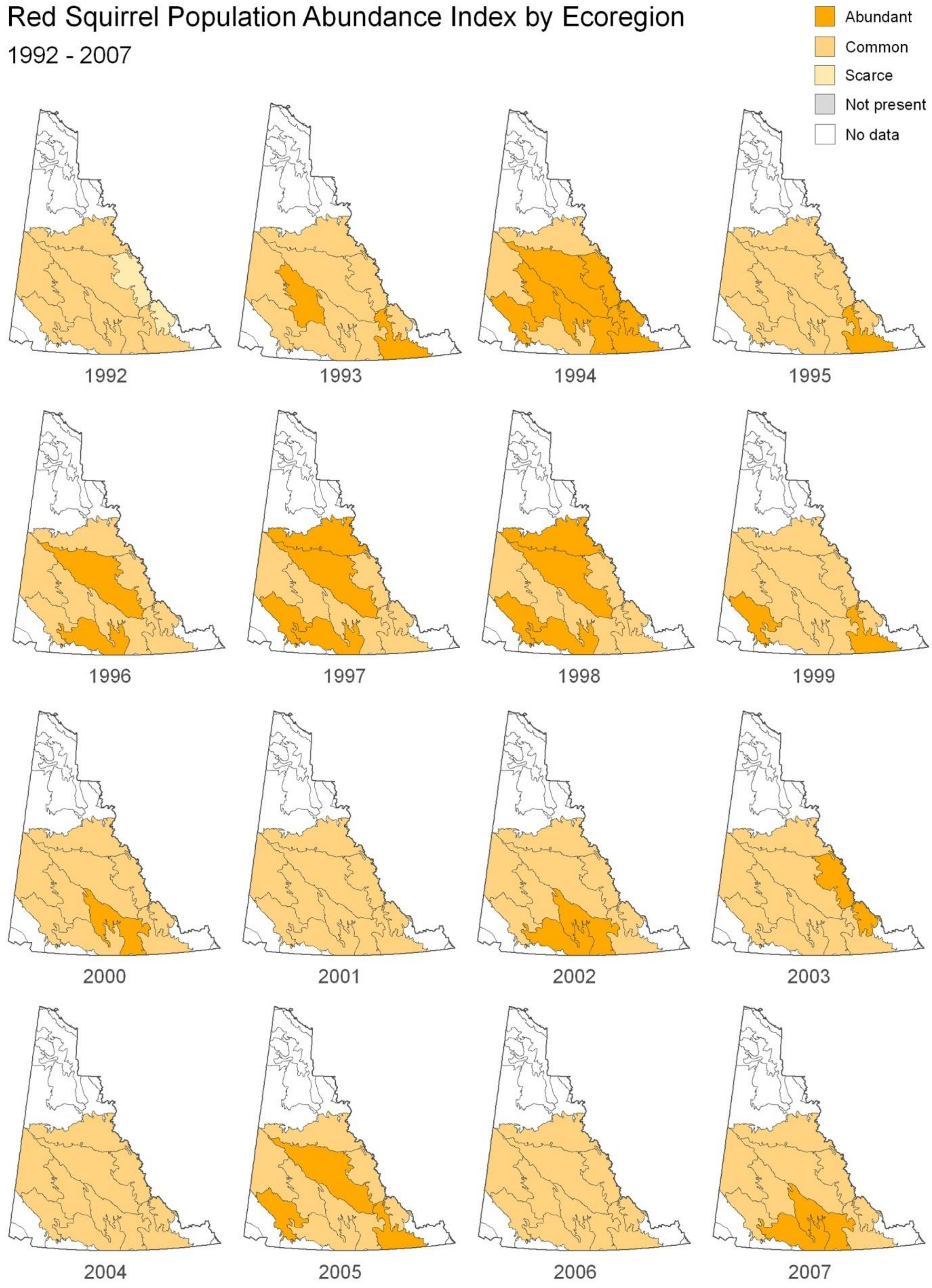
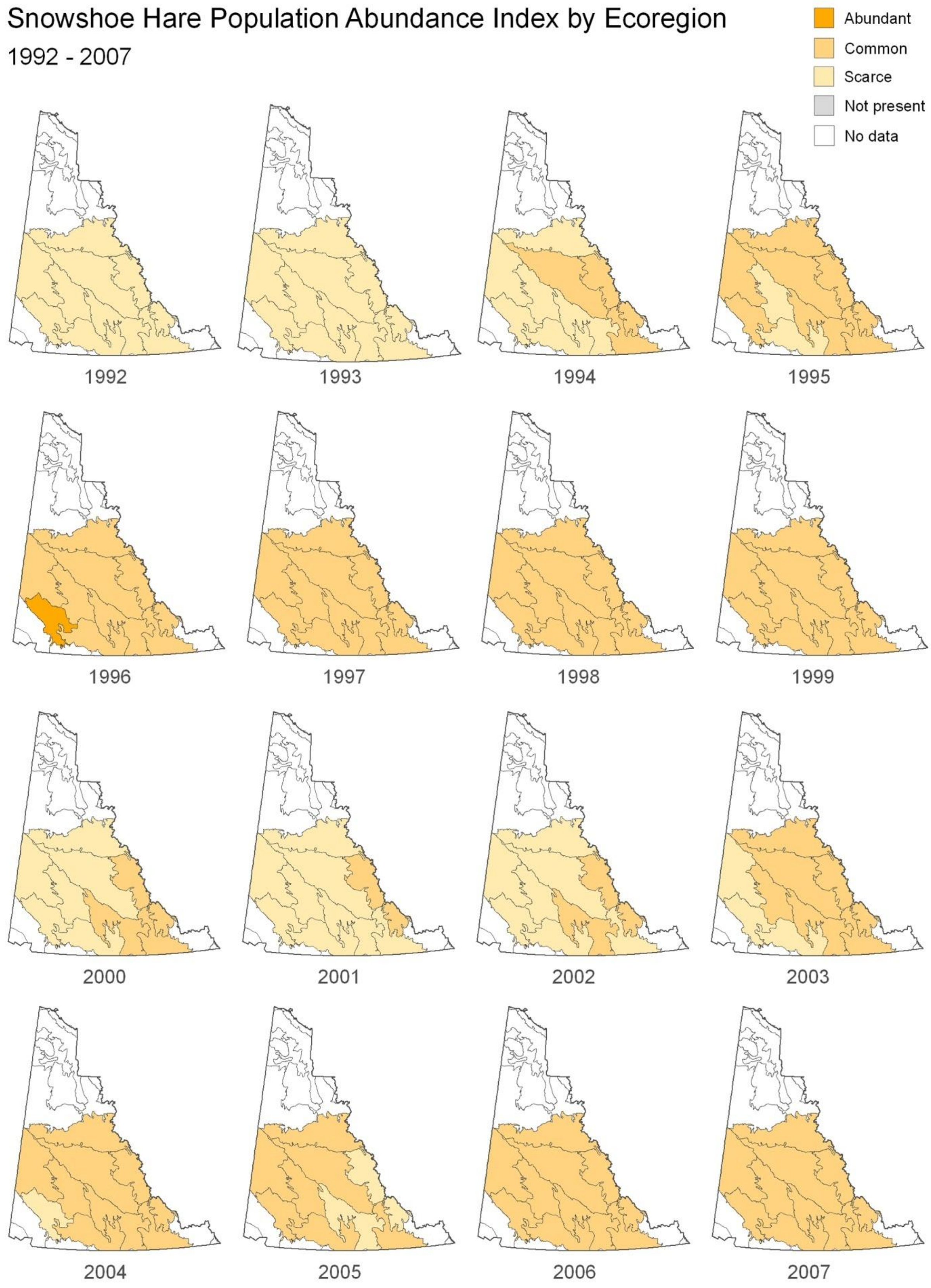


