Appendix 10

Analysis of Relationships among Black Bear Nuisance Activity, Food Availability, and Harvest in Ontario

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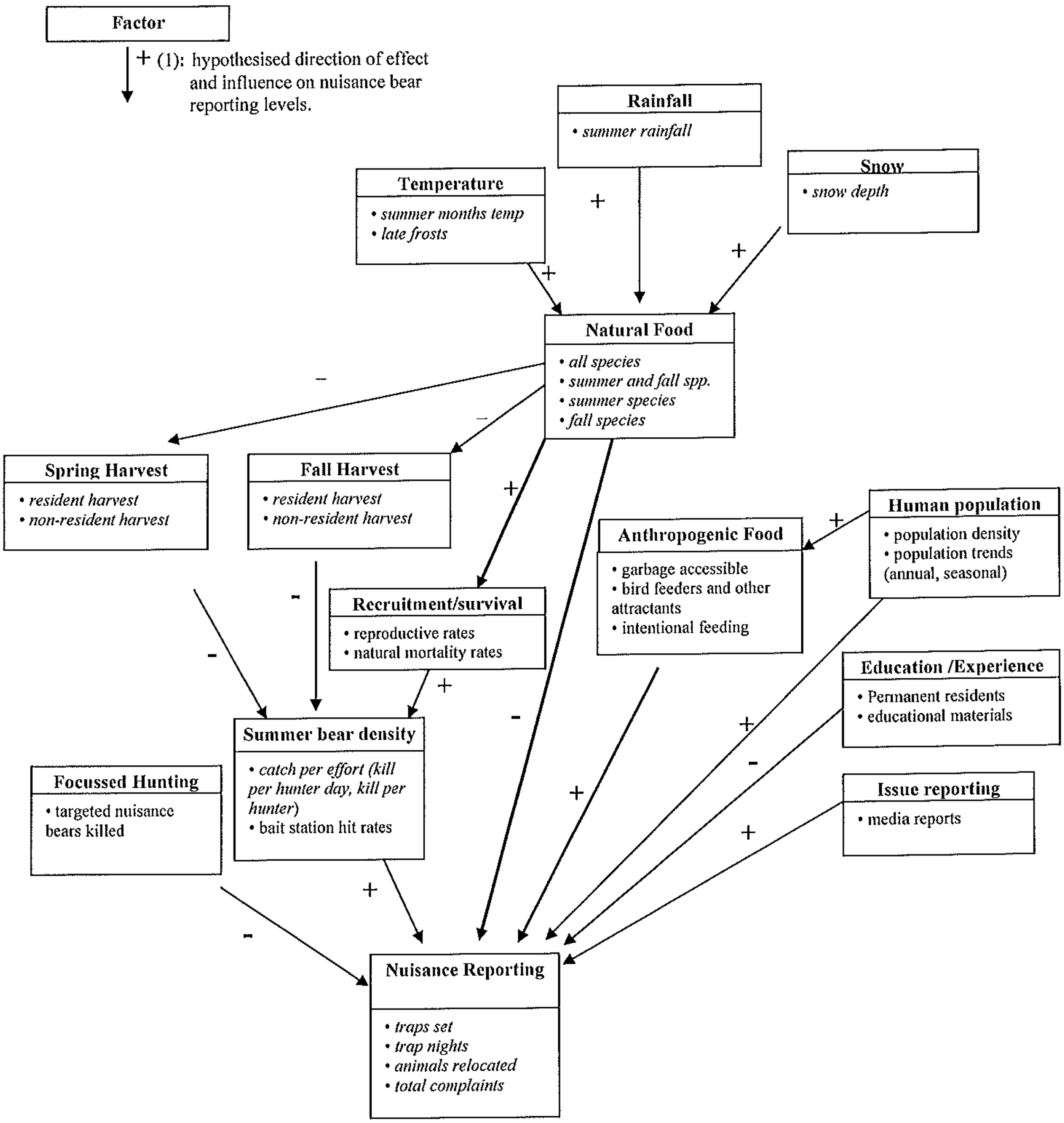
1. INTRODUCTION

Based on the General Conclusions from the Literature Review presented in Chapter 4 and Appendix 9, we identified all sources of data available to populate the Hypothesis of Effects diagram shown in Appendix 9 which would permit testing of hypotheses about the variables that influence nuisance bear activity. Potential variables that might influence nuisance bear activity and reporting, the hypothesised direction of the effect, and the hypothesised influence of the effect on nuisance bear complaints (+ or -) are shown in Fig. 1, as are all variables for which we were able to acquire suitable data for analysis.

Based on the general conclusions from the literature review (Chapter 4, Appendix 9) we generated the following hypotheses, which could be tested with the data available:

1. Weather variables such as air temperature, rainfall, and snow cover affect availability of natural foods.
2. Availability of natural foods affects nuisance bear activity directly (negative relationship), and also indirectly through its influence on recruitment and survival and hence bear abundance (positive relationship).
3. Availability of natural foods influences harvest levels by affecting the vulnerability of black bear to harvest (negative relationship).
4. Harvest influences nuisance bear activity through its effect on bear abundance (negative relationship).

Fig. 1. Hypothesis of effects diagram for nuisance black bear activity in Ontario showing the direction of the effect of the variable and the effect on nuisance bear activity or reporting rate. Potential variables, and variables for which data were acquired and analysed (*italics*), are indicated for each factor.



2. METHODS

We obtained data on nuisance activity by black bears, food availability for black bears, weather parameters, and black bear harvests in Ontario. We contacted individual Ontario Ministry of Natural Resources offices and requested records on complaints about nuisance bears. For food availability information, we used data contained in annual reports of the qualitative Wildlife Food Survey conducted in central Ontario from 1989-1992, and 1998-2001 (Strickland 1990, 1991, 1992, 1993; McLaren 1999, 2000, 2001, 2002, 2003). Weather data for Parry Sound and Sudbury Districts were obtained from Environment Canada. We explored relationships among different measures of nuisance activity, food availability, different weather variables, and number of bears harvested in both the spring and fall as outlined in the hypotheses in the Introduction.

2.1 Data Sources

2.1.1 Nuisance bear activity data

Records of nuisance bear activity were requested from OMNR offices across the province, but not all districts were able to provide historical data. That is because individual complaints about nuisance black bears (usually in the form of telephone calls) received by OMNR offices were not always recorded consistently by all offices in all years, and data may not have been archived. Record keeping for nuisance bear complaints has not been standardised until recently. Data for active OMNR responses to nuisance bears, including the number of traps set, number of trap nights, and number of animals destroyed or relocated by OMNR staff were recorded more consistently and reliably across districts. However, these types of data were available for fewer districts/areas, and fewer years, relative to complaint data. Data on active responses to nuisance bear complaints were used to test for correlations between nuisance activity and weather, food availability, and harvest whenever these indicators of nuisance activity were available.

For most OMNR administrative districts/areas, only data from 1995-2001 were available for analysis. However, both the Sudbury and Parry Sound offices maintained continuous standardised records of nuisance bear activity. Data on nuisance bear activity for Sudbury District have been maintained since 1978 and for the Parry Sound District (Area after 1995) since 1987. These districts or areas therefore received special attention in analyses of relationships between nuisance activity and weather, food availability, and harvest.

2.1.2. Food Availability

Data on food availability for black bears were derived from the qualitative Wildlife Food Survey (WLFS) conducted by OMNR in south-central Ontario (Strickland 1990, 1991, 1992, 1993; McLaren 1999, 2000, 2001, 2002). All WLFS data were collected within the Great Lakes–St. Lawrence Forest Region (GLSL). No estimates of wildlife food availability were available for the boreal forest region.

WLFS data were collected for the former Algonquin region from 1989-1992 in the following districts: Algonquin Park, Bancroft, Bracebridge, Minden, Parry Sound, and Pembroke. Most administrative districts did not conduct Wildlife Food Surveys during 1993-1997. WLFS data collection was reinstated on a regional basis in 1998 (McLaren 1999-2002). In addition to the administrative units within the former Algonquin Region, Sudbury and North Bay districts have collected WLFS data since 1998. These qualitative data do not provide absolute estimates of food available to wildlife, but are useful in demonstrating annual variation in the productivity of natural food plants used by black bears. For detailed methods, see the original Wildlife Food Survey reports by Strickland (1990-1993) and McLaren (1999-2002).

Nearly continuous records of food availability were available only for the Parry Sound Area where only data for 1993 were missing for the period from 1989 to 2001. To determine whether data from Parry Sound are representative of the entire GLSL, we tested for correlation between annual data on food availability in the Parry Sound Area and pooled data from all other Districts/Areas. The pooled data set for food availability in the GLSL was calculated by first averaging scores from multiple reports within each district/area, then averaging within-district/area means to produce the regional mean. This ensured that each district or area contributed equally to the score for the GLSL scores, despite differences in the number of individual samples from different districts or areas. Wildlife food-availability scores from the Parry Sound District (Parry Sound and Bracebridge Areas) were excluded from the pooled data from the rest of the GLSL, to ensure data were distinct. We also calculated food availability for the GLSL including data from the Parry Sound District for comparison with provincial nuisance activity and harvest data.

Regional food availability indices for wildlife species as published in Strickland 1990-1993, and McLaren 1999-2003) do not consider prevalence of different species. They simply average the productivity score for each species present that bears use. To avoid undue influence of uncommon species, we did not use the published regional mean values but calculated new food availability indices from WLFS data for the purposes of this report. The following measures of bear food availability were used:

- All species: average score of all species consumed by bears. (Equivalent to the Food Index for Black Bears as in original WLFS reports).

- Summer species: average of the scores for cherry, juneberry, blackberry, raspberry, and blueberry.
- Fall species: average of the scores for oak, beech, mountain ash and hazel.
- Summer and Fall species: average of the scores for the 5 summer species and the 4 fall species

We augmented WLFS data for Sudbury District with observations of blueberry productivity from Jeanine Larcher- Lalande, chairperson of the annual blueberry festival. Ms. Lalande is an experienced observer of blueberry productivity, and has kept records of year-to-year trends for personal interest and because of connections to the wild blueberry picking industry around Sudbury.

2.1.3 Weather Data

Weather data were obtained from Environment Canada for stations within Parry Sound and Sudbury Districts. Not all of the weather variables requested were available for all years for these areas. The following weather variables were tested against food availability and nuisance activity data from the Parry Sound Area and Sudbury District.

We calculated difference from the long-term mean for total precipitation between June and August in each year. We used the absolute value of this difference to test for effects of either too much or too little rain on food availability (Selas 2000).

Low snow cover in early spring has been suggested as a cause of poor natural food production for black bears (Garshelis 1989). Total snowfall was used as one measure of snow cover, and tested against nuisance activity and food availability data in the Parry Sound Area. Snow cover during week 26 was extracted using the Snow Network for Ontario Wildlife program (SNOW). We tested for effects of snow cover during week 26 (mid-March) on food availability the following summer and fall. We also recorded the last week during which there was still snow on the ground, and tested for correlation with nuisance activity and food availability the following summer and fall.

Minimum daily temperature data was used to test for effects of late spring frosts in April, May and June. April frost data for the Parry Sound Area were only available for 1989, 1990, 1991, 1995, 1996, and 2001.

We tested for correlations between nuisance activity and average temperatures in April, May, and June, to investigate effects of overall cool temperatures in the spring on nuisance activity the same year, and the following year. We also compared the sum of average temperatures in April and May with nuisance activity the same year, and the following year. The difference in May temperatures from the long-term average temperature in May was calculated for 1980-2001, and tested for correlation with nuisance activity the same year, and the following year. We tested for effects of cool spring temperature on nuisance activity the following year because such conditions can affect flower bud formation in berry-producing species, and therefore fruit production the following year (Selas 2000).

Cold winter temperatures when snow cover is light can damage some soft mast producing species. We therefore tested for effects of snow cover and temperature in January on nuisance activity the following summer and fall.

Extremes for summer rainfall can reduce the productivity of soft mast producing plant species (Selas 2000). Since either too little, or too much precipitation can adversely affect soft mast production, we calculated the absolute value of the difference from the long-term mean for summer rainfall and tested for correlation with nuisance activity same and following year.

2.1.4 Harvest Data

District and area-specific non-resident harvest data were obtained for 1987-2002 (from Black Bear License Validation Certificates (BLVC) [Form 33s]) from the database maintained by OMNR's South-central Science Unit (L. Dix-Gibson, personal communication). These data were further divided into bears harvested during the spring and fall hunts. Provincial totals of number of bears harvested and hunter success rate were obtained for 1989-2000, compiled from Provincial Mail Survey of hunters and BLVC. This dataset includes total harvest and number of hunters but is not broken down by spring and fall seasons. The data are organised by Wildlife Management Unit (WMU) rather than OMNR District so data at the WMU level were summed to provide measures of harvest and number of hunters as required for each level of analysis. Hunter success rate was computed as the total harvest divided by the total number of hunters. We explored relationships between harvest (spring harvest, fall harvest, total harvest, hunter success rate) and various indicators of nuisance activity to determine how harvest and nuisance activity were related.

2.2 Analytical Methods

We first examined variation in nuisance activity separately in the Boreal ecoregion and the Great Lakes–St. Lawrence ecoregion to determine whether patterns of nuisance activity differed between ecoregions. We examined four measures of nuisance activity: total number of complaints logged by OMNR offices, number of traps set, total number of trap nights, and number of bears relocated. Variation in the number of nuisance bear complaints may be only partially an effect of variation in nuisance bear activity because recording rate for complaints and reporting rates by citizens may also cause complaint data to vary between areas and years. Therefore, we tested for correlations between nuisance complaint data across districts, to determine if annual variation in the number of complaints about nuisance bears was homogeneous across each ecoregion and across the province.

We next examined the annual variability in natural foods available for black bears in the Great Lakes–St. Lawrence ecoregion based on data from annual Wildlife Food Surveys. Subsequently we evaluated whether data for Parry Sound Area were representative of the entire GLSL ecoregion. Since the data for Parry Sound for nuisance activity and food availability provided the longest and most complete source of data in the province, and recent peaks in nuisance bear complaints have occurred in central Ontario, we evaluated whether data from Parry Sound were representative of all of central Ontario (Great Lakes–St. Lawrence ecoregion).

We next examined the effect of weather variables on food availability and nuisance activity. We explored relationships between the number of nuisance complaints and weather variables, food availability, and harvest rates districts/areas within the province, pooled across all areas for which data were available.

