# PERFORMANCE ASSESSMENT OF TEMPORAL TREND MONITORING DATA FOR THE NORTHERN CONTAMINANTS PROGRAM

Contract No: 20-13-0227

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March 2014

## EXECUTIVE SUMMARY

This report provides an assessment of the performance of temporal trend monitoring in the Environmental Monitoring and Research subprogram of the NCP. The objective is to provide the Management Committee with information on the current status of the core monitoring program and the potential impact of reduced sampling and/or chemical analysis frequency. Data on five representative POPs (αHCH, *p,p'*-DDE, PCB 153, BDE47, PFOS) were obtained from principal investigators and analysed using the PIA computer program that reports the statistical power, and regression metrics for time-series data.

Time series data for nine species were evaluated on the basis of statistical power (with the NCP program target value of 80% confidence at 0.05 significance), the slope of the time series regression as reported by PIA (target of 5% change/y, or a 14 year environmental half-life) and the regression significance (statistical target of $p<0.05$). Of the 107 data sets tested, 9 exceeded the target statistical power of 80%, while 42% were below 10% power. Seventy-nine of the 107 data sets (74%) had negative slopes indicating decreasing concentrations in the environment, however the statistical power was low in most cases indicating a very high uncertainty in detecting trends. Roughly half (45%) of the regressions achieved the target of a significance of 0.05 or lower.

A series of runs with simulated data with the PIA program showed that high statistical power was achieved by a combination of low annual variability and high frequency sampling (e.g. every year). Conditions of high variability, such as those observed in many of the core monitoring programs, lost statistical power quickly as sampling frequency was reduced. Because of the low statistical power in the majority of time series with the major species and POPs, a reduced sampling frequency is expected to significantly raise uncertainty in the monitoring projects and make the detection of trends in environmental levels more difficult.

Several observations were noted in the analysis. Clear declining trends, with high statistical power (>80%), are evident for some POPs compounds in marine mammals and seabirds. However, in many programs, trends are difficult to detect and the statistical power is very low. When the data for slope and statistical power are pooled across the program, the majority of time series have very high levels of uncertainty and the detection of trends is poor. Increased frequency of sampling by the NCP since the mid-2000's does not significantly improve the statistical power of many time series because data with the same sampling frequency are not available for 1980s and 1990s, and data for co-variates such as age or length, which reduce annual variation, are also not available.

It is also evident that the concentrations of many compounds seem to have reached a minimum concentration over the past number of years. Some data sets show occasional increases and declines, but the concentrations remain relatively low. It seems unlikely that continued high frequency monitoring of these compounds in these species will produce much benefit to the NCP.

It is important to emphasize that this project is designed solely to analyse the time-series data using PIA which has been developed to specifically test monitoring data for temporal trends. Principal investigators would also apply other statistical procedures to each individual data set to test hypotheses of geographical trends, the impacts of modifying factors such as sex, age, body condition, and reproductive status to provide more comprehensive tests of hypotheses than are possible with the approach used in this report.

## 1.0 Introduction

The Management Committee of the Northern Contaminants Program has identified a need for a review of the performance of temporal trend monitoring of chemicals in traditional food species in the Canadian North. The goal is to optimize the core elements of the Environmental Monitoring and Research subprogram. The need for increased efficiency is driven in part by reduced funding to the subprogram, but also by the ever expanding number of chemicals that need to be monitored. Increased efficiency in the monitoring program could make more funds available for research on the factors related to transport and distribution of contaminants in the North.

One of the key facets of the NCP monitoring programs since roughly 2004 has been the use of power analysis in the design and implementation of monitoring programs. Power analysis defines the parameters (e.g., sampling frequency, sample numbers) that are necessary to achieve target objectives of the monitoring program. For example, the NCP has stated that sampling programs should be structured to detect a 5% change in concentration per year, with 80% confidence (at a 0.05 level of significance). Monitoring programs for high priority species such as marine mammals, fish and seabirds at key locations are designed to provide results within these statistical parameters. Similar objectives have been defined by the Arctic Monitoring and Assessment Program for the assessment of the effectiveness of the Stockholm Convention for the control and monitoring of POPs.

This report will summarise the results of a subprogram-level comprehensive assessment of the performance of the trend monitoring programs in Environmental Monitoring and Research using data for several groups of wildlife and five representative POPs, including 3 legacy POPs (αHCH, p,p'-DDE, PCB 153) and two newer chemicals (BDE-47, PFOS). The analysis will be conducted using the computer program PIA (Bignert 2007) which was designed for AMAP's trend monitoring programs.

The analysis will be conducted with two major objectives:

1. To assess the performance of the core monitoring program using regression metrics and power analysis,

2. To examine the potential impact of reduced sampling on the ability of the program to detect changes in environmental concentrations in traditional food species.

## 2.0 Methods

### *2.1 Program Description*

The temporal trends in the NCP data were evaluated using the computer program PIA_13 (Version 2008.02.28, distributed 2013.09.27). The program analyses trends in time-series datasets by applying a standard statistical analysis that has been adopted by the Arctic Monitoring and Assessment Program (AMAP) for use in its temporal trend assessments (Bignert 2013). Data are entered into the program in a linear array with the year of collection, concentration (lipid or wet weight basis) and a single co-variate (usually age for mammals and fork or total length for fish). The results of the analysis are reported in terms of a number of metrics of statistical significance, the power to detect a log-linear trend, the slope of the curve (% change in concentration /y), the parameters of a first-order decay equation and the years required to detect a 5%/y slope with 80% confidence.

PIA uses a log-linear regression analysis which has been developed in a number of papers (Cleveland 1979; Nicholson and Fryer 1991, 1992; Fryer and Nicholson 1993, 1999; Nicholson *et al*. 1995, 1998) and has been applied to number of contaminant monitoring programs, but in particular mercury (Bignert *et al*. 2004, 2006; Riget *et al*. 2011). Although limited in the scope of analysis it can perform, the program has several options to manage the type of analysis applied. For example, it is possible to request the use of the median values for the concentrations in a particular year, instead of the geometric mean, to minimize the impact of outliers. Other conditions of the analysis were the default values of a slope of 5% change/y and a statistical significance of 0.05. There is also the ability to control the number of years (e.g., 3, 5, 7 years) used to calculate the smoother analysis of the trends. This analysis partitions the temporal trends into linear and non-linear portions. When the non-linear portions become statistically significant, the data are fit with a data smoother, which is a 3 year running average fitted to the annual geometric mean (indicated by the pink trend lines on the graphs in Appendix A). A value of 3 years was used for all NCP data analysis.

All temporal trends with NCP data were analysed using median values and, where possible, all concentration data were calculated on a lipid weight basis. Data for PFOS were evaluated on a wet weight basis. In some data sets, wet weight concentrations were used when the statistical analysis of the lipid based data showed a poor fit. If supplied by the principal investigator, a co-variate such as age (marine mammals) or total/fork length (fish) was used as the single co-variate in the PIA program. Zero values were replaced with a default value of 0.001 µg/g.

In some cases, age data or length data are not available for some years, usually for older archived samples. In these situations, an analysis was conducted with the co-variate using the limited number of years and then without the co-variate with the additional years of data. The results of the both analyses, or just the better fit, are reported in Appendix B.