Figure 29 Snowshoe Hare Population Abundance and Trend by Ecoregion.



Snowshoe Hare Population Trend Index by Ecoregion

1992 - 2007

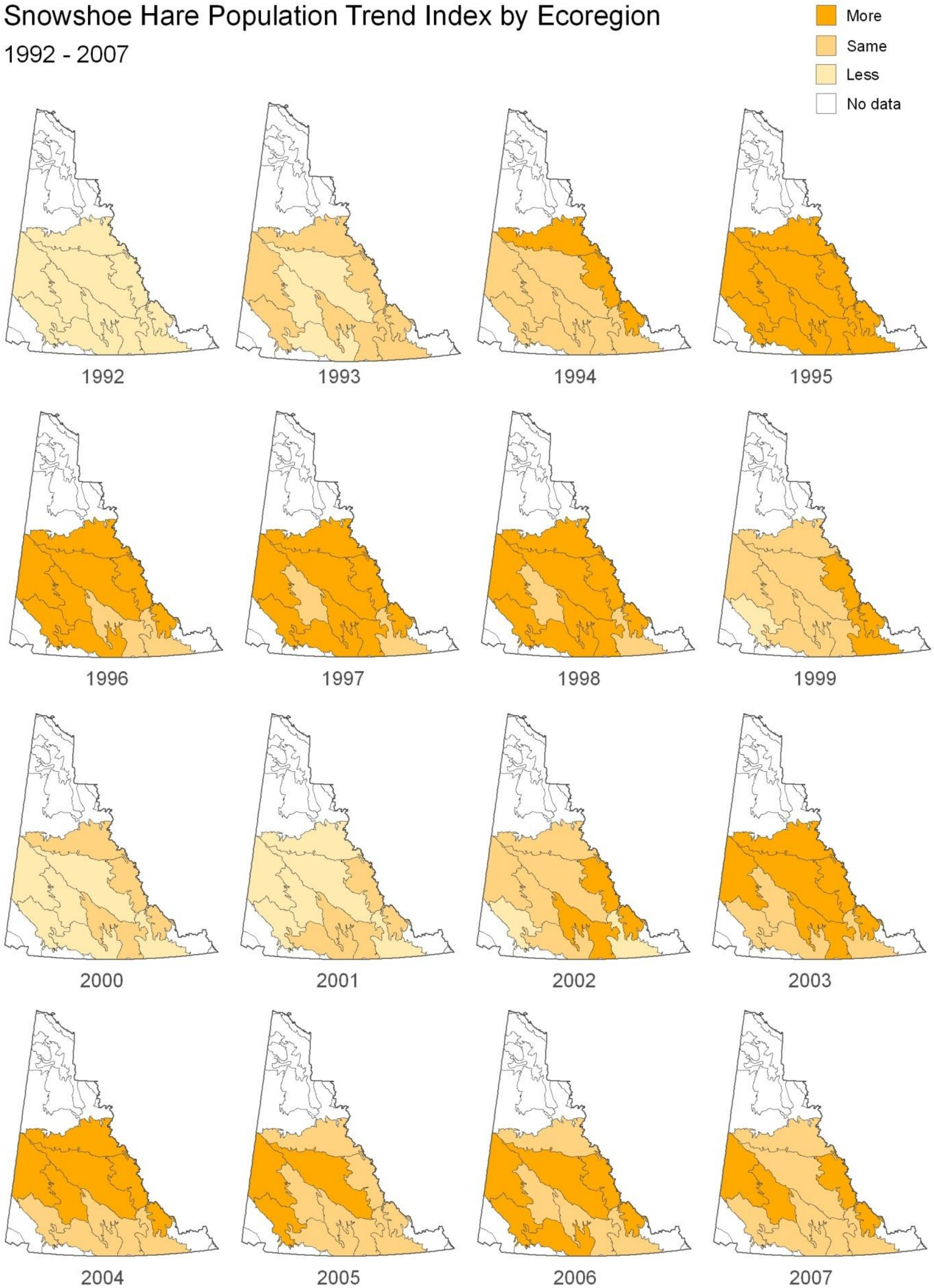
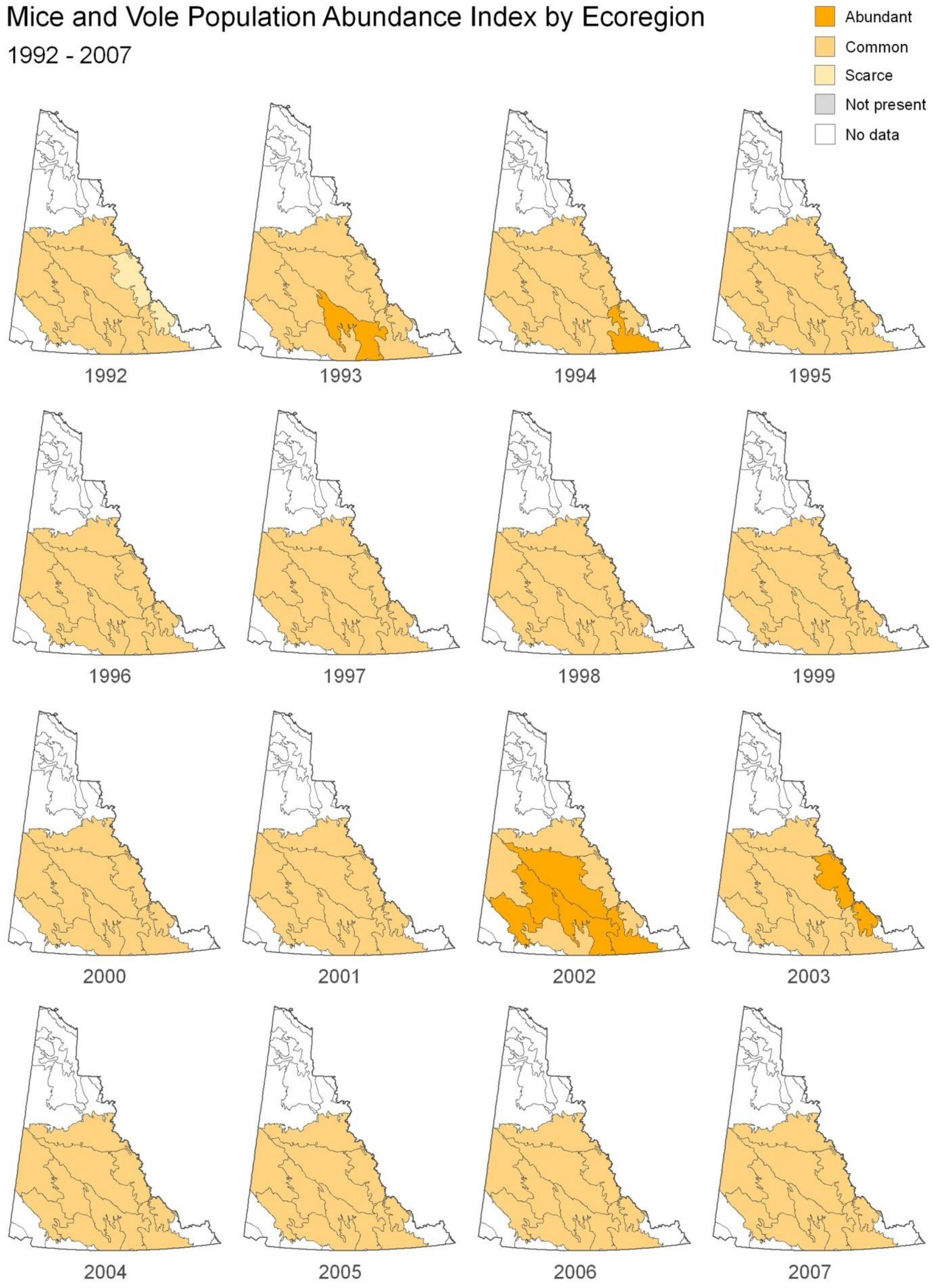