Analyses were performed for four study areas identified as

i) Parry Sound Area of Parry Sound District
ii) Parry Sound District (including Parry Sound and Bracebridge Areas)
iii) Sudbury District, and
iv) Great Lakes–St. Lawrence Ecoregion

This definition of study areas was required to maximise the number of years for which consistent datasets were available for the study areas. For example, Parry Sound Area had the longest food availability dataset. To analyse a larger area (e.g., Parry Sound District), meant that there were fewer years for which food data were available; however, this meant that the numbers of samples for estimating annual food indices, harvest, and nuisance measures was larger. It was not reasonable to undertake Provincial level analysis because annual patterns of nuisance activity appeared to differ between the Great Lakes–St. Lawrence and Boreal ecoregions, and because there were no food data for the Boreal ecoregion. Therefore, the largest extent of analysis was the Great Lakes–St. Lawrence ecoregion.

Within each study area, we explored relationships between:

i) Food availability and nuisance activity

ii) Food availability and harvest

iii) Harvest and nuisance activity

For Parry Sound Area the data set extended from 1989 to 2002, except for total harvest and hunter success rates because estimates of the resident harvest were only available to the year 2000 (this constraint applies in each study area). In expanding the geographic area to Parry Sound District the study period was limited by recorded nuisance data to the 1995 to 2002 period. Sudbury District analysis covered the period from 1987 to 2002, except that food data were only available from 1998 to 2002. For analysis at the largest extent, the Great Lakes-St. Lawrence Ecoregion, the period for which consistent data were available was 1995 to 2002. However, in this case data from a number of districts were amalgamated to provide ecoregion estimates of the variables.

We assessed the significance and the direction of the relationships using the Pearson correlation coefficient and significance probabilities as calculated by Statistica® software. Missing data were pair-wise deleted, which may result in differing samples sizes within an analysis. Results were considered significant at $\alpha \leq 0.05$.

The magnitude of the nuisance data values varied greatly. For example, in the case of Sudbury a 20-fold increase from 15 to over 3000 nuisance calls occurred between 1998 and

2001. To meet the assumptions of the correlation analysis the common practice of applying a natural logarithm transformation was adopted for variables where the distribution of values was highly skewed.

A second related issue arose in analysis of relationships of non-resident spring harvest data where, in 1999, the values for this variable drop to zero and remain at this level. The data distribution is clearly non-normal and the variance in the data after 1998 is zero. It is not appropriate to include data after 1998 to assess relationships with this variable using correlation analysis; and there is no transformation available to remedy the problem. Therefore, in analysis of relationships involving non-resident spring harvest, only data up to 1998 are included. This will show whether spring harvest has a detectable correlation with nuisance activity during the time the hunt was permitted. The effect of the spring harvest dropping to zero can not be assessed with this correlational statistical approach, but it may be described from graphs in the context of other variables of influence.

3 RESULTS

3.1 Annual Variation in Nuisance Bear Activity.

Data were potentially available on four measures of nuisance activity: total number of complaints received by OMNR offices, number of traps set, total number of trap nights, and number of bears relocated.

Information on the number and nature of complaints regarding nuisance bears was not consistently recorded across all OMNR districts, or across all years. OMNR Districts or Areas with the most complete records in the Great Lakes–St. Lawrence ecoregion (GLSL) were Parry Sound, Bracebridge, Sudbury, North Bay and Sault Ste. Marie. Districts in the Boreal ecoregion with the most complete records were Kenora, Thunder Bay, Timmins and Kirkland Lake. Numbers of complaints about nuisance black bears in these districts are shown in Figs. 2a, b.

For the period 1995-2002, districts in the GLSL for which continuous records exist (Parry Sound and Bracebridge, and Sudbury) showed a similar pattern of nuisance complaints (Fig. 2a). Nuisance complaints were high in 1995, followed by relatively high nuisance activity in alternating years (1997, 1999) with unprecedented numbers of complaints in 2001, especially in Sudbury and in Bracebridge Area of Parry Sound District. Sault Ste. Marie and North Bay recorded a high number of complaints in 1995 and in 2001, but the intervening alternate year pattern was not evident. Nuisance complaints dropped in most GLSL districts in 2002 though in Sudbury and Bracebridge the number of complaints was still higher than any other year except 2001.

Data for the Boreal ecoregion were more sparse than the data for the GLSL, so it is more difficult to discern patterns in nuisance activity. However, it is evident that the pattern in the Boreal ecoregion differs from that in the GLSL (Figs. 2a,b). In addition, the available data suggest that nuisance activity in north-western Ontario follows a different pattern from that in north-eastern Ontario (Fig. 2b).

The two districts in north-western Ontario (Kenora and Thunder Bay) recorded high levels of nuisance activity in 1995, but nuisance complaints dropped greatly in 1996 and remained low until 2000. Complaints recorded in Thunder Bay remained at the same level in 2001, but climbed greatly in Kenora in 2001. The number of complaints in 2002 remained at about the same level in Kenora, but rose in Thunder Bay (Fig. 2b).

In north-eastern Ontario, Kirkland Lake recorded low levels of nuisance complaints in all years until 2001, before dropping again in 2002. Despite being a peak year, the total number of complaints recorded in Kirkland Lake in 2001 was only 82. Timmins reported a very different pattern from either the districts in north-western Ontario or Kirkland Lake. In Timmins, the number of complaints was fairly high in 1997, and the peak number of complaints was recorded in 1998. Recorded complaints dropped greatly in 1999 and remained low in 2000 before climbing in 2001 to a level similar to that recorded in 1997. The number of complaints dropped greatly in Timmins in 2002 to the lowest level of all years for which data were available.

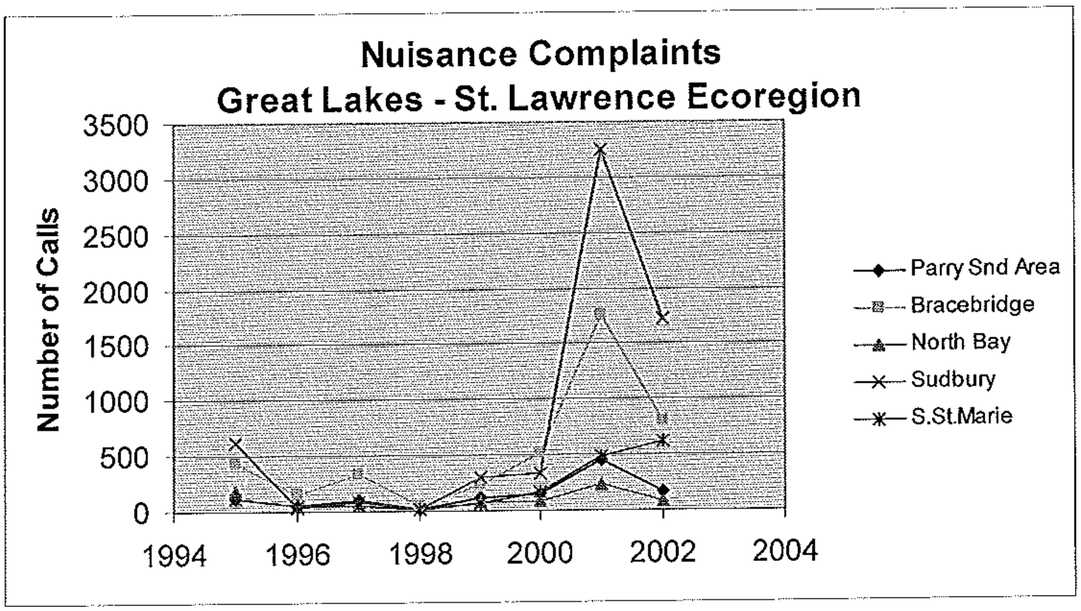


Fig. 2a. Annual variation in number of nuisance bear complaints for districts in the Great Lakes–St. Lawrence ecoregion, 1995-2002.

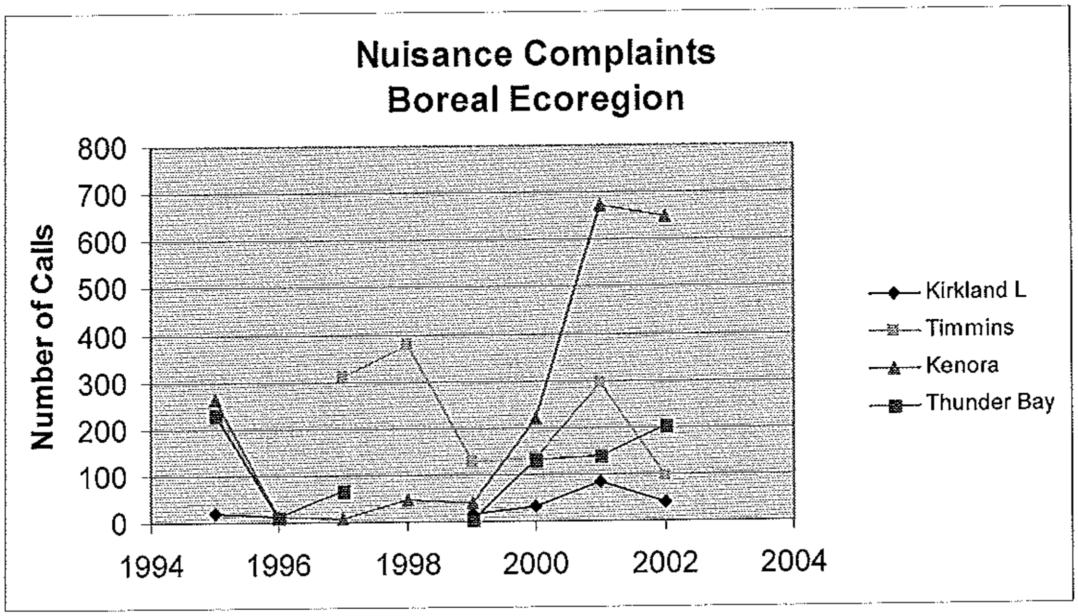


Fig. 2b. Annual variation in number of nuisance bear complaints for districts in the Boreal ecoregion, 1995-2002.

Data on the total number of traps set in a year were only available from four OMNR offices: Parry Sound Area, Bracebridge Area, Sault Ste. Marie, and Thunder Bay (Fig. 3). Annual variation in the pattern of response to nuisance activity measured by number of traps set was different in the GLSL compared to the Boreal. The number of traps set in the GLSL was high in 1995, 1997, 2000 and 2001 then dropped greatly in 2002, whereas in the Boreal peaks occurred in 1995 and 1998.

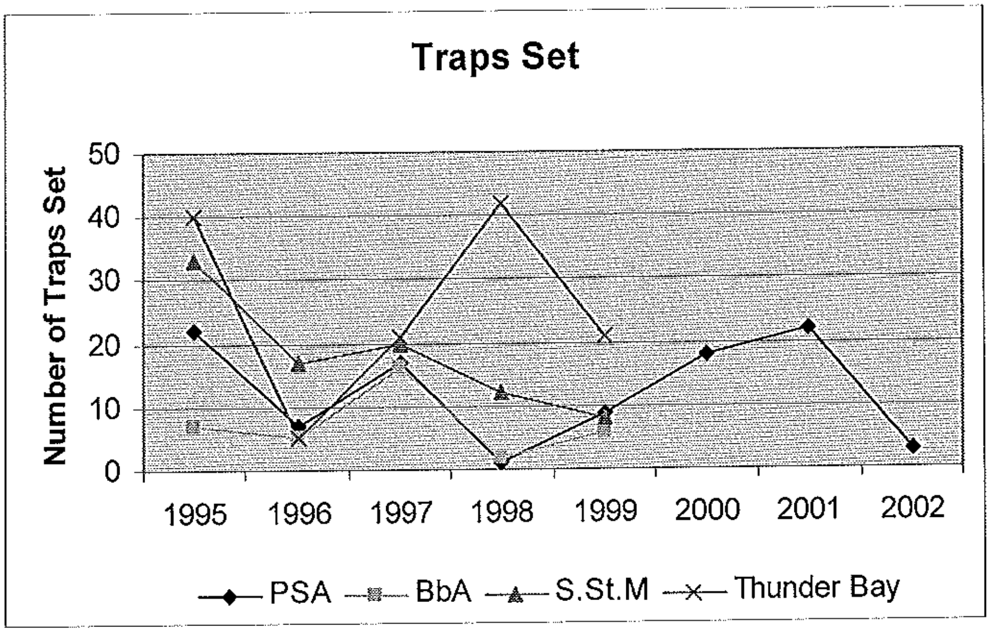


Fig. 3. Total number of traps set in reporting districts (Parry Sound Area, Bracebridge Area, Sault Ste. Marie, Thunder Bay), 1995-2002.

Data on the total number of bears relocated were available from four offices in the GLSL ecoregion: (Parry Sound, Bracebridge, Sudbury, and Sault Ste. Marie), and four offices in the Boreal ecoregion (Kenora, Thunder Bay, Timmins, and Kirkland Lake) (Figs. 4a, b). There was considerable variation among districts in numbers of bears relocated both within and between ecoregions. Sudbury reported peaks in number of bears relocated in 1995 and 2001,whereas in other districts in the GLSL the number of bears relocated was low in all years until 2001 (Fig. 4a). The number of bears relocated dropped in all districts in the GLSL in 2002 except for Sault Ste. Marie. In the Boreal ecoregion the number of bears relocated was high in 1995, 1998, and 2001, and remained high in Kenora and Timmins in 2002 but dropped greatly in Thunder Bay and Kirkland Lake (Fig. 4b).

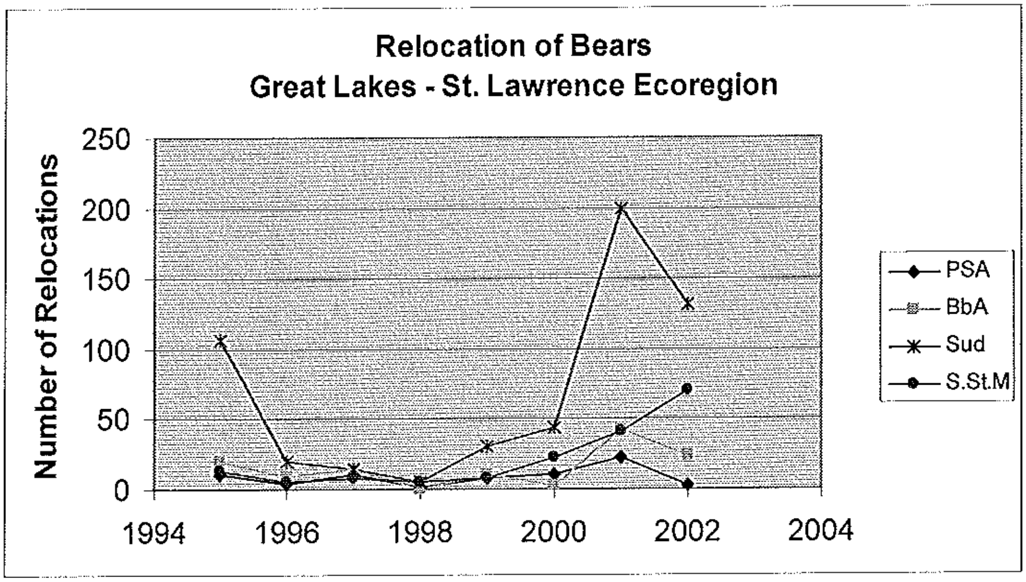


Fig. 4a. Number of bears relocated in districts in the Great Lakes–St. Lawrence ecoregion, 1995-2002.