Indicators used by the PIA program to assess the trends, power and statistical metrics of the data:

- Slope: % change per year calculated for all years in the data set, with a 95% confidence interval,
- Coefficient of determination ($r^2$): a significant value ($P<0.05$, 0.01 or 0.001) is defined as a true change. (A value of $p<0.1$ is plotted as a solid line in Appendix A graphs.)
- Power: the power to detect a log-linear trend in the time series (Nicholson and Fryer 1991).
- The power estimated as if the slope were 5% and the number of years was ten.
- The lowest detectable change for a ten-year period with the between-year variation of the test data and a power of 80% (NOTE: this metric assumes an annual sampling frequency),
- The lowest detectable change with the current number of sampling years.
- The estimated number of years required to detect an annual change of 5% with a power of 80%.

The data are fitted with a first-order decay equation:

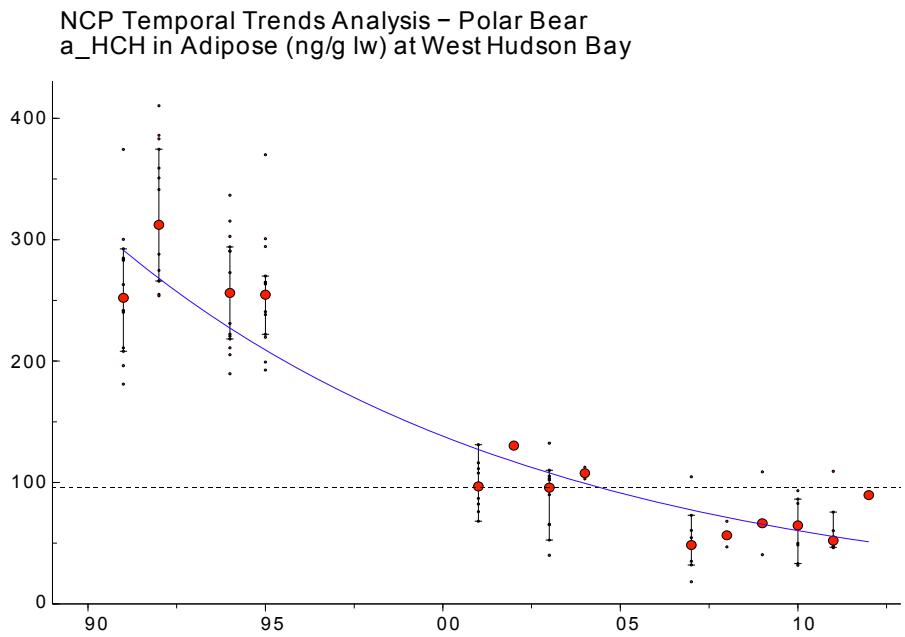
$$\text{Concentration} = a * \exp^{(-b * \text{year})}, \text{ where b is the slope of the trend line ( /year).}$$

In general, trend results fall into 7 classes as follows:

- *Increasing*, a statistically significant increasing log-linear trend.
- *Increasing with a non-linear trend component*, increasing trend with a statistically significant non-linear component.
- *Decreasing,* a statistically significant decreasing log-linear trend.
- *Decreasing with non-linear trend component,* decreasing trend with a statistically significant non-linear component.
- *Non-linear component*, a statistically significant non-linear (fluctuating) trend with no clear increasing or decreasing tendency.
- *No trend*. The time-series did not exhibit a statistically significant trend.
- *Not evaluated*. The time-series is too short or too few years of monitoring to establish a trend.

The output of the PIA program is in the form of several text files from which key parameters can be extracted to evaluate the trends in the data and how well the analysis functioned. Results are

also plotted in a single graph of the median values, annual data, and the first-order decay equation. An example of the output from PIA is shown in Figure 1, with 3 of the metrics reported by PIA.




Species: *Polar Bear*
Location: *western Hudson Bay*
Chemical: *p,p'-DDE*
Co-variate: *none*

Condition: *Lipid basis*
Slope: *-5.2%*
Power: *38%*
Regression significance: *p<0.005*

Figure 1: Example of the graphical output of one run from the PIA program showing the distribution of data and the fit of the first-order decay equation. The slope of the line (-5.2%) is equivalent to an environmental half-life of 13 years. PIA graphs and equations for other species and POPs are presented in Appendices A and B.

### *2.2 Test Analysis With the PIA Program*

The PIA program reports a number of metrics that define the fit of the data to a first-order decay curve, the parameters of the equation and the statistical significance of the fit. In order to interpret the trends observed in the NCP data, a number of runs were made with the PIA program which varied the number of years analysed and variability within each year of sampling.

A low variability test used random data distributed from 10 to 40% of the mean that was calculated using a 5%/y slope in the temporal trend over 26 years. A high variability test used random data

from 10 to 100% of the mean, with the same 5%/y slope. In both cases, single years were randomly removed one at a time from the data set, and the remaining data analysed using PIA (Figure 2).

The results indicate that the statistical power declines much more rapidly in the high variability data set, with a large increase in uncertainty in the metrics of the analysis. High levels of statistical power (>80%) are maintained in the low variability conditions down to 6-7 years of data while 12-13 years are required to detect 5% /y slope in the high variability conditions. The high variability conditions are probably close to the conditions in many of the NCP core monitoring projects (see below).

This analysis indicates that reducing the years of sampling can have a large impact on the detection of trends estimated from data with high annual variability and low sampling frequency, such as is found in many NCP monitoring programs. Using the "statistical power" approach used by the PIA program, it may be possible to reduce sampling in specific monitoring projects and for specific contaminants (e.g., the "legacy" POPs), however there will be an increase in uncertainty in the detection of trends and a loss of confidence in the ability to predict trends.