Figure 30 Mice/Vole Population Abundance by Ecoregion.



Appendix 1 2007 Yukon Trapper Questionnaire

Dear Trapper,

Please answer the following questions from your experience over the past trapping season of **OCTOBER 2006** to **JUNE 2007** for the *trapline identified on the top left corner* of the address label.

This information will be compiled to form regional and territorial statistics.

THANK YOU.

POPULATION LEVELS

Answer if you know:

The animals on my trapline this past winter were: (*please circle the appropriate response*)

1) Beaver	Not Present	Scarce	Common	Abundant
2) Coyote	Not Present	Scarce	Common	Abundant
3) Fisher	Not Present	Scarce	Common	Abundant
4) Fox, Coloured	Not Present	Scarce	Common	Abundant
5) Lynx	Not Present	Scarce	Common	Abundant
6) Marten	Not Present	Scarce	Common	Abundant
7) Mink	Not Present	Scarce	Common	Abundant
8) Muskrat	Not Present	Scarce	Common	Abundant
9) Otter	Not Present	Scarce	Common	Abundant
10) Red Squirrel	Not Present	Scarce	Common	Abundant

11) Weasel	Not Present	Scarce	Common	Abundant
12) Wolf	Not Present	Scarce	Common	Abundant
13) Wolverine	Not Present	Scarce	Common	Abundant
14) Caribou	Not Present	Scarce	Common	Abundant
15) Grouse / Ptarmigan	Not Present	Scarce	Common	Abundant
16) Mice / Voles	Not Present	Scarce	Common	Abundant
17) Moose	Not Present	Scarce	Common	Abundant
18) Snowshoe Hare (Rabbit)	Not Present	Scarce	Common	Abundant