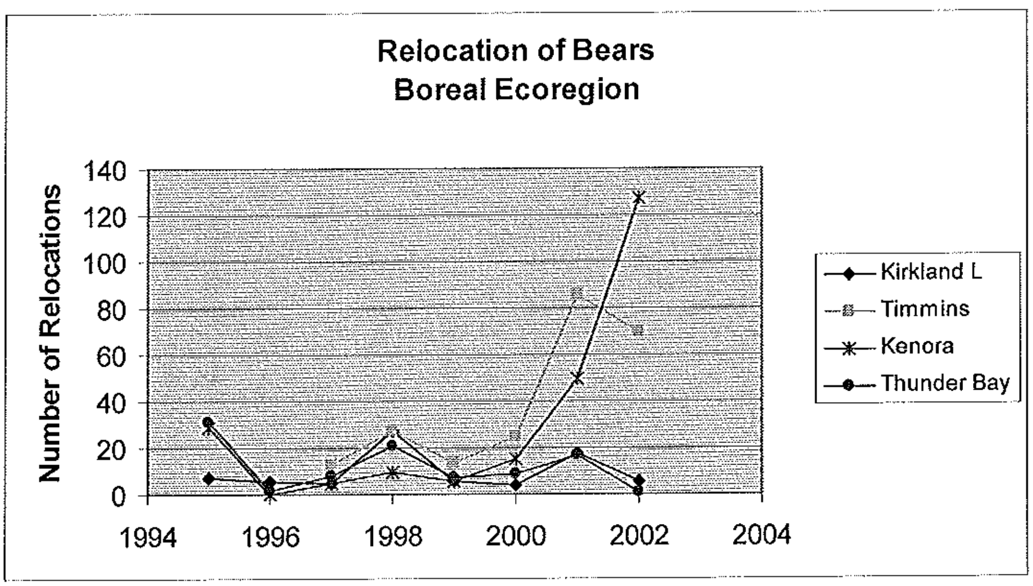


Fig. 4b. Number of bears relocated in districts in the Boreal ecoregion, 1995-2002.

3.2 Annual variation in availability of natural foods for black bears in the Great Lakes–St. Lawrence Forest Region

The different measures of food availability for black bears (summer species, fall species, summer and fall species) were significantly positively correlated ($P < 0.05$) over time for both the Parry Sound Area data and the pooled Great Lakes–St. Lawrence data sets (Algonquin, Bancroft, North Bay, Pembroke, Sudbury). There was a strong correlation over years between the index of summer species and the index of fall species for Parry Sound Area ($r = 0.639$, $P = 0.019$, $n = 13$). When data for summer *versus* fall species were analysed for other districts in the GLSL, the correlation was stronger ($r = 0.648$, $P < 0.0001$, $n = 33$). Since nuisance complaint data were summarised by district for the entire season, and because of the strong correlation between summer and fall food availability we used the combined index for nine summer and fall food species for subsequent analyses.

We next determined whether Wildlife Food Survey data from Parry Sound Area were representative of the entire GLSL ecoregion. The food index for 9 summer and fall species combined for Parry Sound Area was significantly positively correlated over years with the index for summer and fall species for the GLSL excluding Parry Sound ($r = 0.782$, $P = 0.022$, $n = 8$) (Fig. 5). Since data for Parry Sound were strongly correlated with data for the entire GLSL ecoregion and therefore representative of the region, and Parry Sound Area provided the longest sequence of data, we used food availability data for Parry Sound Area in subsequent analyses.

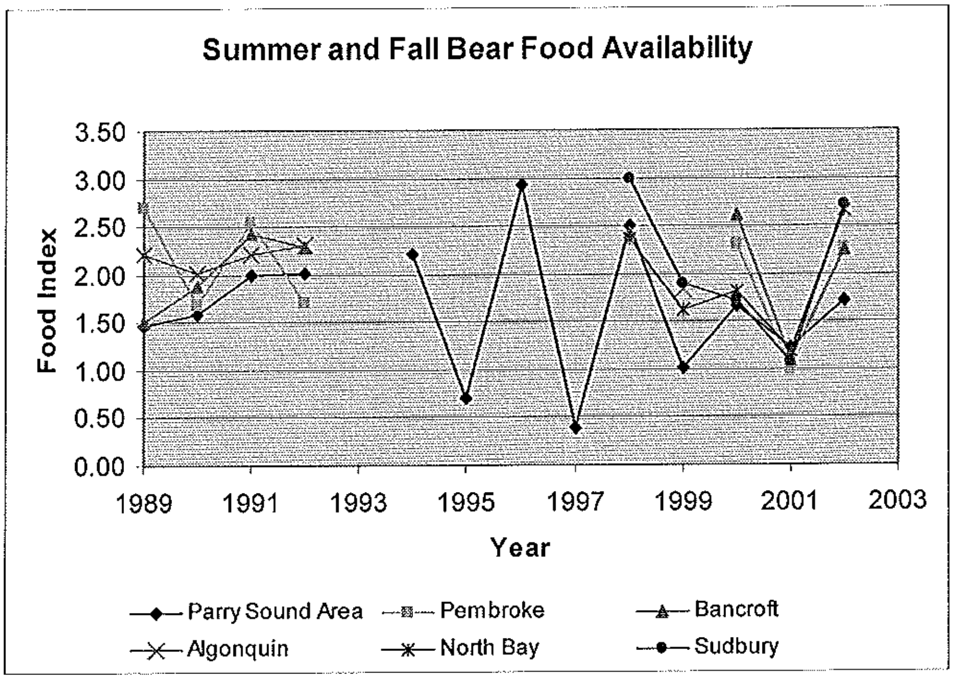


Fig. 5. Food availability for Summer and Fall foods combined for black bears in reporting districts in the Great Lakes–St. Lawrence ecoregion. Food index is derived from Wildlife Food Survey data (Strickland 1990, 1991, 1992,1993; McLaren 1999, 2000, 2001, 2002, 2003).

3.3 Influence of Weather on Food Availability and Nuisance Activity.

There were no statistically significant relationships between any weather variables and nuisance activity, or food availability. It is not known whether the failure to identify relationships was due to failure to identify an appropriate independent variable, or incompleteness of the data that were tested. For example, no minimum daily temperature data were available from Environment Canada for the Parry Sound District between 1997 and 2000, potentially preventing identification of a relationship between weather and food availability.

Years with hard or late spring frosts did not consistently coincide with years of high nuisance activity. No late frosts were apparent in weather data for the past 5 years.

3.4 Analysis of Nuisance Bear Activity, Food Availability, and Harvest for Parry Sound Area.

3.4.1 Relationship between Food Availability and Nuisance Activity.

Data for Parry Sound Area provided the longest and most complete series for both number of nuisance bear complaints and food availability. WLFS data were collected continuously from 1989 to 2002, with the exception of 1993, and WLFS scores for this area were consistently based on a large number of observations from many locations.

Measures of nuisance activity recorded for each year were number of telephone calls (complaints), number of traps set, and total number of trap-nights. Food availability for summer and fall species for the period 1989-2002 was not significantly correlated with number of nuisance calls (r = -0.391, P = 0.209, n = 12), but was significantly negatively correlated with number of traps set (r = -0.691, P = 0.019, n = 11), and total number of trap nights (r = -0.691, P = 0.009, n = 13) (Fig. 6a). Both number of traps set and total number of trap-nights are measures of the district response to a complaint call and include an evaluation by district staff of the seriousness of the complaint.

Visual inspection of the data shown in Fig. 6a suggested that a log-transformation of the data on nuisance calls was appropriate to avoid violating assumptions of regression analysis (because of the extreme value for 2001). Food availability for summer and fall was significantly negatively correlated with the log-transformed number of nuisance calls (r - -0.608, P = 0.036, n

= 12). The relationship between food availability for summer and fall and the log-transformed number of complaints is shown in Fig. 6b.

Two other measures of nuisance activity (number of bears relocated, number of nuisance kills) showed no significant relationship with food availability. The relationship between the index of summer and fall foods and number of bears relocated was not statistically significant (r = -0.593, P = 0.121, n = 8). Similarly, there was no statistically significant relationship between food availability and number of nuisance kills.

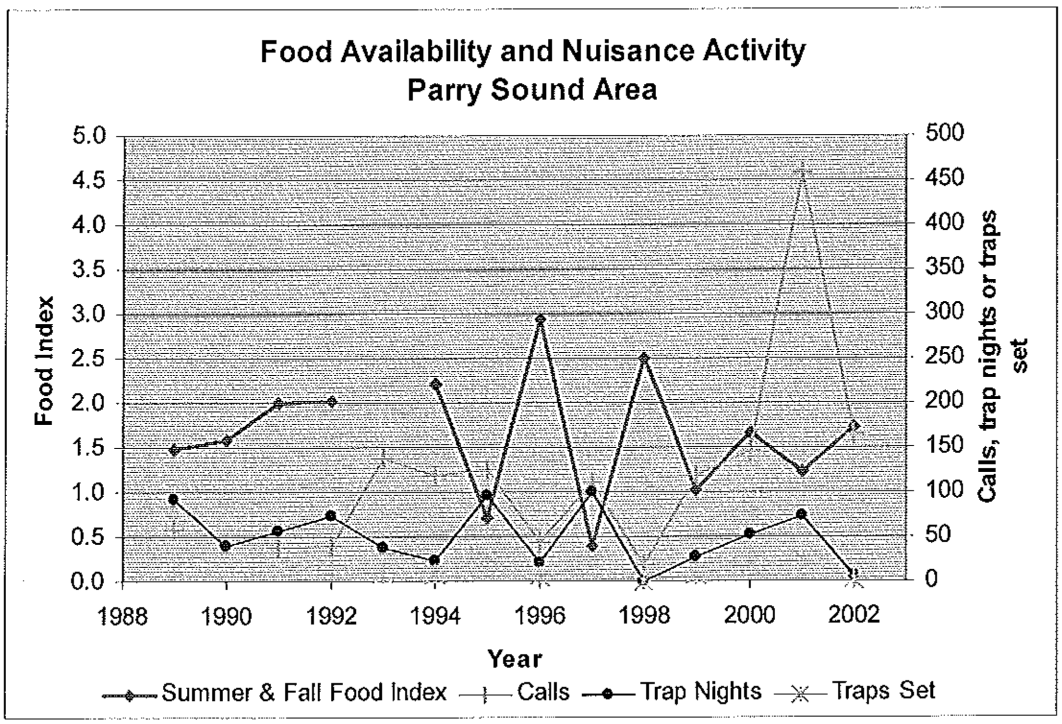


Fig. 6a. Relationship between Wildlife Food Survey Index for summer and fall species, and number of nuisance bear calls, number of trap nights, and number of traps set for Parry Sound Area, 1989-2002.

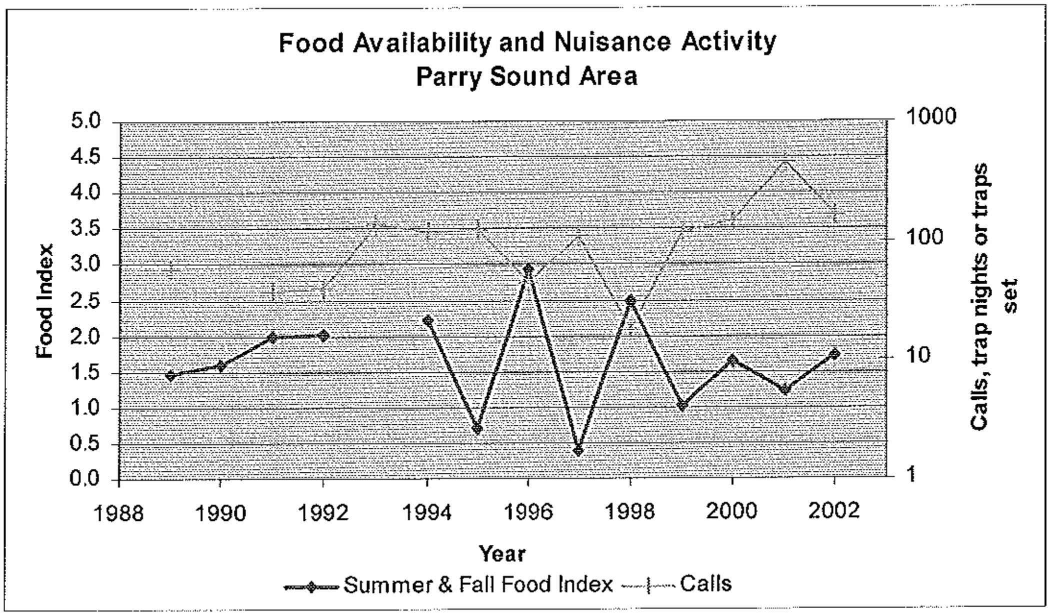


Fig. 6b. Relationship between Wildlife Food Survey Index for summer and fall species, and number of nuisance bear calls for Parry Sound Area, 1989-2002 (number of calls is on a logarithmic scale. $r = -0.608$, $P = 0.036$, $n = 12$)

As the major food species for black bears do not begin to appear until mid-summer we examined the seasonal distribution of nuisance complaints within years to determine whether it reflected the seasonal cycle of food production. Seasonal information on calls was available for the period 1995-2002 for Parry Sound Area. We divided the data into two periods: April-June and July-September for analysis. There was less annual variation in spring nuisance activity than in summer and fall nuisance activity, though spring nuisance levels were still negatively related to food availability in the same year (Fig. 7).