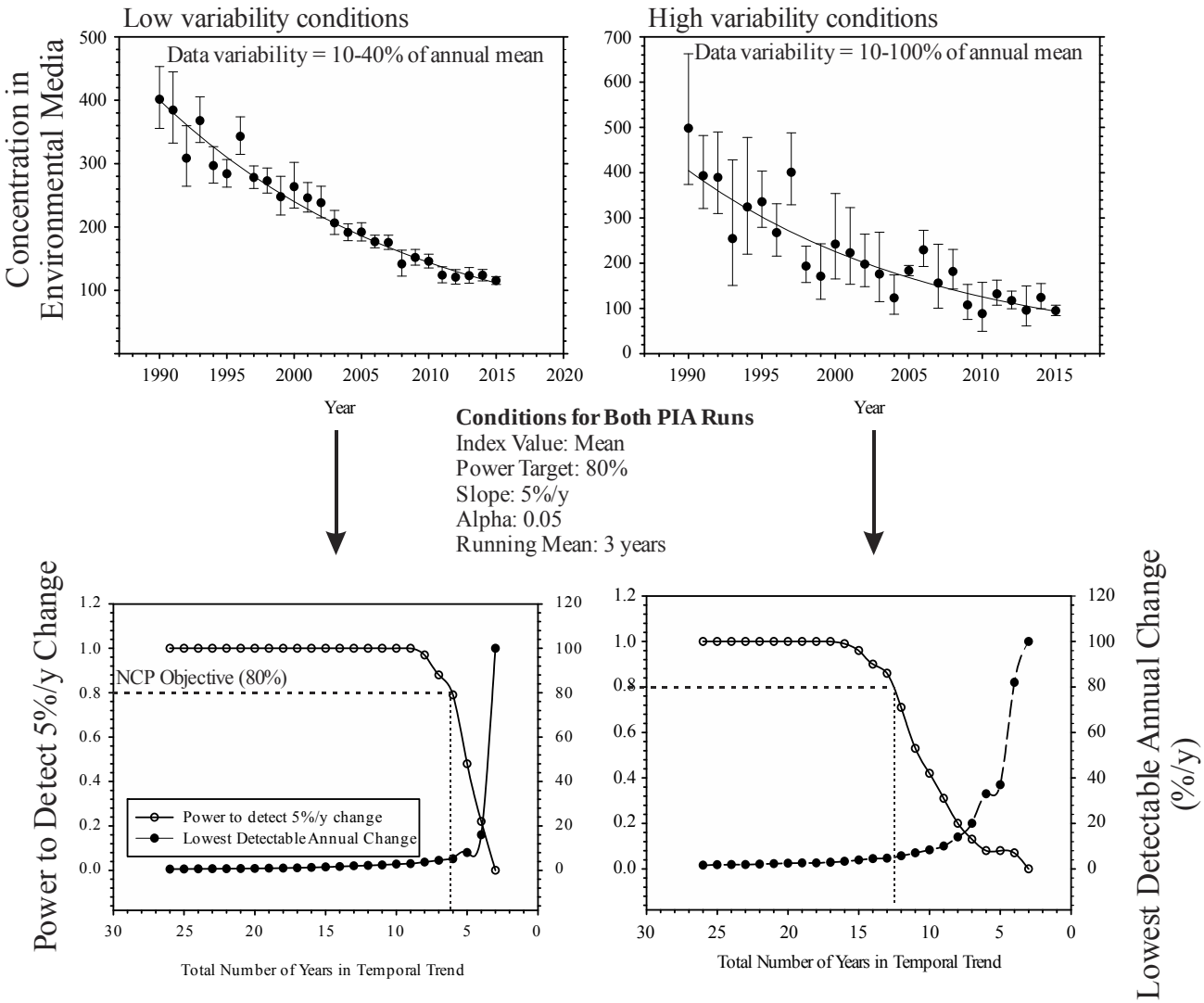



Figure 2 The effect of data variability and randomly reducing the number of years of monitoring on the statistical power of the temporal trend analysis using PIA. Panels on the left indicate low variability (10-40% of the annual mean) and the effect of reducing the years of sampling from 26 to effectively zero. Panels to the right show the results of the PIA simulations with high variability (10-100% of the annual mean). Slope in both cases is 5%/y, starting with a statistical power of 1.0 (i.e. 100%).

## 3.0 Assessment of the Environment and Monitoring Core Monitoring Data

Data from individual monitoring programs were submitted to the NCP Secretariat from the individual principal investigators (Table 1) in electronic form. Where possible, data were converted to lipid weight basis before entering to PIA (except for PFOS), and the size/age co-factor entered with the concentration data.

Table 1 Northern species and representative POPs used to evaluate temporal trends in the NCP core monitoring program.

| Species | Principal Investigator | Locations | Chemicals | Modifying Factors[1] |
|---|---|---|---|---|
| Beluga | Stern | Hendrickson Island, Sanikiluaq | αHCH, *p,p'*-DDE, PCB 153 | Age, lipid basis |
| | Tomy | Hendrickson Is., Pangnirtung | BDE-47, PFOS | No age, no lipid data |
| Ringed seal | Muir | Beaufort region, Lancaster Sound, Hudson Bay | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Age, lipid content |
| Polar bear | Letcher | western Hudson Bay, southern Hudson Bay | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | No age, lipid basis |
| Burbot | Stern | Fort Good Hope | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Fork length, lipid content |
| | Evans | Great Slave Lake (West Basin) | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Fork and total length, lipid content |
| Lake trout | Stern | Lac Laberge, Kusawa Lake | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Fork length, lipid content |
| | Evans | Great Slave Lake (West Basin and East Arm) | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Fork and total length, lipid content |
| Sea-run Arctic char | Evans | Nain, Pond Inlet, Cumberland Sound | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Fork and total length, lipid content |
| Land-locked Arctic char | Muir | Char L., Amituk, Resolute, Hazen | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | Length, lipid content |
| Northern fulmar | Braune | Prince Leopold Island | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | No age, lipid basis |
| Thick-billed murre | Braune | Prince Leopold Island, Coats Island | αHCH, *p,p'*-DDE, PCB 153, BDE-47, PFOS | No age, lipid basis |

1 – only 1 co-variate is entered into PIA at a time. Where possible, concentration data were converted to a lipid weight basis in Excel, and then entered into PIA with the co-variate of age or length.

### *3.1 Results*

The summarised results of the analysis of individual POPs for each monitoring species are presented in Tables 2 to 6. Results for individual compounds and species are reported graphically in Appendix A and numerically in Appendix B. Because of the inability of the PIA program to save graphics and tabular results for more than one run, data were recorded after each run to maintain a record of results. In cases where two runs were conducted on a given species/POPs combination (e.g. wet weight basis vs lipid weight basis, or with/without a co-variate) produced very similar results, tabular data for both runs are presented in Appendix B. For summary data (see below), the regression with the highest power or statistical significance was used for comparison with other data sets.

Table 2 Summary of time intervals, sample sizes and conditions in marine mammals, with a summary of regression results. The last column refers to the graph number in Appendix A. Leg: *-sig at 95%; ** sig at 99.0%; ***-sig at 99.9%

| Chemical | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope (%/y) | Power | Sig. | |
| **Beluga** | | | | | | | | | |
| αHCH | Hendrickson Isl. | 169 | 1989-2012 | 16 | Age co-variate, lipid basis | -4.0% | 94% | p<0.001*** | A1 |
| | Sanikiluaq | 45 | 1994 - 2009 | 4 | No co-variate; lipid basis | -12% | 6.4% | p<0.055 | A2 |
| *p,p'*-DDE | Hendrickson Isl. | 169 | 1989-2012 | 16 | Age co-variate, lipid basis | 0.11% | 54% | p<0.903 | A3 |
| | Sanikiluaq | 45 | 1994-2009 | 4 | No co-variate; lipid basis | 10% | 6.0% | p<0.172 | A4 |
| PCB 153 | Hendrickson Isl. | 168 | 1989-2012 | 16 | Age co-variate, lipid basis | -0.85% | 100% | p<0.184 | A5 |
| | Sanikiluaq | 45 | 1994-2009 | 4 | No co-variate; lipid basis | 0.53% | 6.1% | p<0.878 | A6 |
| BDE-47 | Hendrickson Isl. | 102 | 1993-2008 | 10 | No co-variate; wet weight basis | 5.3% | 28% | p<0.026* | A7 |
| PFOS | Hendrickson Isl. | 131 | 1984 - 2009 | 13 | No co-variate; wet weight basis | 2.0% | 48% | p<0.152 | A8 |
| | Pangnirtung | 79 | 1982 - 2010 | 12 | No co-variate; wet weight basis | 0.35% | 20% | p<0.812 | A9 |
| **Ringed Seal** | | | | | | | | | |
| αHCH | Beaufort | 86 | 1981-2010 | 7 | Age co-variate; lipid basis | -2.1% | 19% | p<0.035* | A10 |
| | Hudson Bay | 91 | 1986-2006 | 6 | Age co-variate; lipid basis | -8.8% | 5.9% | p<0.046* | A11 |
| | Lancaster S. (1) | 103 | 1975-2010 | 9 | Age co-variate; lipid basis | -3.6% | 12% | p<0.017* | A12 |
| | Lancaster S. (2) | 238 | 1972-2012 | 18 | No co-variate; lipid basis | -4.0% | 59% | p<0.001*** | A13 |
| *p,p'*-DDE | Beaufort | 116 | 1981-2010 | 9 | Age co-variate; lipid basis | -1.1% | 35% | p<0.430 | A14 |
| | Hudson Bay | 106 | 1986-2008 | 8 | Age co-variate; lipid basis | -6.8% | 8.4% | p<0.020* | A15 |
| | Lancaster S. (1) | 201 | 1975-2012 | 15 | Age co-variate; lipid basis | -1.7% | 41% | p<0.112 | A16 |
| | Lancaster S. (2) | 238 | 1972-2012 | 18 | No co-variate; lipid basis | -1.4% | 81% | p<0.059 | A17 |
| PCB 153 | Beaufort | 139 | 1981-2010 | 11 | Age co-variate; lipid basis | -1.2% | 24% | p<0.282 | A18 |
| | Hudson Bay | 157 | 1986-2001 | 13 | Age co-variate; lipid basis | -5.8% | 32% | p<0.001*** | A19 |
| | Lancaster S. (1) | 166 | 1975-2012 | 14 | Age co-variate; lipid basis | -1.1% | 48% | p<0.244 | A20 |
| | Lancaster S. (2) | 203 | 1972-2012 | 17 | No co-variate; lipid basis | -1.2% | 89% | p<0.061 | A21 |