POPULATION CHANGES

Answer if you know:

Compared to a year ago, the number of animals on my trapline are:

(please circle the appropriate response)

1) Beaver	More	Same	Less
2) Coyote	More	Same	Less
3) Fisher	More	Same	Less
4) Fox, Coloured	More	Same	Less
5) Lynx	More	Same	Less
6) Marten	More	Same	Less
7) Mink	More	Same	Less

8) Muskrat	More	Same	Less
9) Otter	More	Same	Less
10) Red Squirrel	More	Same	Less
11) Weasel	More	Same	Less
12) Wolf	More	Same	Less
13) Wolverine	More	Same	Less
14) Caribou	More	Same	Less
15) Grouse / Ptarmigan	More	Same	Less
16) Mice / Voles	More	Same	Less
17) Moose	More	Same	Less
18) Snowshoe Hare (Rabbit)	More	Same	Less

Did you visit your trapline this year? YES NO

(circle one)

If you answered YES above,

would you say that the effort you put into trapping this season was:

(*circle answer*)

MORE SAME LESS

Appendix 2 Using trapper knowledge to monitor population trends of wolverine, *Gulo gulo*, in the Yukon.

Using Trapper Knowledge to Monitor Population Trends of Wolverine, *Gulo gulo*, in the Yukon

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Fish and Wildlife Branch, Yukon Department of Environment, Box 2703, Whitehorse, Yukon, Canada.
[1] corresponding author: thomas.jung@gov.yk.ca
[2] present address: 35 Cronkhite Road, Whitehorse, Yukon, Canada

Introduction

Wolverine (*Gulo gulo*) are a species of special management interest across their Canadian range because they are both a species at risk and a valued furbearer. Further, they are often of cultural significance to Aboriginal Peoples across the north. Monitoring wolverine population abundance and trends, however, is notoriously difficult. Traditional monitoring methods applied to wolverine, such as mark-recapture or probability sampling, often lack precision because animals are normally distributed in exceedingly low densities and they or their sign are rarely observed. While intensive methodologies such as aerial snow tracking or DNA tagging can provide very good information, these data are often constrained both spatially and temporally. Intensive methods to monitor populations are too expensive and labourious to be applied at the temporal and spatial scales necessary to reliably inform managers of changes in status.

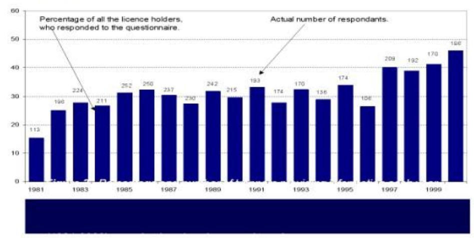
Trappers have much knowledge of the year-to-year changes in abundance of species of interest to them on their traplines and, collectively, their information spans broad spatio-temporal scales. Communities view active and long-time trappers as some of the most reliable sources of local information on wildlife trends. Indeed, active trappers are often the only eyes on the ground during winter in many remote areas. In the Yukon, there are 400-600 licensed trappers each year, operating on 347 spatially-distinct registered traplines and 12 group traplines. Individual traplines average about 250 km^2, and cover much of the Yukon. Thus, we recognize the potential wealth of information that trappers hold regarding changes in wolverine population.

Since 1977, Yukon furbearer managers have annually collected information from trappers on a variety of species, including wolverine, which are a valued species to Yukon trappers (Fig. 1). Here, we retrospectively apply data collected by trappers in the Yukon, through annual questionaires, to estimate broad population trends of wolverines across a large area (>400,000 km^2) and long time span (23 years, 1977-2000). Trappers also reported on abundance of other furbearers and their prey, and correlations of these data and wolverine abundance are also explored.