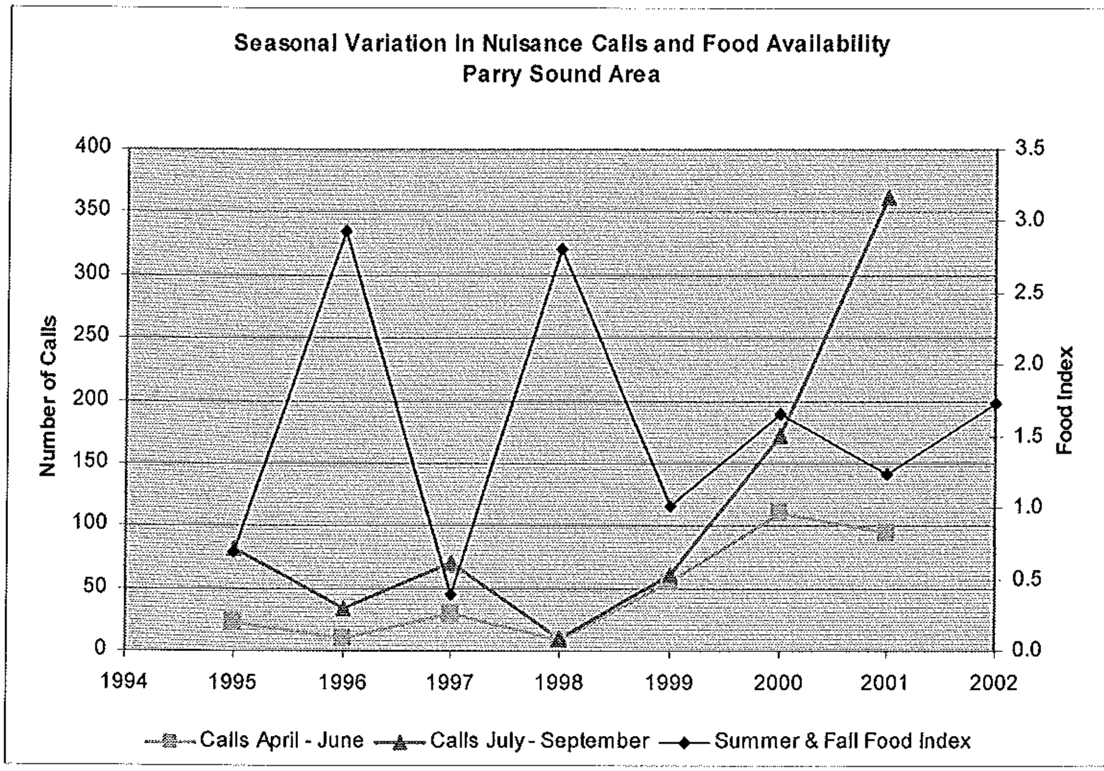


Fig. 7. Seasonal variation in nuisance calls as related to summer and fall food index for Parry Sound Area, 1995-2002

3.4.2. Influence of Food Availability on Harvest.

We tested for relationships between summer and fall food availability and the number of bears harvested by non-residents in spring, the number of bears harvested by non-residents in fall, total annual harvest by non-residents and residents combined, and hunter success rates in Parry Sound Area. No significant relationships were observed between any of the harvest variables and the summer and fall food variable (Table 1). Wildlife Food Survey data were available for 13 of 14 years from 1989-2002. Non-resident harvest data were available for all 13 of these years and total annual harvest and hunter success rates were available for 11 of these years.

Table 1. Relationship between summer and fall food availability and measures of harvest for Parry Sound Area, 1989-2002.

	Non-resident spring harvest (1989-1998)	Non-resident fall harvest (1989-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1989-2000)	Hunter success rate (1989-2000)
Summer and fall food index	r = 0.-0.2138 $P = 0.581$ n = 9	r = 0.0665 $P = 0.829$ n = 13	r = 0.2992 $P = 0.371$ n = 11	r = 0.0707 $P = 0.836$ n = 11

3.4.3. Relationship between Harvest and Nuisance Activity.

We tested for relationships between the number of bears harvested by non-residents in spring, the number of bears harvested by non-residents in fall, total annual harvest by non-residents and residents combined, and hunter success rates and four nuisance activity variables (annual number of complaints, number of traps set, total number of trap nights, and number of animals relocated) for Parry Sound Area, 1989-2002.

None of the harvest variables showed a significant correlation with any of the nuisance activity variables (Table 2; Figs. 8a,b).

Table 2. Relationships between four measures of nuisance bear activity and four harvest measures for Parry Sound Area, 1989-2001.

Nuisance activity variable	Non-resident spring harvest (1989-1998)	Non-resident fall harvest (1989-2002)	Total annual harvest (Non-resident and resident, spring and fall) (1989-2000)	Hunter success rate (1989-2000)
Annual number of complaints	r = 0.01 *P* = 0.980 n = 9	r = -0.1937 *P* = 0.526 n = 13	r = 0.3662 *P* = 0.268 n = 11	r = 0.4663 *P* = 0.148 n = 11
Log-transformed number of complaints	r = 0.2059 *P* = 0.595 n = 9	r = -0.3476 *P* = 0.245 n = 13	r = 0.2698 *P* = 0.422 n = 11	r = 0.4632 *P* = 0.151 n = 11
Number of traps set	r = 0.4864 *P* = 0.222 n = 8	r = -0.0581 *P* = 0.858 n = 12	r = 0.608 *P* = 0.868 n = 10	r = 0.3849 *P* = 0.272 n = 10
Total number of trap nights	r = 0.4038 *P* = 0.247 n = 10	r = 0.1487 *P* = 0.612 n = 14	r = -0.3041 *P* = 0.337 n = 12	r = -0.0063 *P* = 0.984 n = 12
Number of bears relocated	r = 0.7474 *P* = 0.253 n = 4	r = -0.0997 *P* = 0.814 n = 8	r = 0.0348 *P* = 0.948 n = 6	r = 0.4084 *P* = 0.421 n = 6

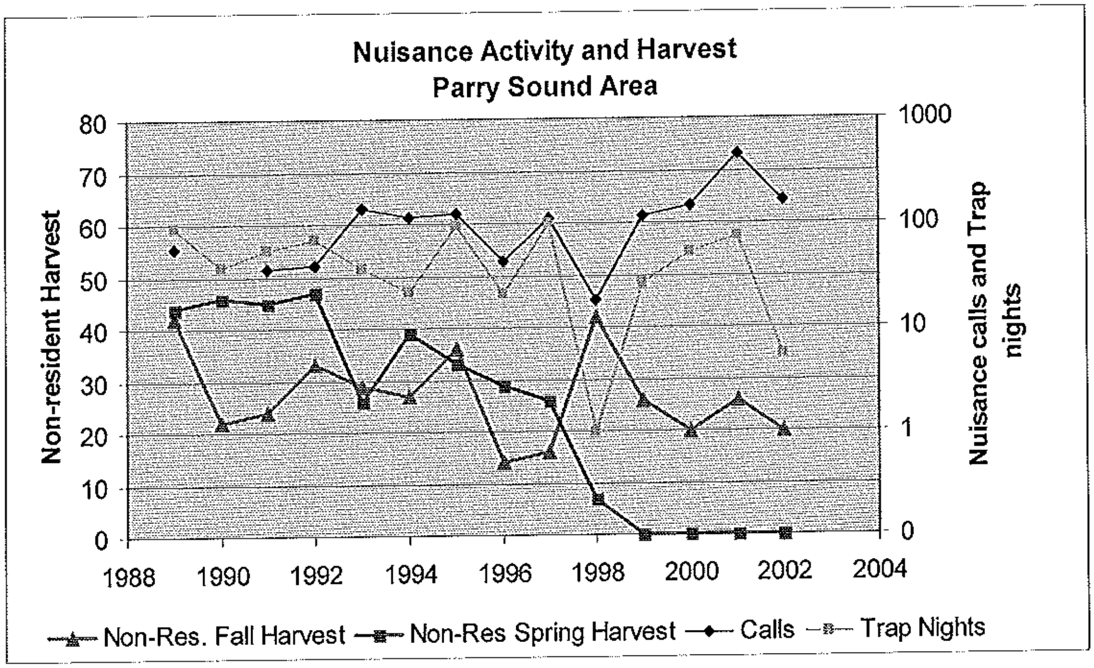


Fig. 8a. Relationships between non-resident harvest (Spring and Fall) and measures of nuisance activity for Parry Sound Area, 1989-2002 (logarithmic scale for nuisance measures).

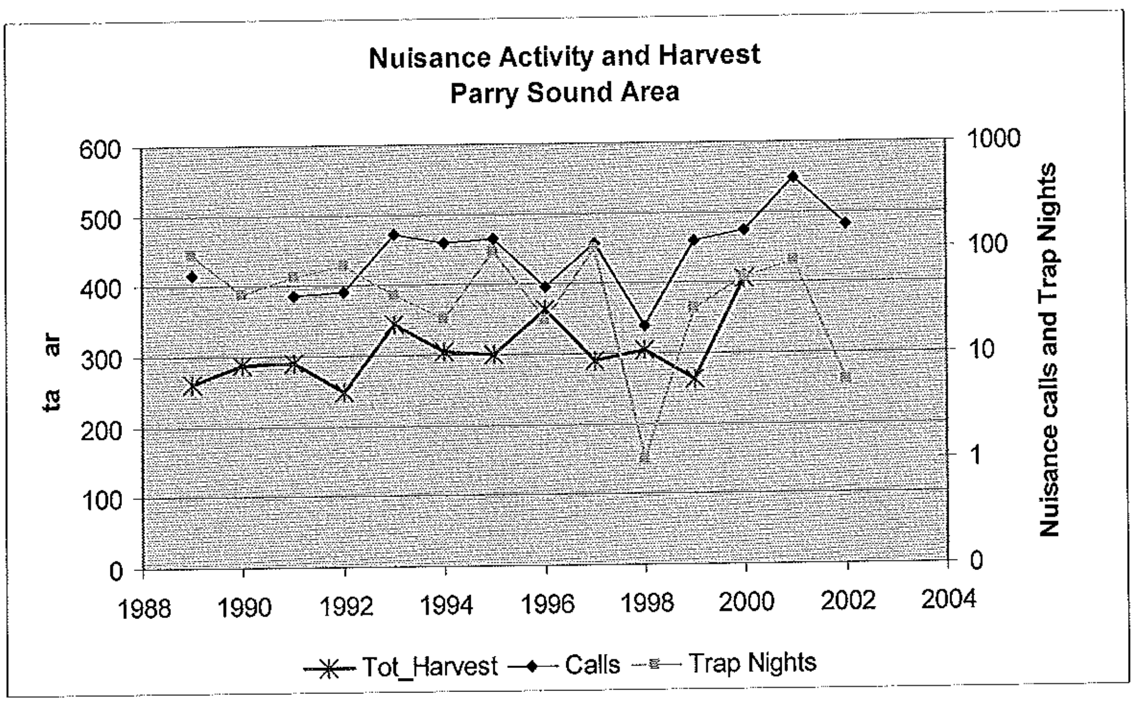


Fig. 8b. Relationship between total harvest and measures of nuisance activity for Parry Sound Area, 1989-2002 (logarithmic scale for nuisance measures).

3.5. Analysis of Nuisance Bear Activity, Food Availability, and Harvest for Parry Sound District (Parry Sound and Bracebridge Areas).

To expand the geographic area in central Ontario over which the factors affecting nuisance bear activity were investigated we combined data for OMNR's Parry Sound Area and Bracebridge Area of Parry Sound District. This increased the sample sizes for annual estimates for some data (e.g., Wildlife Food Survey index, resident harvest) but reduced the number of years for which data were available. For the combined areas nuisance activity data were available for number of complaints (1995-2002), number of traps set (1995-1999), and number of animals relocated (1995-2002). Harvest data for non-residents were available for the period 1995-2002; however, total harvest and hunter success rates were only available for 1995-2000.

3.5.1 Relationship between Food Availability and Nuisance Activity.

Similar to the pattern shown for the longer data set for Parry Sound Area, the number of complaints recorded by the Parry Sound and Bracebridge Area offices was not significantly correlated with summer and fall food availability for 1995-2002 ($r = -0.2728$, $P = 0.513$, $n = 8$). A similar pattern held for the relationship between summer and fall food index and number of traps set ($r = -0.846$, $P = 0.071$, $n = 5$), and for the relationship between summer and fall food index and number of animals relocated ($r = -0.599$, $P = 0.117$, $n = 8$). However, similar to the situation for data Parry Sound Area, visual inspection of the data for Parry Sound District indicated that log-transformation of the nuisance activity data was appropriate because of the extreme values for 2001. This transformation strengthened the relationships, but there were still no significant correlations. The relationships between summer and fall food index and nuisance activity data is shown in Table 3 and Fig. 9.

Table 3. Relationship between summer and fall food availability and measures of nuisance activity for Parry Sound District, 1995-2002.

	Total annual number of complaints	Log-transformed annual number of complaints	Number of bears relocated	Log-transformed number of bears relocated
Summer and fall food index	r = -0.2728 $P = 0.513$ n = 8	r = -0.5191 $P = 0.187$ n = 8	r = -0.485 $P = 0.223$ n = 8	r = -0.5989 $P = 0.117$ n = 8

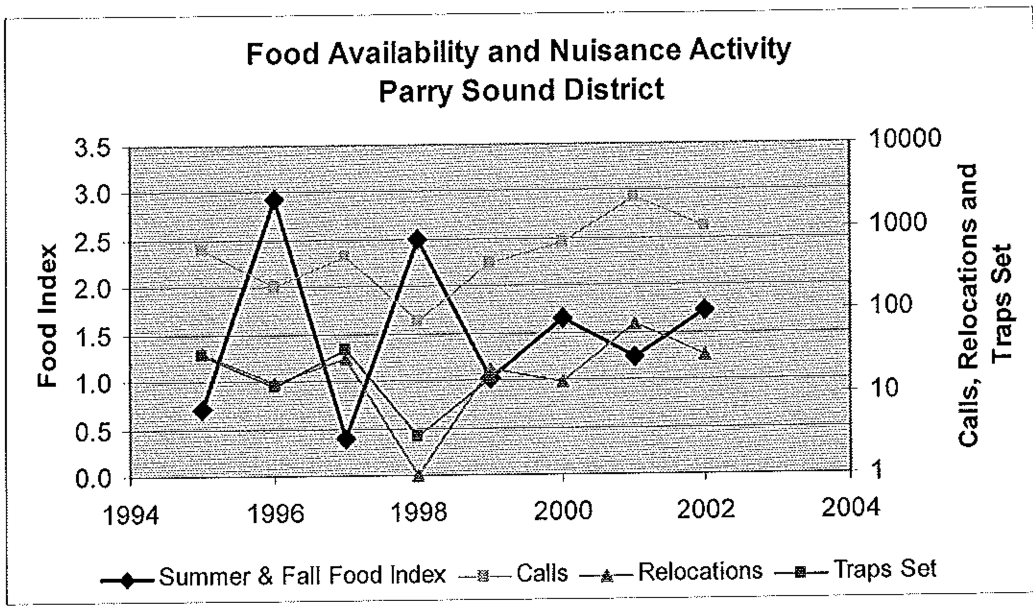


Fig. 9. Relationship between Wildlife Food Survey Index for summer and fall species, and number of nuisance bear calls, number of traps set, and number of bears relocated for Parry Sound District, 1995-2002 (logarithmic scale for nuisance measures).