Table 2(cont'd) Summary of time intervals, sample sizes and conditions in marine mammals, with a summary of regression results. The last column refers to the graph number in Appendix A. Leg: *-sig. at 95%; ** sig. at 99.0%; ***-sig. at 99.9%

| Chemical | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope (%/y) | Power | Sig. | |
| **Ringed seal (cont'd)** | | | | | | | | | |
| BDE-47 | Beaufort | 90 | 1981-2011 | 9 | Age co-variate; lipid basis | 8.4% | 14% | $p<0.001^{***}$ | A22 |
| | Hudson Bay | 96 | 1998-2011 | 10 | Age co-variate; lipid basis | -2.6% | 13% | $p<0.515$ | A23 |
| | Lancaster S. (1) | 98 | 2000-2011 | 9 | Age co-variate; lipid basis | 6.5% | 6% | $p<0.478$ | A24 |
| | Lancaster S. (2) | 125 | 1972-2011 | 12 | No co-variate; lipid basis | 6.7% | 9.2% | $p<0.019^{*}$ | A25 |
| PFOS | Beaufort (1) | 68 | 2001-2011 | 6 | Age co-variate; wet basis | -6.0% | 6.0% | $p<0.411$ | A26 |
| | Beaufort (2) | 77 | 1972-2011 | 7 | No co-variate; wet basis | 2.6% | 6.2% | $p<0.233$ | A27 |
| | Hudson Bay (1) | 118 | 1998-2011 | 10 | Age co-variate; wet basis | -11% | 12% | $p<0.027^{*}$ | A28 |
| | Hudson Bay (2) | 128 | 1992-2011 | 11 | No co-variate; wet basis | -3.8% | 11% | $p<0.303$ | A29 |
| | Lancaster S. (1) | 104 | 2000-2011 | 9 | Age co-variate; wet basis | -10% | 10% | $p<0.070$ | A30 |
| | Lancaster S. (2) | 139 | 1972-2011 | 12 | No co-variate; wet basis | -3.5% | 10% | $p<0.116$ | A31 |
| **Polar Bear** | | | | | | | | | |
| αHCH | W. Hudson Bay | 113 | 1991-2012 | 14 | No co-variate; lipid basis | -8% | 75% | $p<0.001^{***}$ | A32 |
| | S. Hudson Bay | 67 | 2007-2012 | 5 | No co-variate; lipid basis | 2.2% | 10% | $p<0.629$ | A33 |
| *p,p'*-DDE | W. Hudson Bay | 113 | 1991-2012 | 14 | No co-variate; lipid basis | -5.2% | 38% | $p<0.005^{**}$ | A34 |
| | S. Hudson Bay | 67 | 2007-2012 | 5 | No co-variate; lipid basis | 4.1% | 8.6% | $p<0.484$ | A35 |
| PCB 153 | W. Hudson Bay | 113 | 1991-2012 | 14 | No co-variate; lipid basis | 1.9% | 32% | $p<0.278$ | A36 |
| | S. Hudson Bay | 67 | 2007-2012 | 5 | No co-variate; lipid basis | -5.9% | 6.1% | $p<0.578$ | A37 |
| BDE 47 | W. Hudson Bay | 113 | 1991-2012 | 14 | No co-variate; lipid basis | 11% | 58% | $p<0.001^{***}$ | A38 |
| | S. Hudson Bay | 67 | 2007-2012 | 5 | No co-variate; lipid basis | 13% | 12% | $p<0.041^{*}$ | A39 |
| PFOS | S. Hudson Bay | 60 | 2007-2012 | 5 | No co-variate; wet basis | -10% | 6.0% | $p<0.369$ | A40 |

Note: PFOS in ringed seal in Beaufort: results differ if 1972 is included in regression; but no age as co-factor. Slope varies from -6.0 ($p<0.411$) with age co-variate (no 1972) to 2.6% ($p<0.233$) including 1972 but no age co-variate.

Table 3 Summary of temporal trend statistics for representative POPs in sea-run arctic char and burbot. Leg: *-sig at 95%; ** sig at 99.0%; ***-sig at 99.9%