Government of Yukon

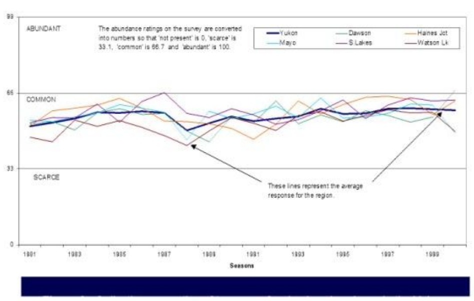
Methods

Annual questionnaires were mailed out to each individual licensed trapper. Trappers were asked to report on their perceptions and observations on the *ABUNDANCE* and *TREND* of selected species in their concession. For abundance they were asked if the species was *ABUNDANT*, *COMMON*, *SCARCE*, or *NOT PRESENT* during the most recent trapping season. For *TREND*, they were asked if there are *MORE*, *LESS*, or the *SAME* abundance in the most recent trapping season compared to the trapping season immediately previous to the one reported on. Trappers were not provided definitions for each rank. Six weeks after the deadline for submission of the questionnaire, licensed trappers whom did not respond were mailed a reminder. Ranks of abundance and trends by trappers were converted to numerical values. We used univariate and multiple linear regression to explore relationships in the dataset, and correlate the ranks with trapping activity variables (including: year, harvest, pelt price, and number of trapping licenses) and biological variables (including: reported abundance of wolves, red squirrels, variables such as harvest rate, pelt prices, grouse, snowshoe hare, and mice and voles).



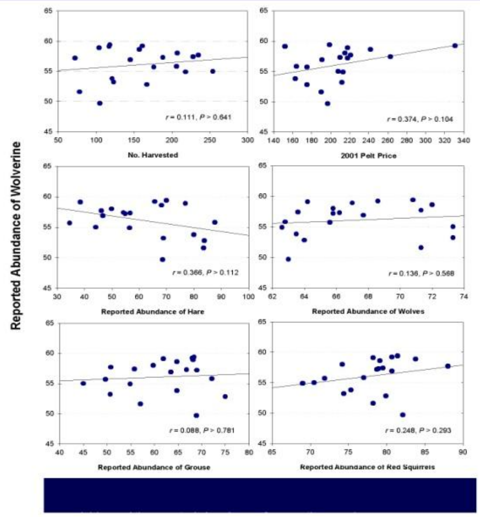
Preliminary Results

Between 106 and 252 trappers provided information per year: generally one-third of all licensed Yukon trappers in each year (Fig. 2). Annual response rates increased with time (r = 0.775, P > 0.001) and marginally with wolverine pelt price (r = 0.364, P = 0.115), and decreased with the number of licensed trappers (r = 0.572, P = 0.008). There was no relationship between the number of wolverine harvested and the annual response rate (r = -0.001, P = 0.997).



In much of the Yukon, trappers have consistently reported that wolverine were slightly less than common across the study period (Fig. 3). This trend was reported from all regions of the Yukon, despite the biophysical and climatic differences among these regions (Fig. 3). No clear population cycles were evident in the data over the 23-year study period.

Reported abundance of wolverine was not correlated with the number of wolverine harvested, but was marginally positively correlated with the pelt price (Fig. 4).



Reported abundance of wolverine was not correlated with the reported abundance of wolves, red squirrels, or grouse (Fig. 4). There was, however, a marginal negative correlation between the reported abundance of wolverine and snowshoe hare (Fig. 4). The multiple linear regression model including all 4 species and year identified only snowshoe hare as the predictor variable for wolverine abundance, although year had more predictive power than hare abundance in the model (wolverine abundance = constant $_{2.887}$ + year $_{3.243}$ - snowshoe hare abundance $_{2.137}$) .

Conclusions

Our analysis are retrospective in nature: the questionnaire was not specifically designed to monitor wolverine populations, nor to assess factors that limit or regulate wolverine numbers. We are cognisant that definitions of abundance will vary among individuals and regions depending on bioregional differences and personal perceptions and values. Additionally, we do not provide a comparison between the local knowledge used and that obtained through rigorous field study. Regardless, we demonstrate that the collection and use of information from trappers has great potential in monitoring trends in abundance of this elusive furbearer at large spatio-temporal scales. If properly designed, these data can also be used to explore questions regarding ecological relationships and limiting factors. Further work will be on the development of a more detailed questionnaire (including definitions to aid in standardizing perceptions across individuals) and focal groups with a select number of long-time trappers.

Acknowledgements

We are grateful to all of the Yukon trappers who took the time to fill in the Yukon Trapper Questionnaire over the years. Without thier time, effort and highly-tuned observation skills these analyses would not be possible. We thank T. Fox assisted with data entry and processing. The Yukon Trapper's Association is acknowledged for supporting the use of trapper information in population status assessments and monitoring. Funding was provided by the Yukon Fish and Wildlife Branch.

Appendix 3 Ecozones and Ecoregions of the Yukon.