3.5.2 Influence of Food Availability on Harvest.

For the larger geographic area of Parry Sound District, there were no significant relationships between food availability and spring, fall, or total harvest (Table 4).

Table 4. Relationship between summer and fall food availability and measures of harvest for Parry Sound District, 1995-2002.

	Non-resident spring harvest (1995-1998)	Non-resident fall harvest (1995-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1995-2000)	Hunter success rate (1995-2000)
Summer and fall food index	r = -0.9235 $P = 0.077$ n = 4	r = -0.592 $P = 0.122$ n = 8	r = 0.4562 $P = 0.363$ n = 6	r = 0.109 $P = 0.837$ n = 6

3.5.3 Relationship between Harvest and Nuisance Activity.

We tested for relationships between the number of bears harvested by non-residents in spring, the number of bears harvested by non-residents in fall, total annual harvest by non-residents and residents combined, and hunter success rates and three nuisance activity measures (annual number of complaints, number of traps set, and number of animals relocated) for Parry Sound District, 1995-2002.

No harvest variables showed a significant correlation with any of the untransformed nuisance activity variables. However, there was a significant positive relationship between non-resident spring harvest and log-transformed number of traps set, between non-resident fall harvest and the log-transformed annual number of complaints, and between non-resident fall harvest and log-transformed number of bears relocated (Table 5; Figs. 10a,b).

Table 5. Relationships between three measures of nuisance bear activity and four harvest measures for Parry Sound District, 1995-2002.

Nuisance activity variable	Non-resident spring harvest (1995-1998)	Non-resident fall harvest (1995-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1995-2000)	Hunter success rate (1995-2000)
Annual number of complaints	r = 0.9638 *P* = 0.036* n = 4	r = 0.3865 *P* = 0.344 n = 8	r = 0.2842 *P* = 0.585 n = 6	r = 0.5162 *P* = 0.294 n = 6
Log-transformed number of complaints	r = 0.9687 *P* = 0.031* n = 4	r = 0.713 *P* = 0.047* n = 8	r = 0.1768 *P* = 0.738 n = 6	r = 0.523 *P* = 0.287 n = 6
Number of traps set	r = 0.9972 *P* = 0.003* n = 4	r = 0.6535 *P* = 0.232 n = 5	r = -0.0269 *P* = 0.966 n = 5	r = 0.4080 *P* = 0.495 n = 5
Number of bears relocated	r = 0.9738 *P* = 0.026 n = 4	r = 0.4723 *P* = 0.237 n = 8	r = -0.1284 *P* = 0.808 n = 6	r = 0.3322 *P* = 0.519 n = 6

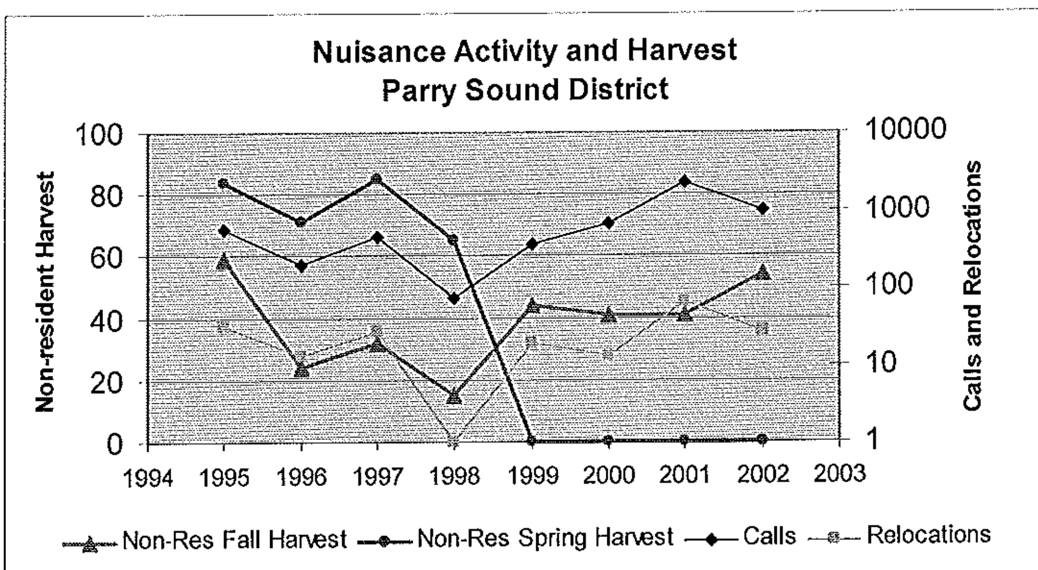


Fig. 10a. Relationships between non-resident harvest (Spring and Fall) and measures of nuisance activity for Parry Sound District, 1989-2002 (logarithmic scale for nuisance measures).

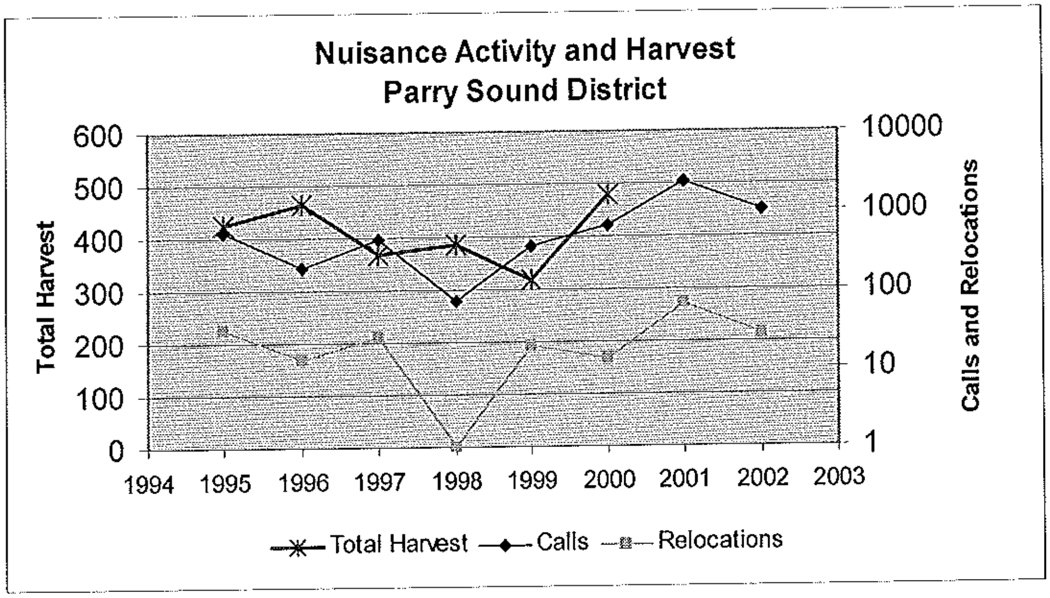


Fig. 10b. Relationships between total harvest and measures of nuisance activity for Parry Sound District. 1989-2002 (logarithmic scale for nuisance measures).

3.6 Analysis of Nuisance Bear Activity and Food Availability for Sudbury District.

Sudbury District provided long-term data on nuisance bear complaints (1978-2002), number of nuisance bears handled (1981-2002), but food availability data only for 1998 to 2002.

3.6.1 Relationship between Food Availability and Nuisance Activity

Five years of available food data were tested against the two measures of nuisance activity available for Sudbury District (number of complaints, number of bears handled). Data for number of nuisance bears handled are similar to the number of nuisance bears relocated recorded by other districts since most nuisance bears trapped in Sudbury District were relocated (M. Hall, Sudbury District, OMNR, personal communication). Visual inspection of the data for number of complaints suggested that a log transformation would be appropriate because of the extreme value reported for 2001. A log transformation of the annual complaint data strengthened the relationships but none were statistically significant (Table 6; Fig. 11).

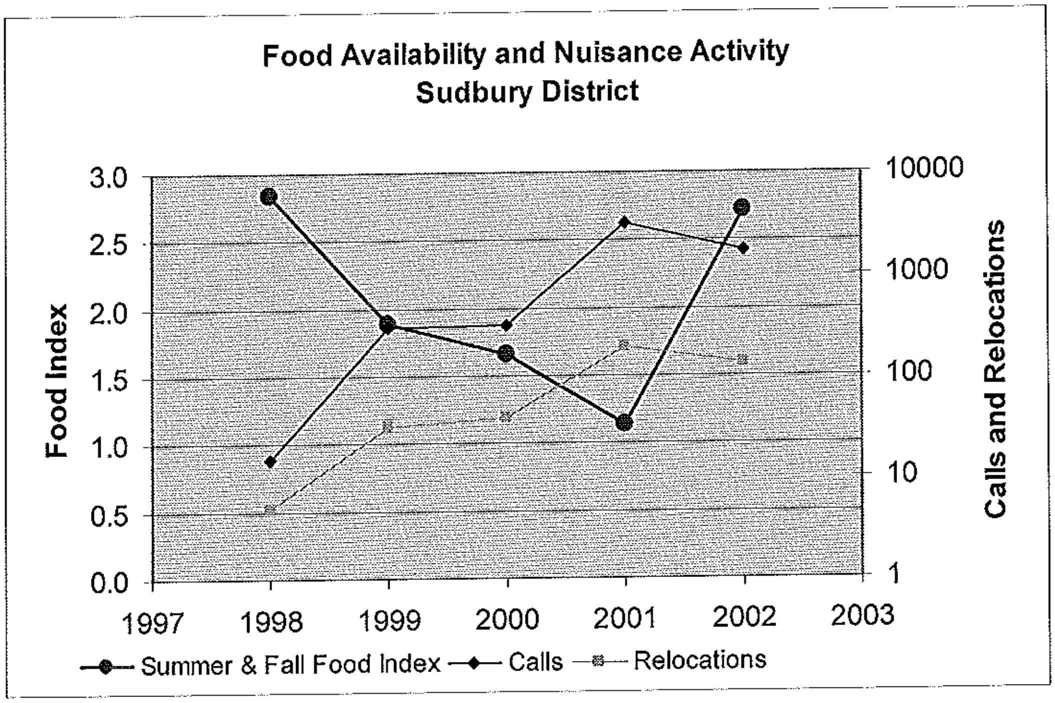


Fig. 11. Relationship between Wildlife Food Survey Index for summer and fall species, and number of nuisance bear calls and number of bears handled for Sudbury District, 1998-2002.

Table 6. Relationship between summer and fall food availability and measures of nuisance activity for Sudbury District, 1998-2002.

	Total annual number of complaints	Log-transformed annual number of complaints	Number of bears handled	Log-transformed number of bears handled
Summer and fall food index	r = -0.4884 *P* = 0.404 n = 5	r = -0.5602 *P* = 0.326 n = 5	r = -0.4613 *P* = 0.434 n = 5	r = -0.5401 *P* = 0.347 n = 5

To examine the seasonal distribution of nuisance complaints and provide a comparison to the information available for Parry Sound Area, we compared the monthly distribution of nuisance calls for Sudbury District for 2000 and 2001 (Fig. 12). Though the patterns for 2000 and 2001 are different they demonstrate that nuisance complaints in April-June vary less than the

July-September period among years. In 2001 nuisance complaints increased in June, dropped slightly in July then rose dramatically in August and September instead of tailing off in the fall as in 2000 (Fig. 12).

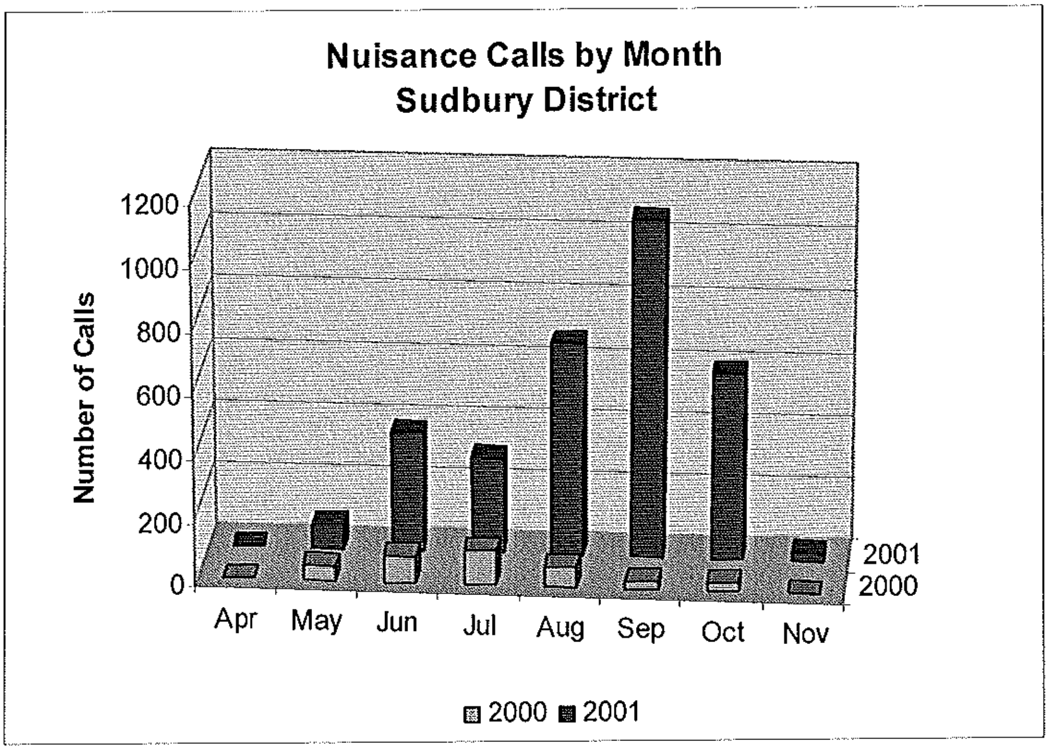


Fig. 12. Seasonal distribution of nuisance complaints for Sudbury District, 2000-2001.

3.6.2 Influence of Food Availability on Harvest.

For the 5-year period 1998-2002 there were no significant relationships between the summer and fall food index and any of three measures of harvest: non-resident fall harvest, total annual harvest (non-residents and residents, fall only), and hunter success rate (Table 7). Wildlife food survey data for Sudbury only began in 1998 therefore no relationship between non-resident Spring harvest and food availability could be examined.

Table 7. Relationship between summer and fall food availability and measures of harvest for Sudbury District, 1998-2002.