| Chemical | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope (%/y) | Power | Sig. | |
| **Sea-run Arctic char** | | | | | | | | | |
| αHCH | Pond Inlet | 67 | 1987-2010 | 7 | Length co-variate; lipid basis | -6.1% | 6.2% | p<0.108 | A41 |
| | Nain | 48 | 1999-2010 | 5 | Length co-variate; lipid basis | -11% | 6.9% | p<0.041* | A42 |
| | Cambridge Bay | 58 | 2004-2010 | 6 | Length co-variate; lipid basis | -7.3% | 5.3% | p<0.726 | A43 |
| *p,p'*-DDE | Pond Inlet | 67 | 1987-2010 | 7 | Length co-variate; lipid basis | -0.81% | 8.4% | p<0.694 | A44 |
| | Nain | 48 | 1999-2010 | 5 | Length co-variate; lipid basis | -0.68% | 5.9% | p<0.871 | A45 |
| | Cambridge Bay | 58 | 2004-2010 | 6 | Length co-variate; lipid basis | 12% | 7.9% | p<0.156 | A46 |
| PCB 153 | Pond Inlet | 67 | 1987-2010 | 7 | Length co-variate; lipid basis | 1.6% | 8.1% | p<0.486 | A47 |
| | Nain | 48 | 1999-2010 | 5 | Length co-variate; lipid basis | -2.8% | 6.2% | p<0.557 | A48 |
| | Cambridge Bay | 58 | 2004-2010 | 6 | Length co-variate; lipid basis | -25% | 5.5% | p<0.149 | A49 |
| BDE-47 | Pond Inlet | 56 | 2005-2010 | 6 | Length co-variate; lipid basis | -22% | 5.5% | p<0.266 | A50 |
| | Nain | 41 | 2007-2010 | 4 | Length co-variate; lipid basis | 26% | 5.9% | p<0.541 | A51 |
| | Cambridge Bay | 57 | 2004-2010 | 6 | Length co-variate; lipid basis | -3.6% | 5.8% | p<0.775 | A52 |
| **Burbot** | | | | | | | | | |
| αHCH | Great Slave L. (W. Basin) | 117 | 1995-2010 | 13 | Length co-variate; lipid basis | -19% | 41% | p<0.001*** | A53 |
| | Fort Good Hope | 181 | 1988-2012 | 15 | Length co-variate; lipid basis | -12% | 29% | p<0.001*** | A54 |
| *p,p'*-DDE | Great Slave L. (W. Basin) | 122 | 1995-2000 | 13 | Length co-variate; lipid basis | -14% | 26% | p<0.001*** | A55 |
| | Fort Good Hope | 181 | 1988-2012 | 15 | Length co-variate; lipid basis | 1.1% | 15% | p<0.761 | A56 |
| PCB 153 | Great Slave L. (W. Basin) | 123 | 1995-2010 | 13 | Length co-variate; lipid basis | -14% | 24% | p<0.001*** | A57 |
| | Fort Good Hope | 181 | 1988-2012 | 15 | Length co-variate; lipid basis | 1.1% | 14% | p<0.753 | A58 |
| BDE 47 | Great Slave L. (W. Basin) | 50 | 2006-2010 | 5 | Length co-variate; lipid basis | -7.2% | 6.3% | p<0.555 | A59 |
| | Fort Good Hope (1) | 116 | 1988-2011 | 12 | Length co-variate; lipid basis | 4.3% | 13% | p<0.187 | A60 |
| | Fort Good Hope (2) | 117 | 1988-2011 | 12 | Length co-variate; wet weight basis | 5.8% | 30% | p<0.007** | A61 |
| PFOS | Fort Good Hope (1) | 106 | 1986-2011 | 11 | No co-variate; wet weight basis | -17% | 5.4% | p<0.075 | A62 |
| | Fort Good Hope (2) | 96 | 1999-2011 | 10 | Length co-variate; wet weight basis | -11% | 12% | p<0.018* | A63 |

Table 4 Summary of temporal trend statistics for representative POPs in lake trout.
Leg: *-sig at 95%; ** sig at 99.0%; ***-sig at 99.9%

| Chemical | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope | Power | Sig. | |
| **Lake trout** | | | | | | | | | |
| αHCH | L. Laberge | 147 | 1993-2012 | 15 | Length co-variate; lipid basis | -12% | 28% | p<0.001*** | A64 |
| | L. Kusawa | 139 | 1993-2012 | 14 | Length co-variate; lipid basis | -13% | 9.2% | p<0.032* | A65 |
| | Great Slave (w. Basin) | 99 | 1999-2010 | 10 | Length co-variate; lipid basis | -28% | 6.5% | p<0.009** | A66 |
| | Great Slave (East Arm) | 121 | 1993-2010 | 13 | Length co-variate; lipid basis | -11% | 24% | p<0.001*** | A67 |
| *p,p'*-DDE | L. Laberge | 147 | 1993-2012 | 15 | Length co-variate; wet weight basis | -10% | 11% | p<0.045* | A68 |
| | L. Kusawa | 139 | 1993-2012 | 14 | Length co-variate; wet weight basis | -18% | 6.0% | p<0.098 | A69 |
| | Great Slave (w. Basin) | 109 | 1999-2011 | 11 | Length co-variate; lipid basis | -11% | 6.0% | p<0.370 | A70 |
| | Great Slave (East Arm) | 121 | 1993-2010 | 13 | Length co-variate; lipid basis | 0.3% | 7.3% | p<0.919 | A71 |
| PCB 153 | L. Laberge | 146 | 1993-2012 | 15 | Length co-variate; wet weight basis | -15% | 13% | p<0.002** | A72 |
| | L. Kusawa | 139 | 1993-2012 | 14 | Length co-variate; lipid basis | -15% | 12% | p<0.004** | A73 |
| | Great Slave (w. Basin) | 108 | 1999-2011 | 11 | Length co-variate; lipid basis | -16% | 5.9% | p<0.177 | A74 |
| | Great Slave (East Arm) | 121 | 1993-2010 | 13 | Length co-variate; lipid basis | 1.1% | 25% | p<0.666 | A75 |
| BDE-47 | L. Laberge | 58 | 1993-2011 | 9 | Length co-variate; wet weight basis | -1.2% | 5.7% | p<0.851 | A76 |
| | L. Kusawa | 68 | 1999-2011 | 9 | Length co-variate; wet weight basis | -5.5% | 5.4% | p<0.678 | A77 |
| | Great Slave (w. Basin) | 69 | 2004-2010 | 7 | Length co-variate; lipid basis | -12% | 6.9% | p<0.251 | A78 |
| | Great Slave (East Arm) | 72 | 2004-2010 | 7 | Length co-variate; lipid basis | -2.5% | 6.0% | p<0.829 | A79 |
| PFOS | L. Laberge | 50 | 2006-2012 | 6 | Length co-variate; wet weight basis | -16% | 5.1% | p<0.630 | A80 |
| | L. Kusawa | 56 | 2006-2012 | 6 | Length co-variate; wet weight basis | -26% | 5.7% | p<0.090 | A81 |
| | Great Slave (w. Basin) | 38 | 2004-2010 | 6 | Length co-variate; wet weight basis | -17% | 27% | p<0.002** | A82 |
| | Great Slave (East Arm) | 69 | 1993-2010 | 12 | Length co-variate; wet weight basis | -3.8% | 6.0% | p<0.690 | A83 |

Table 5 Summary of temporal trend statistics for representative POPs in land-locked arctic char. Leg: *-sig at 95%; ** sig at 99.0%; ***-sig at 99.9%

| | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope | Power | Sig. | |
| **Land-locked Arctic char** | | | | | | | | | |
| αHCH | Amituk | 94 | 1989-2012 | 12 | No co-variate; lipid basis | -15% | 50% | $p<0.001^{***}$ | A84 |
| | Resolute | 148 | 1997-2012 | 15 | Length co-variate; lipid basis | -7.1% | 93% | $p<0.001^{***}$ | A85 |
| | Char L. | 71 | 1993-2012 | 12 | No co-variate; lipid basis | -13% | 49% | $p<0.001^{***}$ | A86 |
| | L. Hazen | 112 | 1990-2012 | 12 | Length co-variate; lipid basis | -9.5% | 37% | $p<0.001^{***}$ | A87 |
| *p,p'*-DDE | Amituk | 94 | 1989-2012 | 12 | No co-variate; wet weight basis | -6.5% | 9.6% | $p<0.076$ | A88 |
| | Resolute | 148 | 1997-2012 | 15 | Length co-variate; wet weight basis | -6.2% | 25% | $p<0.075$ | A89 |
| | Char L. | 71 | 1993-2012 | 12 | No co-variate; lipid basis | -9.8% | 20% | $p<0.002^{**}$ | A90 |
| | L. Hazen | 112 | 1990-2012 | 12 | No co-variate; lipid basis | -5.5% | 8.5% | $p<0.183$ | A91 |
| PCB 153 | Amituk | 94 | 1989-2012 | 12 | No co-variate; wet weight basis | -5.0% | 34% | $p<0.005^{**}$ | A92 |
| | Resolute | 149 | 1997-2012 | 15 | Length co-variate; lipid basis | -7.9% | 45% | $p<0.004^{**}$ | A93 |
| | Char L. | 71 | 1993-2012 | 12 | No co-variate; lipid basis | -8.6% | 28% | $p<0.001^{***}$ | A94 |
| | L. Hazen | 112 | 1990-2012 | 12 | No co-variate; lipid basis | -5.6% | 10% | $p<0.105$ | A95 |
| BDE-47 | Amituk | 56 | 2002-2011 | 8 | Length co-variate; lipid basis | -18% | 7.0% | $p<0.045^{*}$ | A96 |
| | Resolute | 122 | 1997-2011 | 14 | Length co-variate; lipid basis | 7.7% | 33% | $p<0.020^{*}$ | A97 |
| | Char L. | 48 | 2001-2011 | 8 | Length co-variate; lipid basis | -5.4% | 26% | $p<0.042^{*}$ | A98 |
| | L. Hazen | 94 | 1992-2011 | 10 | Length co-variate; lipid basis | 16% | 8.7% | $p<0.007^{**}$ | A99 |
| PFOS | Amituk | 46 | 2007-2011 | 4 | Length co-variate; wet weight basis | -9.5% | 9.4% | $p<0.140$ | A100 |
| | Char L. | 45 | 1993-2011 | 6 | No co-variate; wet weight basis | 1.5% | 33% | $p<0.101$ | A101 |
| | L. Hazen | 50 | 2003-2011 | 5 | Length co-variate; wet weight basis | 32% | 5.6% | $p<0.070$ | A102 |

Table 6 Summary of temporal trend statistics for representative POPs in seabirds. Leg: *-sig. at 95%; ** sig. at 99.0%; ***-sig. at 99.9%

| Chemical | Location | No. Samples | Range of years | No. of Years Sampled | Conditions | PIA Results | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Slope | Power | Sig. | |
| **Northern fulmar** | | | | | | | | | |
| αHCH | Prince Leopold Is. | 70 | 1975-2012 | 15 | No co-variate; lipid basis | -6.9% | 16% | $p<0.001^{***}$ | A103 |
| *p,p'*-DDE | Prince Leopold Is. | 70 | 1975-2012 | 15 | No co-variate; lipid basis | -4.4% | 94% | $p<0.001^{***}$ | A104 |
| PCB 153 | Prince Leopold Is. | 70 | 1975-2012 | 15 | No co-variate; lipid basis | -3.8% | 93% | $p<0.001^{***}$ | A105 |
| BDE-47 | Prince Leopold Is. | 52 | 1975-2012 | 13 | No co-variate; lipid basis | 2.6% | 17% | p<0.117 | A106 |
| PFOS | prince Leopold Is. | 57 | 1975-2012 | 12 | No co-variate; wet weight basis | -0.01% | 30% | p<0.938 | A107 |
| **Thick-billed murre** | | | | | | | | | |
| αHCH | Prince Leopold Is. | 70 | 1975-2012 | 16 | No co-variate; lipid basis | -5.4% | 8.4% | p<0.069 | A108 |
| | Coats Island | 50 | 1993-2011 | 10 | No co-variate; lipid basis | -12% | 5.4% | p<0.253 | A109 |
| *p,p'*-DDE | Prince Leopold Is. | 70 | 1975-2012 | 16 | No co-variate; lipid basis | -2.8% | 91% | $p<0.001^{***}$ | A110 |
| | Coats Island | 50 | 1993-2011 | 10 | No co-variate; lipid basis | -4.3% | 31% | $p<0.021^{*}$ | A111 |
| PCB 153 | Prince Leopold Is. | 70 | 1975-2012 | 16 | No co-variate; lipid basis | -3.1% | 92% | $p<0.001^{***}$ | A112 |
| | Coats Island | 50 | 1993-2011 | 10 | No co-variate; lipid basis | -4.6% | 62% | $p<0.002^{**}$ | A113 |
| BDE-47 | Prince Leopold Is. | 53 | 1975-2012 | 13 | No co-variate; lipid basis | 2.4% | 24% | p<0.081 | A114 |
| | Coats Island | 40 | 1993-2011 | 8 | No co-variate; lipid basis | -5.0% | 9.5% | p<0.112 | A115 |
| PFOS | Prince Leopold Is. | 55 | 1975-2012 | 12 | No co-variate; lipid basis | -0.51% | 23% | p<0.659 | A116 |

### 3.1 Summary of Regression Results

Slope and power data from Tables 2 to 6 and Appendix B were pooled and analysed in order to evaluate the performance of these indices in all monitoring programs as a group. The distribution of three parameters is shown in Figure 3 for all data sets listed in Tables 2 to 6. The data show a wide range of values, with a grouping of more values around the target values for each parameter.