	Non-resident fall harvest (1998-2002)	Total annual harvest (Non-resident and resident, fall, 1998-2000)	Hunter success rate (1998-2000)
Summer and fall food index	r = -0.7725 P = 0.126 n = 5	r = 0.4954 P = 0.670 n = 3	r = -0.677 P = 0.527 n = 3

3.6.3 Relationship between Harvest and Nuisance Activity.

For the period 1987-2002 we examined relationships between two measures of nuisance bear activity (total annual number of complaints, number of animals handled) and four measures of harvest (non-resident spring harvest 1987-1998, non-resident fall harvest 1987-2002, total annual harvest for non-residents and residents 1987-2000, and hunter success rate 1987-2000) (Table 8; Figs. 13a,b). There were significant positive correlations between non-resident fall harvest and the total annual number of complaints and the number of bears handled (Table 8). A log transformation of the total number of complaints strengthened the relationship with non-resident fall harvest (Table 8; Fig. 13a). There were no other significant relationships between measures of nuisance activity and harvest (Table 8).

Table 8. Relationships between two measures of nuisance bear activity and four harvest measures for Sudbury District, 1987-2002.

Nuisance activity variable	Non-resident spring harvest (1987-1998)	Non-resident fall harvest (1987-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1987-2000)	Hunter success rate (1987-2000)
Annual number of complaints	r = 0.4471 P = 0.145 n = 12	r = 0.612 P = 0.012* n = 16	r = 0.342 P = 0.231 n = 14	r = 0.423 P = 0.132 n = 14
Log-transformed number of complaints	r = 0.3982 P = 0.200 n = 12	r = 0.6474 P = 0.007* n = 16	r = 0.3251 P = 0.257 n = 14	r = 0.2749 P = 0.342 n = 14
Number of bears handled	r = 0.3813 P = 0.247 n = 11	r = 0.580 P = 0.024* n = 15	r = 0.381 P = 0.199 n = 13	r = 0.521 P = 0.068 n = 13

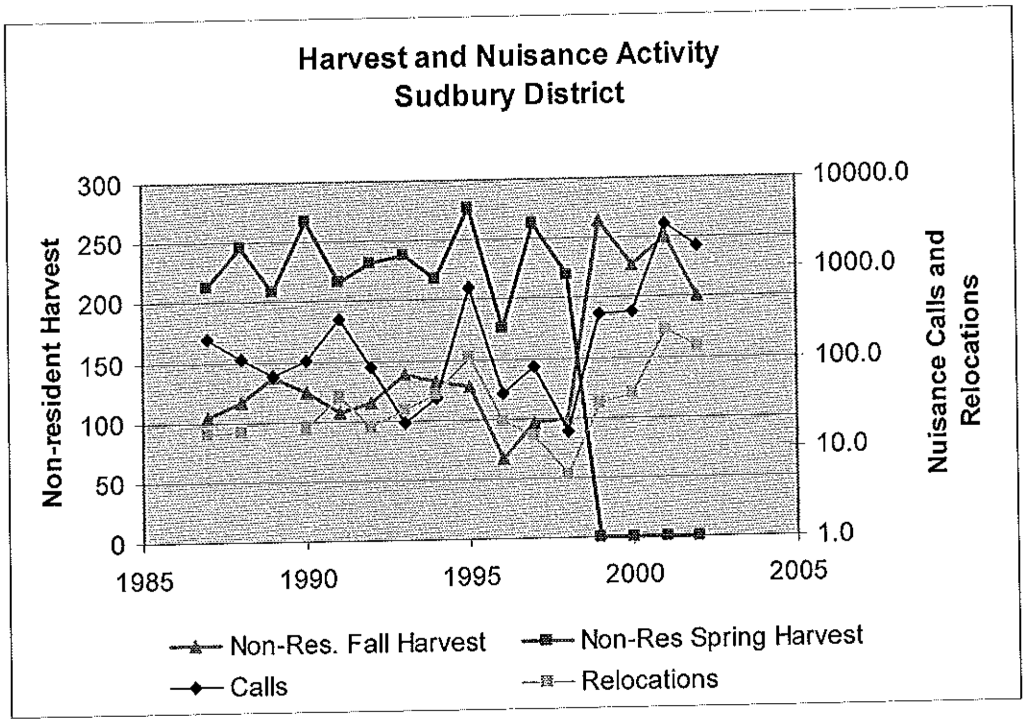


Fig. 13a. Relationships between non-resident harvest (Spring and Fall) and measures of nuisance activity for Sudbury District, 1987-2002 (logarithmic scale for nuisance measures).

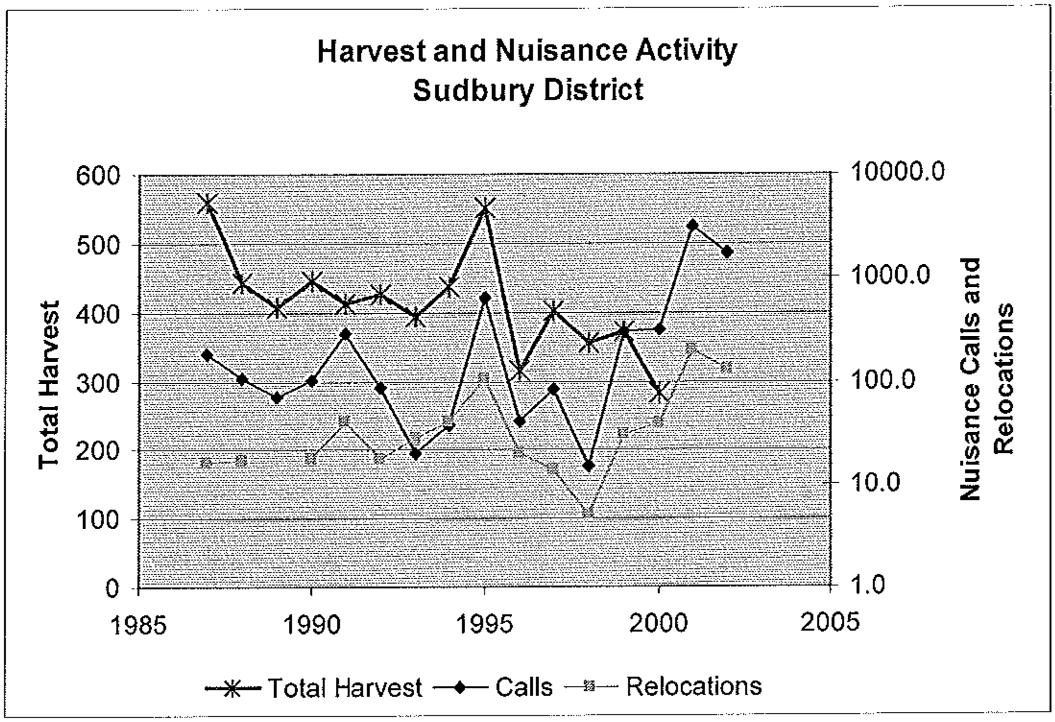


Fig. 13b. Relationships between total harvest and measures of nuisance activity for Sudbury District, 1987-2002 (logarithmic scale for nuisance measures).

3.7 Analysis of Patterns of Nuisance Bear Activity in the Great Lakes–St. Lawrence Ecoregion.

We extended the geographic coverage of our analysis to include the entire Great Lakes–St. Lawrence ecoregion in order to assess larger scale patterns of variation in nuisance activity, food availability, and harvest for the period 1995-2002 (our analysis could not include the Boreal ecoregion since no food survey data were available). For measures of nuisance activity we combined data on annual number of complaints (calls) and number of bears relocated for Parry Sound Area, Bracebridge Area, Sudbury District and Sault Ste. Marie District as these districts provided the most complete data set. For the index of summer and fall food availability for the GLSL we averaged the data for reporting districts each year. For non-resident harvest data we combined data from the following Districts or Areas: Sault Ste. Marie, Blind River, Espanola, Sudbury, North Bay, Algonquin, Pembroke, Bracebridge, Parry Sound, Bancroft and Minden. For resident harvest data we combined data for WMUs 36-37 and 42-61.

3.7.1 Relationship between Food Availability and Nuisance Activity

Because of the extreme values for nuisance bear complaints recorded for 2001 we log transformed the data for annual number of calls. For the GLSL ecoregion there were no significant relationships between summer and fall food index and two measures of nuisance activity (Table 9) (Fig. 14).

Table 9. Relationship between summer and fall food availability and measures of nuisance activity for the Great Lakes–St. Lawrence ecoregion, 1995-2002.

	Total annual number of complaints	Log-transformed annual number of complaints	Number of bears relocated
Summer and fall food index	$r = -0.220$ $P = 0.601$ n = 8	$r = -0.3956$ $P = 0.332$ n = 8	$r = -0.268$ $P = 0.521$ n = 8

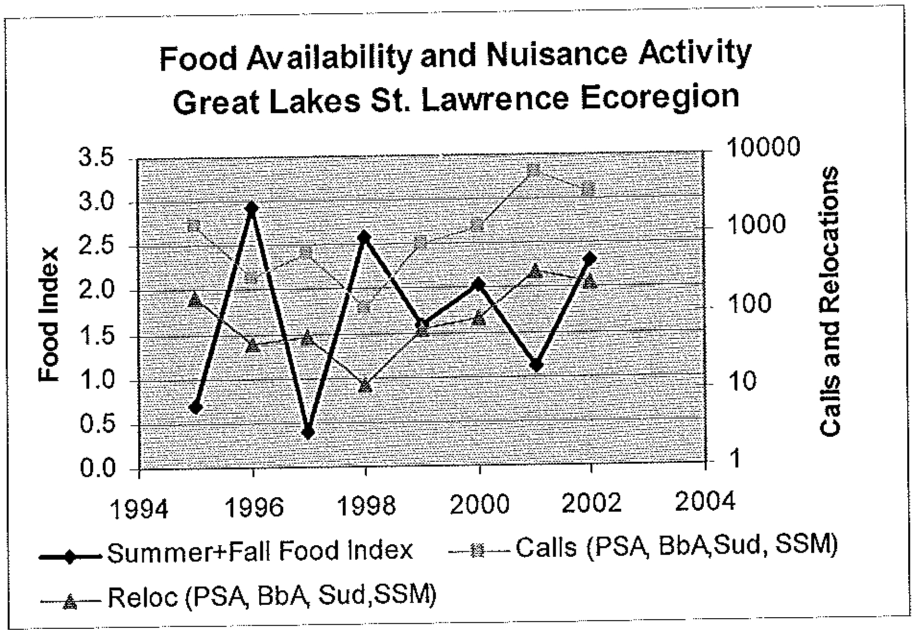


Fig. 14. Relationship between Wildlife Food Survey Index for summer and fall species, and number of nuisance bear calls and number of bears relocated for the Great Lakes–St. Lawrence ecoregion, 1995-2002.

3.7.2 Influence of Food Availability on Harvest

For the GLSL ecoregion there were no significant relationships between the summer and fall food index and non-resident spring harvest, non-resident fall harvest, total annual harvest and hunter success rate (Table 10).

Table 10. Relationship between summer and fall food availability and measures of harvest for the Great Lakes–St. Lawrence ecoregion, 1995-2002.

	Non-resident spring harvest (1995-1998)	Non-resident fall harvest (1995-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1995-2000)	Hunter success rate (1995-2000)
Summer and fall food index	r = -0.8029 $P = 0.197$ n = 4	r = -0.2088 $P = 0.620$ n = 8	r = -0.5217 $P = 0.288$ n = 6	r = -0.5865 $P = 0.221$ n = 6

3.7.3 Relationship between Harvest and Nuisance Activity

For the period 1995-2002 we examined relationships between two measures of nuisance activity (total annual number of complaints, number of animals relocated) and four measures of harvest (non-resident spring harvest 1995-1998, non-resident fall harvest 1995-2002, total annual harvest for non-residents and residents 1995-2000, and hunter success rates 1995-2000). We log transformed the nuisance complaint data for analysis because of the extreme values recorded for 2001. There were no significant relationships between non-resident spring harvest and measures of nuisance activity (Table 11; Fig 15a). However, there was a significant positive relationship between non-resident fall harvest and both the log transformed total annual number of complaints and the number of bears relocated (Table 11; Fig. 15a.) Similarly, there were significant positive correlations between hunter success rates and both log transformed total annual number of calls and number of bears relocated (Table 11). Total annual harvest was positively correlated with number of bears relocated, but there was no significant correlation with number of complaints (Table 11; Fig. 15b).

Table 11. Relationships between two measures of nuisance bear activity and four harvest measures for the Great Lakes–St. Lawrence ecoregion, 1995-2002.

Nuisance activity variable	Non-resident spring harvest (1995-1998)	Non-resident fall harvest (1995-2002)	Total annual harvest (Non-resident and resident, spring and fall, 1995-2000)	Hunter success rate (1995-2000)
Total annual number of complaints	r = 0.2591 *P* = 0.741 n = 4	r = 0.7695 *P* = 0.026* n = 8	r = 0.6079 *P* = 0.200 n = 6	r = 0.8580 *P* = 0.029* n = 6
Log-transformed number of complaints	r = 0.2755 *P* = 0.725 n = 4	r = 0.8537 *P* = 0.007* n = 8	r = 0.4753 *P* = 0.341 n = 6	r = 0.8174 *P* = 0.047* n = 6
Number of bears relocated	r = 0.1072 *P* = 0.893 n = 4	r = 0.7495 *P* = 0.032* n = 8	r = 0.8581 *P* = 0.029* n = 6	r = 0.9622 *P* = 0.002* n = 6

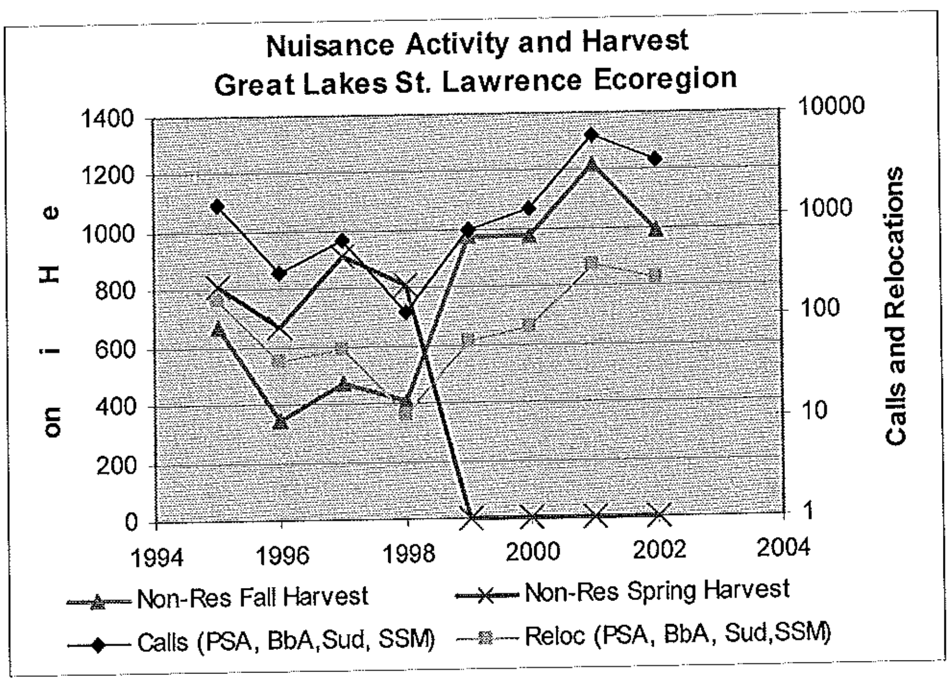


Fig. 15a. Relationships between non-resident harvest (Spring and Fall) and measures of nuisance activity for the Great Lakes–St. Lawrence ecoregion, 1995-2002 (logarithmic scale for nuisance measures).