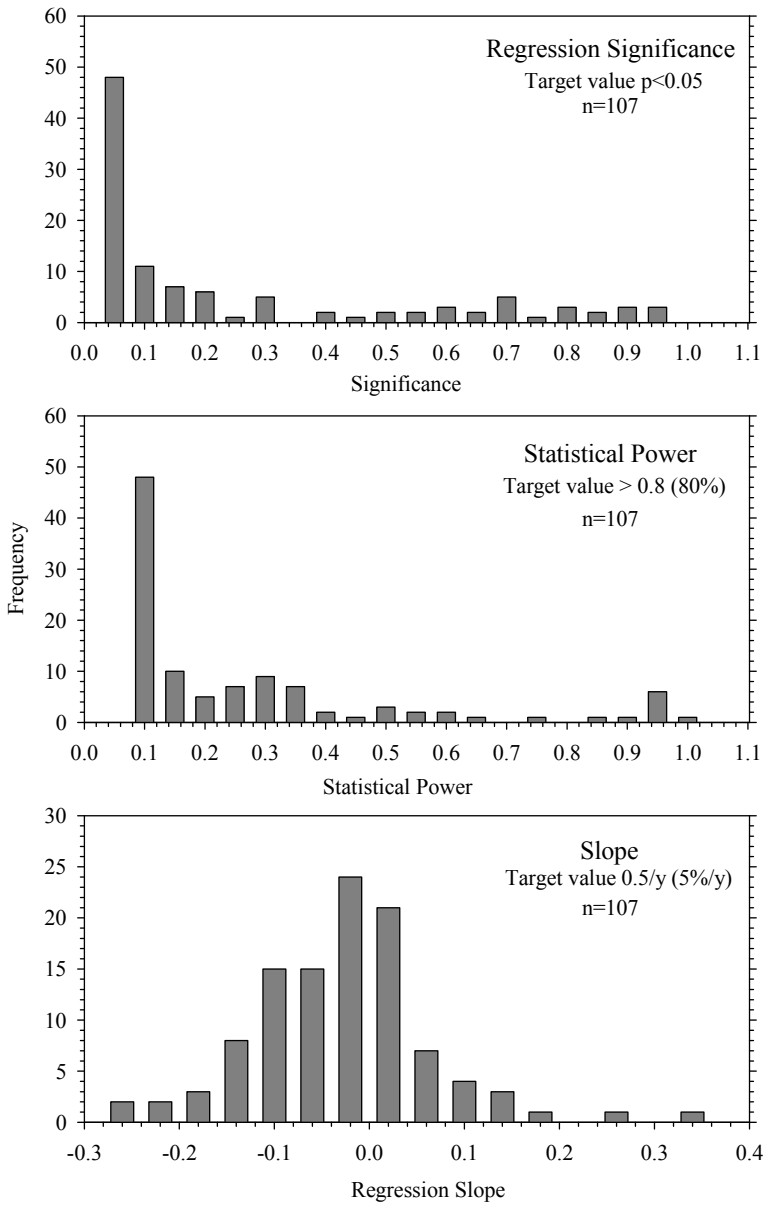



Figure 3 Distribution of time-series metrics from the NCP monitoring data

The data show that very few time-series exceed the 80% power objective (Fig. 4), while several others show decreasing and increasing trends but with very low statistical power. The highest power values are observed for αHCH, PCB 153 and *p,p'*-DDE in marine mammals and seabirds, which showed clear declines since the 1990's (Fig A1, A13, A34, A110, A112). Other time-series show high rates of increase or decline, but very low statistical power, often less than 10% (Fig 4).

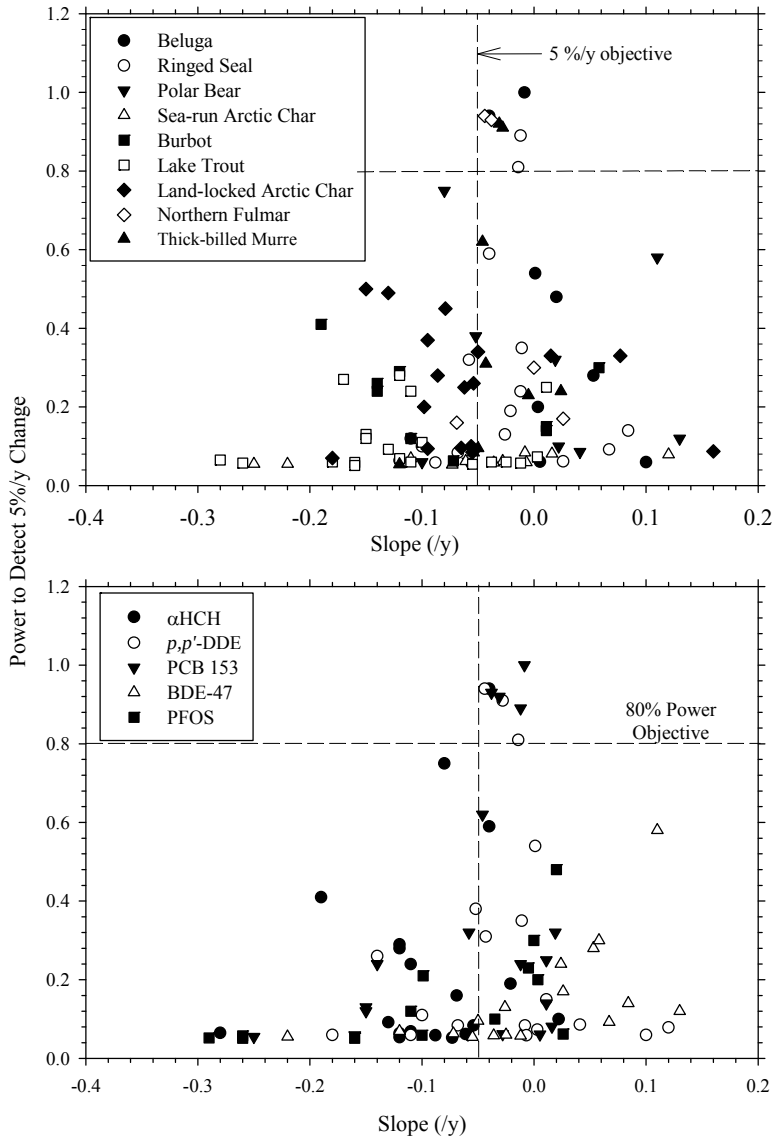



Figure 4 Slope (/y) and power for the individual time-series listed in Tables 2 to 6. Top panel shows the two indices on a species basis while the lower panel shows the data in terms of individual compounds.

A significant trend observed in several species was the increase of BDE-47 since the 1990s. Although most time-series have relatively low statistical power, beluga (Fig A7) and ringed seal (Fig A22) from the Beaufort region and polar bear in Hudson Bay (Fig A38, A39) showed significant increases. Other monitoring programs, including seabirds, showed no discernable

trends for this compound. This inconsistency make program-wide predictions difficult and may result in the need to manage each monitoring program individually.

A breakdown of the distribution of indices shows that 9 out of 107 data sets (8.4%) show a statistical power >80%. In general, these data sets have used archived samples to extend the time series over more years and have data back into the 1970's or 1980's and usually relate to PCB153, p,p'-DDE and αHCH. Ancillary data on ages or body condition are not available for many of the early data sets, however the additional years of data help to increase the power of the time series.

Forty-five of the 107 data sets (42%) had power less than 10%, indicating very high uncertainty in the detected trend. Of the slopes reported in Tables 2 to 6, 79 out of 107 (74%) had negative slopes, indicating a declining trend, while 28 had a positive slope, indicating an increasing trend. The highest observed positive slopes were reported for BDE47 in polar bear and DDE in char and beluga from the eastern Arctic, while the highest declining slopes were reported in one analysis of PFOS in burbot. The regression statistic was statistically significant in a relatively high proportion of the test sets, with 48 out of 107 (45%) below the $p<0.05$ level.

The mean values of slope and power data for each species (Tables 2 to 6) and each chemical were calculated in order to determine trends between individual species and POPs. Data are plotted in Figure 5 (by species) and Figure 6 (by compound) as box plots that show median values and 25/75$^{th}$ percentiles and 10/90$^{th}$ percentiles.

The comparison by species shows that the median slope for the marine mammal species is grouped near the zero point, and includes both positive and negative values. The power of this group extends from low values to above 80%. On a species basis, char, burbot and lake trout show the lowest median value for slopes which indicate consistent declines in concentrations, however the statistical power is low for these species (lower panel), indicating high levels of uncertainty. In the case of arctic char, the low power is partly the result of the sea-run char program commencing in the mid-2000's and a relatively short interval for the time-series.

When viewed on a compound-specific basis (Figure 6), the highest pooled values are observed for BDE-47 which appears to be increasing in several species. The values for PFOS show a high number of decreasing values, however the number of data sets for PFOS is very low and the number of samples is relatively low. The lower number of samples and sampling years for the PFOS data will affect the overall performance assessment.