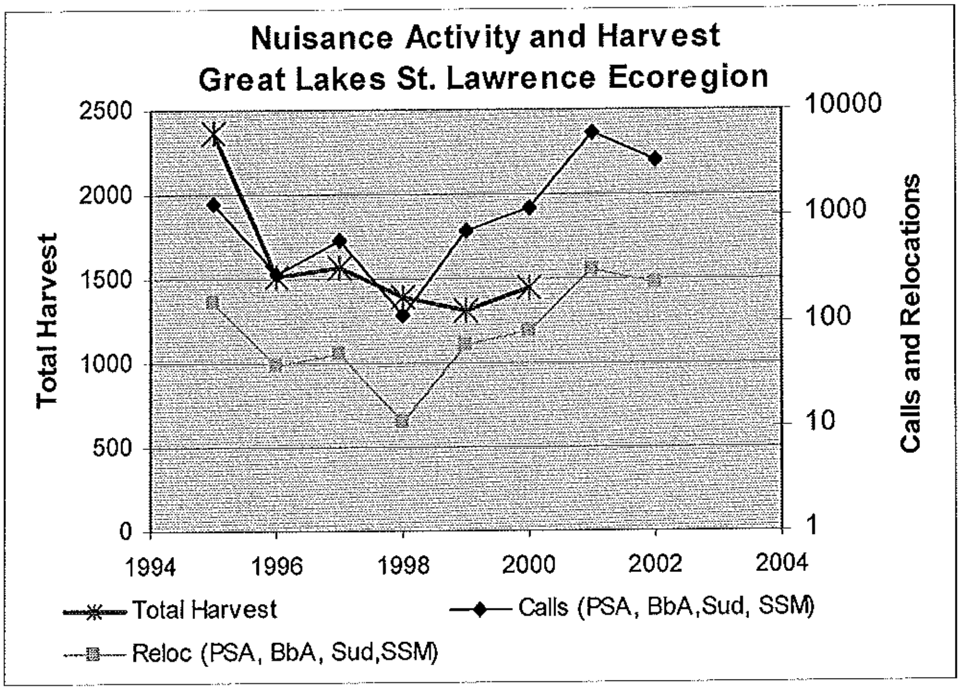


Fig. 15b. Relationships between total harvest and measures of nuisance activity for the Great Lakes–St. Lawrence ecoregion, 1995-2002 (logarithmic scale for nuisance measures).

4. DISCUSSION

4.1 Data Sources

4.1.1 Nuisance Activity Data

Several factors contribute to variability in the number of nuisance bear complaints received, such that changes in the number of complaints may not accurately represent changes in nuisance bear activity. Especially prior to 1995, not all complaints about nuisance bears were recorded in some OMNR administrative districts/areas. One apparent problem was the lack of standardisation in recording the seriousness of a call from the public. Some recorded calls about bears were simple sightings where no actual nuisance problem was occurring. In addition, multiple calls about the same bear could inflate estimates of nuisance bear activity based solely on calls received. The number of complaints recorded in different years does not always include all recipients of calls about nuisance black bears because complaints telephoned to municipalities or bear trapping agents may not be included in complaint data in all years. Lastly, changes in the number of nuisance bear complaints may reflect changes in the reporting rate by citizens. Data for 1999-2002 may reflect the heightened public awareness about bears resulting from the controversy over the cancellation of the spring bear hunt.

Nevertheless, the general agreement between complaints data and other measures of nuisance bear activity, provides support for the reliability of nuisance complaint data provided they can be interpreted in light of changes to reporting rate. Data on responses to nuisance bears are less variable than complaint data. This may be partly due to limitations in resources available (staff and funds) for responding to nuisance bear problems. However, responses to nuisance bear complaints likely provide a more realistic measure of nuisance activity because the resulting response includes a staff member's evaluation of the seriousness of the situation.

4.1.2 Food Availability Data

The scope of this study was limited by the absence of data on abundance of food for areas outside the Great Lakes–St. Lawrence Forest Region. In addition, WLFS data rely on experienced observers returning to the same areas and recording productivity of as many species as possible. It may be that new staff or inexperienced observers enter moderate scores for all species until they are familiar with the variation in productivity of food plants in an area. This would reduce the year-to-year variability in WLFS data, potentially obscuring relationships with nuisance activity or harvest levels during years when productivity was much higher, or lower, than the average. When a survey is first started in an area it is important that scores be re-evaluated in subsequent years relative to scores for the current year until observers are familiar with the variability in production by food plants. If reported scores for the first years of a series are not subsequently adjusted relative to scores for following years, the first years may not reflect true values and could be incorrectly high or low. Despite these problems, Wildlife Food Survey data were useful in detecting much of the variation in natural food availability for black bears in the Great Lakes–St. Lawrence ecoregion of Ontario. Similar surveys have proven to be effective in other jurisdictions (e.g., Minnesota: Noyce and Coy 1990; Noyce and Garshelis 1997).

4.1.3 Weather Data

We assume that the weather data provided by Environment Canada are accurate. Failure to detect relationships between any weather variable and food availability is surprising and is likely due to the simplistic nature of the analyses performed. For the purposes of this report, we tested only one weather variable at a time against measures of food availability and nuisance activity, but food availability likely depends on a complex interaction of different weather factors. It should also be noted that some gaps in weather data were present, such as the lack of minimum daily temperatures for the Parry Sound Area between 1997 and 2000.

It may be that a multivariate approach to data analysis, or that relationships with an appropriate large-scale weather phenomenon would have been more informative. For example, Zack et al. (2003) recently suggested that in New Mexico the Southern Oscillation Index which measures the strength of El Niño and La Niña weather events could be used to predict increased rates of nuisance black bear activity. El Niño weather events are a distinct wet phase that produce wet, warm winters and springs in New Mexico. In contrast, La Niña weather events produce cold, dry winters and springs. Encounters between humans and black bears occurred 4.7 times more often during La Niña years than during El Niño years, presumably because of effects on available food (Zack et al. 2003). Future work in Ontario should aim at determining whether an analogous large-scale weather event can be used as an explanatory or predictive variable.

4.1.4 Harvest Data

Resident harvest data summarised by OMNR administrative district and broken down by season were not available for analysis. Resident harvest may be more important than non-resident harvest in parts of central Ontario, which would make detecting relationships between harvest and food availability or nuisance activity at the District level difficult. For comparing spring and fall harvests, we were limited to analysis of non-resident seasonal harvest data. However, for total annual harvest we were able to combine data for non-residents with aggregated data for residents from Wildlife Management Units that approximated District and ecoregional boundaries. Therefore, the relationships demonstrated between total harvest and measures of nuisance activity are based on a reliable estimate of the total harvest.

4.2 Annual Variation in Nuisance Bear Activity in Ontario

Similar trends in nuisance activity were recorded among OMNR Districts in the Great Lakes–St. Lawrence ecoregion (Figs. 2a, 4a), and the north-east Boreal and north-west Boreal ecoregions (Figs. 2b, 4b). Peaks in nuisance activity were recorded in all three regions in 1995 and 2001 suggesting large-scale phenomena affected the interaction between humans and black bears in those years across the province.

Though data from Sudbury follow the general pattern of other Districts in the GLSL, there were disproportionately more complaints in 1995 and 2001 in Sudbury than other Districts. Two factors may affect the amount of variability demonstrated by the data for Sudbury. The first is that the blueberry crop may be more important to black bears in Sudbury district than in other GLSL districts (M. Hall, personal communication). The other factor that may influence reporting rate of nuisance complaints is that Sudbury District, in conjunction with Cambrian College, has had a very active nuisance bear relocation program since 1995 (e.g., Landriault 1998). This well publicised program may generate a positive feedback loop that intensifies the reporting rate for nuisance complaints.

In the north-east Boreal, as represented by data from Timmins, another peak in nuisance activity occurred in 1998 when a widespread food failure affected the black bear population (Obbard, unpublished data). In 1998, there were large numbers of nuisance complaints in the north-east Boreal a pattern distinctive from the rest of Ontario that year. In Timmins, as in other areas of the province, a peak of nuisance complaints was recorded in 2001 (293 calls) though this total was less than the totals recorded in 1997 and 1998 (Fig. 2b). The number of complaints dropped to 96 in 2002. Surprisingly, the number of bears relocated only declined from 86 in 2001 to 70 in 2002. The number of bears relocated in Timmins in 2001 was much higher than the number relocated in 1998 (27) when there was a higher number of nuisance complaints. In Timmins, an agent has been responsible for handling nuisance bears since 1999 so it may be that a higher proportion of bears is being captured and relocated than previously when OMNR staff dealt with nuisance bears.

In the north-west Boreal, peaks in nuisance complaints occurred in 1995 and 2001. In food failure years in Kenora district, black bears are attracted into town by fruit trees in backyards and easy access to garbage dumpsters. In addition, bears seem to travel through town to reach stands of bur oak (J. Maffei, personal communication).

In the Great Lakes–St. Lawrence ecoregion nuisance activity appeared to vary in a 2-year pattern beginning in 1995 (Fig. 2a). A poor food year in 1995 (Fig. 5) may have synchronised reproduction in black bears after 1995 as has been demonstrated for black bears in Maine (McLaughlin et al. 1994). Many adult females likely failed to produce cubs in the winter of 1996, resulting in most of the female population coming available to mate in 1996 (which had one of the highest food indexes recorded), and producing cubs in 1997. These same adult females would have been available to mate in 1998 and produce cubs again in 1999. This would result in high numbers of sub-adult bears being present in the population in 1999, 2000, and 2001. Sub-adults, particularly sub-adult males, lack well-defined home ranges because they have dispersed from their natal area (Rogers 1987, Garshelis 1994). When young males disperse, they are prone to encounter human development and to develop nuisance behaviour (Beeman and Pelton 1980). The age distribution of the Ontario black bear harvest shows that the age structure is currently skewed towards younger bears, and that a large year-class was born in 1997 and 1999 (L. Dix-Gibson, personal communication) (Fig. 16). Though food index data are not available for the Boreal ecoregion, the nuisance activity data (Fig. 2b) suggest that there was poor food production in 1995 in the Boreal ecoregion and likely a large year-class born in 1997 as a result. The 1997 cohort is evident as 2-year-olds in the 1999 harvest. A food failure occurred in north-eastern Ontario in 1998 (Obbard unpublished data) so few cubs would have been born in 1999, meaning that synchrony in parts of the Boreal may now differ from southern Ontario. This explains why the 1999 cohort, which appears in the 2001 harvest, is smaller than the 1997 cohort.

Despite the overall synchrony in the relationship between food availability and nuisance complaints in the GLSL, the pattern was disrupted in 2001. The rise in number of nuisance complaints in 2001 appears to be out of proportion to the decline in food availability, and the relationship may have become masked after 1999. The food index for Parry Sound Area in 1998 was high and, consistent with our hypothesis, the number of nuisance complaints was very low (Figs. 6a,b). The food index fell in 1999 to a level similar to that of 1995 and the number of nuisance calls was similar to that recorded in 1995. However, in 2000 the food index rose considerably and the number of complaints rose rather than fell. In 2001, the food index fell to a level similar to that recorded in 1999 and 1995, but the number of nuisance complaints was about four times that recorded in 1999 or 1995. A similar pattern was shown by the data from Bracebridge and Sudbury where since 1999 the relationship between the food index and nuisance complaints appears to have changed. In fact, the increase in nuisance complaints in both Bracebridge and Sudbury between 2000 and 2001 was much greater than the increase that occurred in Parry Sound.

A number of explanations are possible for the dramatic increases in complaints about nuisance black bears observed across the GLSL in 2001. Natural food availability scores in 2001 were low, and were similar to those from 1995 and 1999. This natural food crop failure, in combination with the skewed age distribution and large number of females accompanied by cubs of the year as discussed above, could have resulted in unprecedented levels of nuisance bear activity in 2001. An almost unprecedented drought affected central Ontario in August and September 2001 resulting in large numbers of nuisance complaints late in the year as bears were forced to search for alternate food sources (Fig. 12). Many observations of females accompanied by cubs of the year were reported in July, August and September 2001 in the Great Lakes–St. Lawrence ecoregion (Obbard, unpublished data), and an unprecedented number of orphaned cubs was reported in late August and September (de Almeida and Obbard 2003). Both sexes travel further and are more attracted to anthropogenic food sources in poor food years (Garshelis 1989), but the behaviour of females changes more than that of males and females become more vulnerable to harvesting (Noyce and Garshelis 1997). Lactating females are under great energetic stress, which is likely exacerbated during poor food years. In fact, adult females may abandon cubs during extreme food failures (Fair 1978).

It seems likely that all the above biological factors interacted in 2001 resulting in very high nuisance complaint levels. However, the increase in nuisance bear complaints after 1999 is likely only partially due to biological factors. The steady increase in complaints observed in most districts/areas since 1999 may be an effect of heightened awareness about black bears. Heightened awareness may mean that the public is more likely to call an OMNR office to complain about bears on or near their property. Although the number of active responses to nuisance bears is high in 2001, the magnitude of the increase is much smaller than the magnitude of the increase in complaints. This may reflect the inability of the OMNR to respond to an actual threefold or greater increase in nuisance bear activity, but may also suggest that the magnitude of the increase in nuisance bear complaints is disproportionate to the actual increase in nuisance bear activity. Summer and fall food index scores were much higher in 2002 than in 2001 and measures of nuisance activity dropped considerably (Figs. 6a,b; 9; 11; 14), though they were still higher than in previous years with similar food index scores.

Some increase in total nuisance activity may be attributable to the effect of declines in total harvest since 1999, though this effect was not detected by our analysis. Average total harvest in Ontario for the period 1996-1998 was 6247 bears, and for the period 1999-2001 the average harvest was 4688 meaning that for the period since 1998 approximately 1,550 fewer black bears were harvested annually (de Almeida and Obbard 2003). This difference in harvest level represents only 1.5 to 2.1 % of the total estimated provincial population of 75,000-100,000 black bears (de Almeida and Obbard 2003). It seems highly unlikely that a 1.5-2.1 % decrease in harvest could result in an increase in nuisance complaints of two orders of magnitude such as occurred in Sudbury District where complaints rose from 15 in 1998 to 310 in 1999, 319 in 2000, 3100 in 2001 and 1719 in 2002 (Fig. 11).

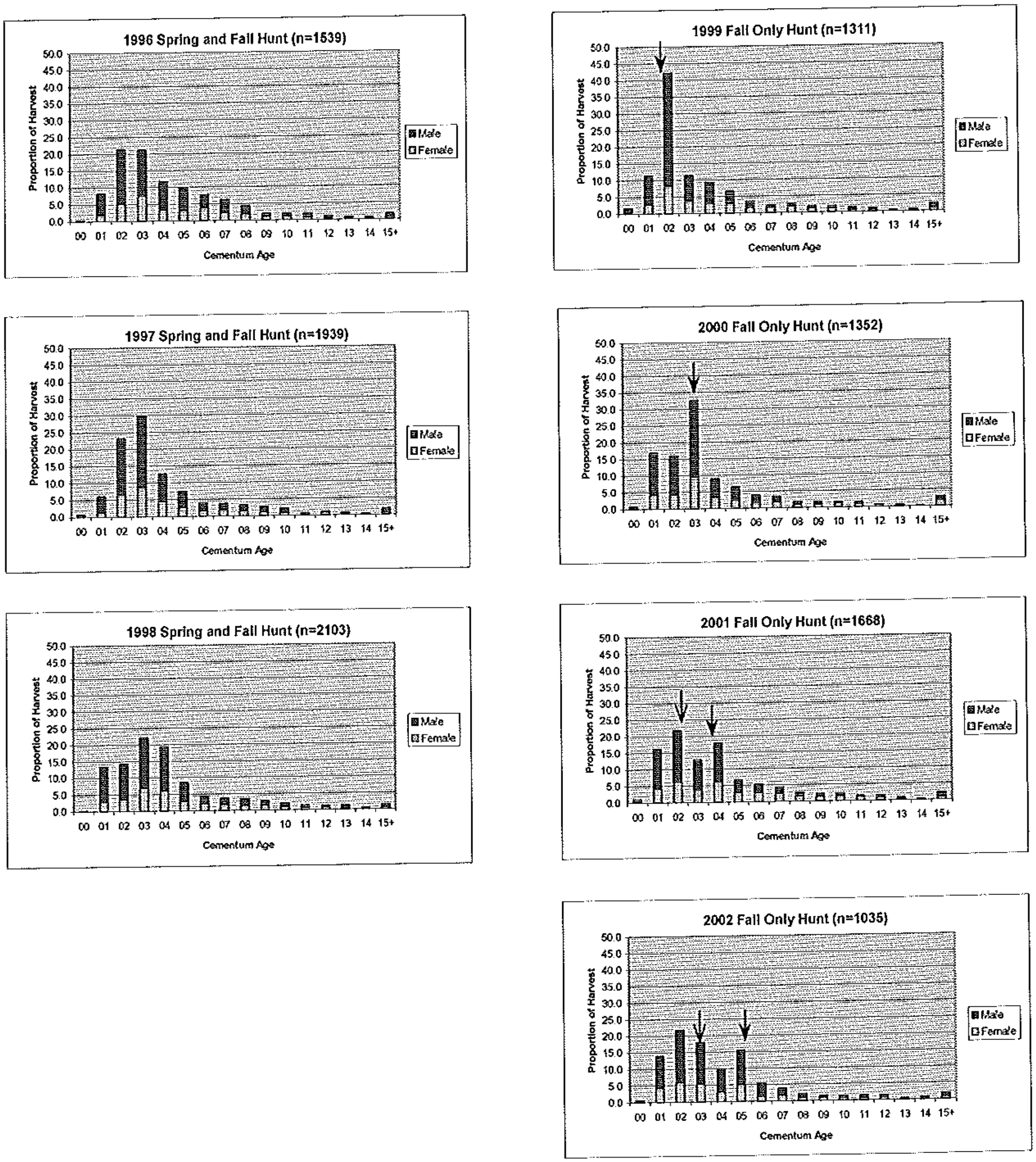


Fig. 16. Age and sex distribution of the black bear harvest in Ontario, 1996-2002. (n= sample size; age estimate from tooth age; 2002 data incomplete; arrows mark the 1997 year class →, and 1999 year class →). Source: L. Dix-Gibson, OMNR South-central Science, Bracebridge.

4.3 Annual Variation in Availability of Natural Foods

The similar trends in food availability over time across the Great Lakes–St. Lawrence ecoregion, the relationship between food availability and nuisance activity demonstrated for Parry Sound Area (Fig. 6), and the differing patterns shown for north-eastern Ontario and north-western Ontario suggest that annual changes in nuisance activity result from changes in food availability that are synchronous across a large area. Three large areas of the province appear to cycle largely independently, though occasionally in similar directions. These areas are the Great Lakes–St. Lawrence ecoregion, the north-east Boreal ecoregion, and the north-west Boreal ecoregion.

Though our analysis uncovered no significant weather variables that explained annual variation in food production, it seems likely that such changes are a result of large-scale regional weather patterns, that differ from year-to-year, but are similar across a large geographic area. Future analysis should attempt to uncover large-scale weather patterns that might be used as explanatory or predictive variables such as that discussed by Zack et al. (2003). Such a broad-scale pattern would enable OMNR staff to better understand variation in nuisance bear activity and might provide advance indications of a potentially busy nuisance bear season. In the Boreal ecoregion flowering by blueberry plants can be adversely affected by localised ground frosts (Usui 1996) which may not be detected by available temperature data from weather reporting stations. Some combination of regional scale and local scale information may be required to gain a full understanding of the effects of weather on food production.

The Wildlife Food Survey data for the GLSL provided useful insights into annual variation in nuisance activity in this analysis. Similar food surveys have proved to be useful in interpreting patterns of nuisance activity and harvest in Minnesota (Garshelis 1989, Noyce and Garshelis 1997), and information on variation in food supply explained reproductive synchrony and subsequent uneven age distributions in black bear populations in Maine (McLaughlin et al. 1994). Based on the obvious utility of wildlife food survey information for interpreting aspects of black bear biology and for management of black bear populations, we recommend that a wildlife food survey be designed and implemented for the Boreal ecoregion. A wildlife food survey for the Boreal ecoregions should include species such as wild sarsaparilla, raspberry, blueberry, pin cherry, hazel, and mountain ash (Romain 1996, Brown et al. 1999). For north-western Ontario, designers of the survey should consider adding bur oak to the list of species monitored.

4.4 Relationships among nuisance activity, food availability, and harvest.

The analysis for Parry Sound Area indicated that the wildlife food survey index for summer and fall foods had a significant negative correlation with the log-transformed number of nuisance calls, number of traps set, and total number of trap nights (Figs. 6a,b). This clearly demonstrates that annual variation in nuisance activity by black bears in Ontario is dependent on annual variation in the availability of natural foods. A similar relationship has been reported in a variety of studies across the range of black bears (Shorger 1946, Piekielek and Burton 1975, Rogers 1976, Rogers 1987, Garshelis 1989, Garshelis and Noyce 2001).

The significant negative relationship between the food index and measures of nuisance activity was not maintained when we examined the relationship over larger geographic areas but shorter periods (Parry Sound District and Great Lakes–St. Lawrence ecoregion: 1995-2002; Sudbury District: 1998-2002). We are unsure why the significant relationship disappeared when considering larger geographic areas (Parry Sound District, GLSL) but it may be that the disproportionate increase in nuisance measures in the years 2000-2002 masks the true relationship (i.e., the years 2000-2002 are a higher proportion of the total number of years available for analysis for the period 1995-2002 than for the series 1989-2002 that was available for Parry Sound Area). This is supported by the increase in strength of the relationships between the food index and log-transformed measures of nuisance activity, though none were significant. For Sudbury District, only five years of food index data were available so nuisance activity data for the period 2000-2002 would have a high influence on any relationship between the two variables. In fact, data for 1999 and 2000 follow the hypothesised direction (i.e., food index value drops slightly from 1999 to 2000, and number of calls and relocations increases slightly. Nuisance activity data for the years 2001 and 2002 appear to overwhelm the overall relationship between food availability and nuisance activity for Sudbury District for the 1998-2002 period.

Our results indicated that there were no significant relationships between food availability and harvest measures at any scale of analysis (Parry Sound Area, Parry Sound District, Sudbury District, GLSL). This result is surprising, as vulnerability of bears to harvest has been shown to vary with changes in food availability (Gilbert et al. 1978, Litvaitis and Kane 1994, Noyce and Garshelis 1997). In Maine, hunter success was high when food abundance was low (McDonald et al. 1994), as it was in Minnesota where hunter success was inversely related to fall food index (Noyce and Garshelis 1997). In addition, in Minnesota fall food supply had a weak influence on vulnerability of males to harvest, but hunter success and harvest rates for females showed a strong negative relation with fall food (Noyce and Garshelis 1997). Similar result would be expected, especially for fall harvests, in a jurisdiction such as Ontario where most hunters hunt over bait (de Almeida and Obbard 2001). For the larger geographic areas where data on food availability were only available for a few years, it may be that the period was too short to show any relationship. Further, for our longest data set for Parry Sound Area it is perhaps to be expected that there was no relationship between the summer and fall food index and spring harvest in the same year. However, it was unexpected that there would be no significant negative relationship between summer and fall food availability and measures of harvest for the Parry Sound Area. We can offer no explanation why there was no significant negative relationship between food availability and harvest.

Our analysis of the relationships between harvest and nuisance activity produced contradictory results depending on the scale of analysis. For Parry Sound Area, we found no significant relationships between measures of nuisance bear activity and harvest measures (Table 2). However, for the larger geographic areas (Parry Sound District, Sudbury District, GLSL) our results indicated a significant positive relationship between various harvest measures and measures of nuisance activity. In general, nuisance activity and harvest measures co-varied directly so that when nuisance activity increased harvest increased. There was no indication that harvest (either spring harvest, fall harvest or total harvest) acted to reduce nuisance activity levels.

4.5. Summary

Hypothesis 1. *Weather variables such as air temperature, rainfall, and snow cover affect availability of natural foods.* We did not detect any weather variables that had an effect on food availability. Therefore, results of our analysis do not support the hypothesis.

Hypothesis 2. *Availability of natural foods affects nuisance bear activity directly (negative relationship), and also indirectly through its influence on recruitment and survival and hence* *bear abundance (positive relationship).* Results of our analysis support this hypothesis. There was a strong negative relationship between food availability and nuisance activity for Parry Sound Area. There is strong evidence that a food failure in 1995 synchronised reproduction in the black bear population and that a good food year in 1996 resulted in a very large cohort being born in 1997 and again in 1999 which affected nuisance activity in 1999 and 2001.

Hypothesis 3. *Availability of natural foods influences harvest levels by affecting the vulnerability of black bear to harvest (negative relationship).* Results of our analysis do not support this hypothesis, though this relationship has been demonstrated in other jurisdictions.

Hypothesis 4. *Harvest influences nuisance bear activity through its effect on bear abundance (negative relationship).* Results of our analysis do not support this hypothesis. In our study, harvest rates and nuisance activity rates co-varied directly. There was no evidence that spring harvest reduced nuisance bear activity. Fall harvest, total harvest, and hunter success rate all increased when nuisance activity increased.

5. CONCLUSIONS

1. Unusually high levels of nuisance activity occur in the same years across the Great Lakes–St. Lawrence Forest ecoregion, and occasionally across the province in both the Great Lakes–St. Lawrence and the Boreal ecoregions. Generally, the three regions (Great Lakes–St. Lawrence, Boreal east, and Boreal west) show different patterns of nuisance activity.
2. Natural food availability varied synchronously across the Great Lakes–St. Lawrence Forest Region.
3. Annual variation in food availability in the Parry Sound Area was representative of the Great Lakes–St. Lawrence Forest Region in most years.
4. This study did not successfully identify weather variables that influence food availability and nuisance activity in Ontario.
5. Annual variation in nuisance activity by black bears is correlated with annual variation in the availability of natural foods in the same year (depending on scale of analysis). Food shortages lead to increases in nuisance activity levels.
6. Food failures synchronise the breeding cycle of black bear populations resulting in large cohorts being born as happened in 1997, 1999, and 2001 in Ontario. These large cohorts have a compounding effect on nuisance activity rates in poor food years.
7. Most of the annual variation in nuisance activity occurs in late summer and fall, when major food items mature and become available to bears.
8. Despite the relationship described in 5 (above), no relationship was detected between summer and fall food availability and harvest rates at any scale of analysis.

9. Harvest rates and nuisance activity co-vary directly, not inversely. Therefore, despite the lack of relationship noted in 8 (above) both are likely similarly dependent on other factors (including food availability). Higher harvest rates (within the range of harvest rates observed in Ontario) are not associated with reduced rates of nuisance activity.

10. The reduction in total harvest of black bears since the cancellation of the spring hunt in 1999 (approximately 1550 animals/year or 1.5%-2.1 % of the total provincial population), and any subsequent population increase could not have produced the dramatic increase in nuisance complaints that occurred in 2001.

11. Results of this study do not support the hypothesis that a spring bear hunt controls, limits, or reduces levels of nuisance activity by black bears.

RECOMMENDATIONS

1. A standardised approach should be developed to collecting data on complaints about nuisance bears in all OMNR districts including number of calls, number of traps set, number of trap nights, number of bears relocated, and number of nuisance bears killed. Such information should be compiled annually in each region from reports submitted by each district. This will enable meaningful comparisons of nuisance activity across districts and among regions and will enhance the interpretation of annual variation in nuisance bear activity.

2. Since the Wildlife Food Survey data from the Great Lakes–St. Lawrence ecoregion was so useful to this analysis of the relationships among nuisance activity, food availability, and harvest, a Wildlife Food Survey should be developed for the Boreal east ecoregion and the

Boreal west ecoregion and implemented as soon as possible. Data from such a survey will enhance the interpretation of annual variation in nuisance bear activity in the Boreal ecoregions and enhance our understanding of black bear population dynamics.

3. Future analysis should attempt to uncover large-scale weather patterns that might be used as explanatory or predictive variables to enable OMNR to better understand variation in food availability and nuisance bear activity.

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Fig. 17. Hypothesised direction of effects of variables influencing nuisance bear activity and reporting of nuisance bear complaints. Variable for which we obtained data are *italicised.* Variables that were shown by our analysis to have a statistically significant effect on nuisance bear activity are in **bold.**