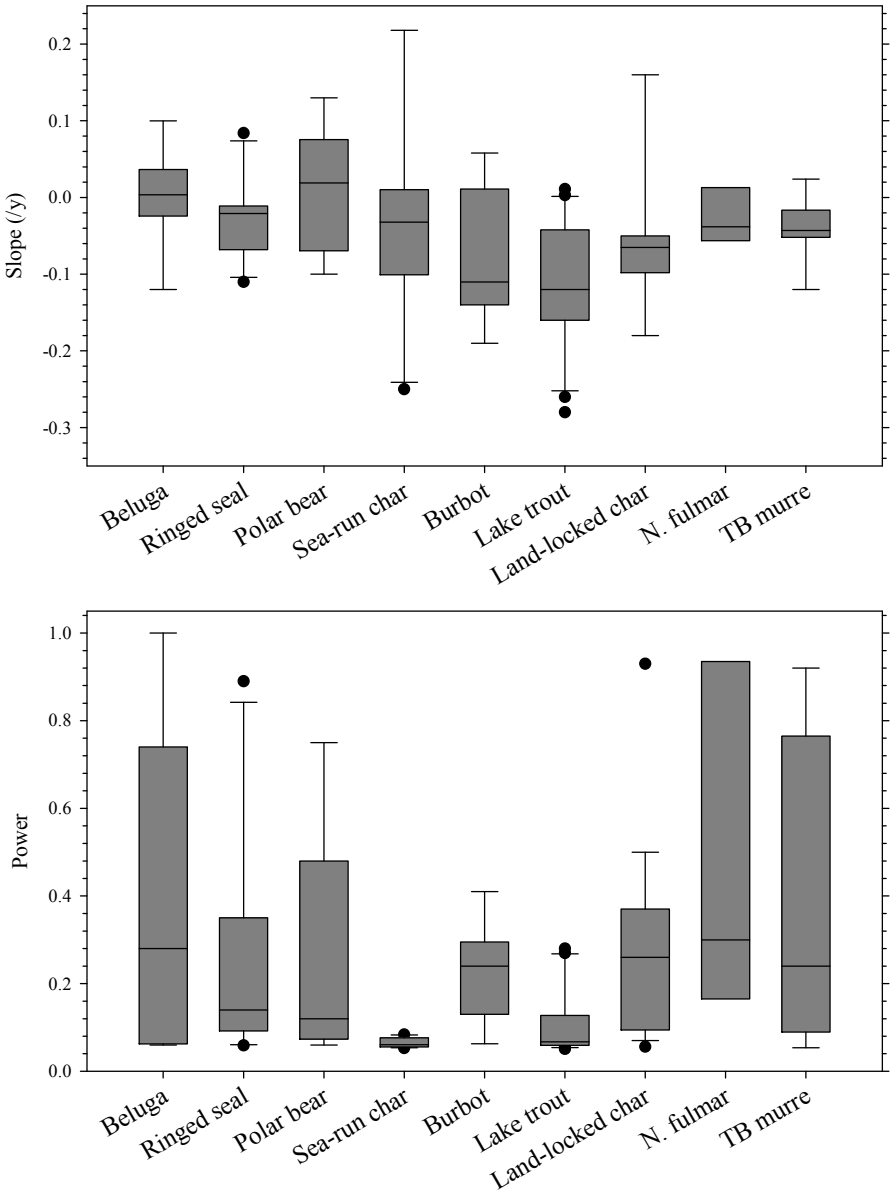



Figure 5 Box plots of slope and power values from time-series for each northern species. Lines represent median, with the upper and lower limits of the box 25 and 75%-tiles of the data. The bars represent 10 and 90%-tiles, and the dots are outliers.

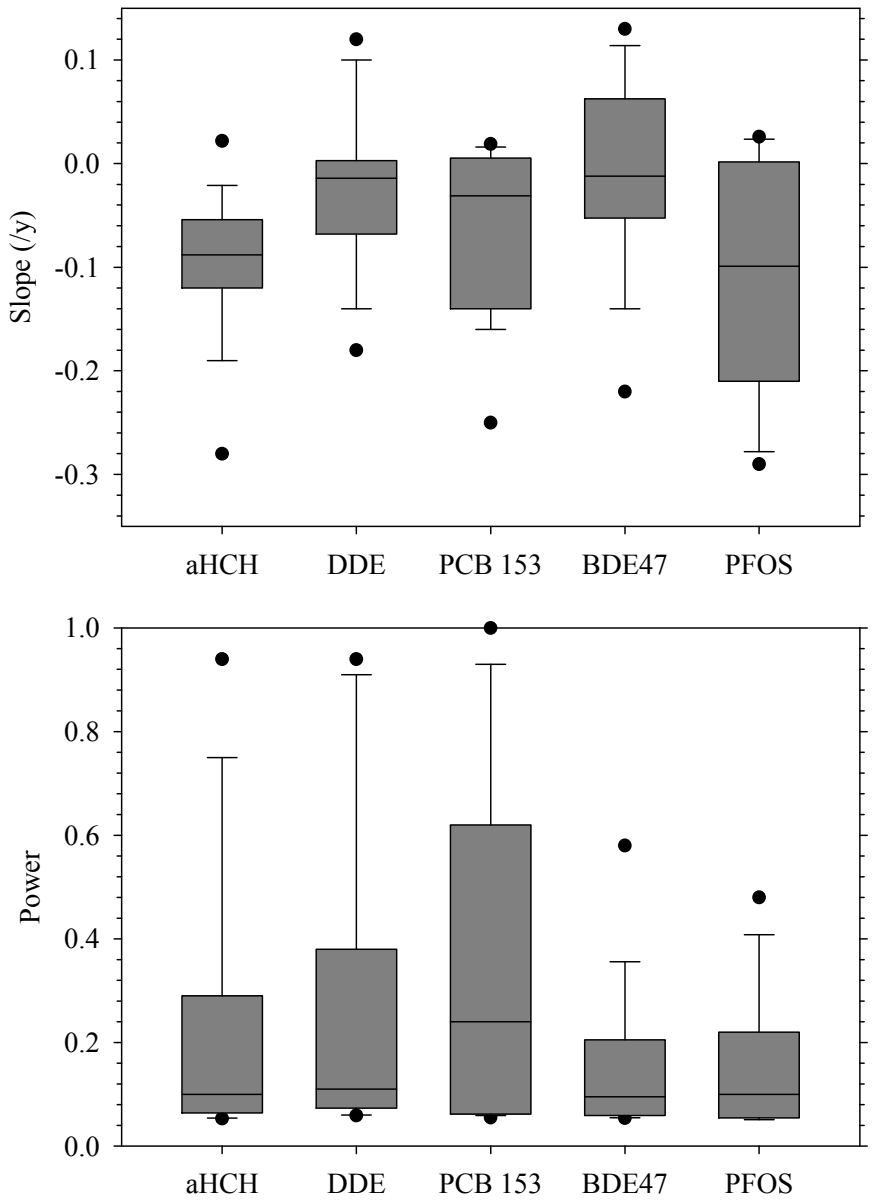



Figure 6 Box plots of slope and power values from time-series for each other the representative POPs. Single lines represent median, with the upper and lower limits of the box 25 and 75%-tiles of the data. The bars represent 10 and 90%-tiles, and the dots are outliers.

An analysis was conducted of the relationship between the declines of αHCH, PCB 153 and *p,p'*-DDE (Figure 7), three compounds with similar physicochemical properties and reduced inputs to the environment. Strong correlation between the compounds indicates that some legacy compounds might be used as surrogates to monitor the decline of other compounds with similar characteristics. This relationship would have to be tested on a larger number of chemicals to determine if the correlation holds for a larger number of compounds.

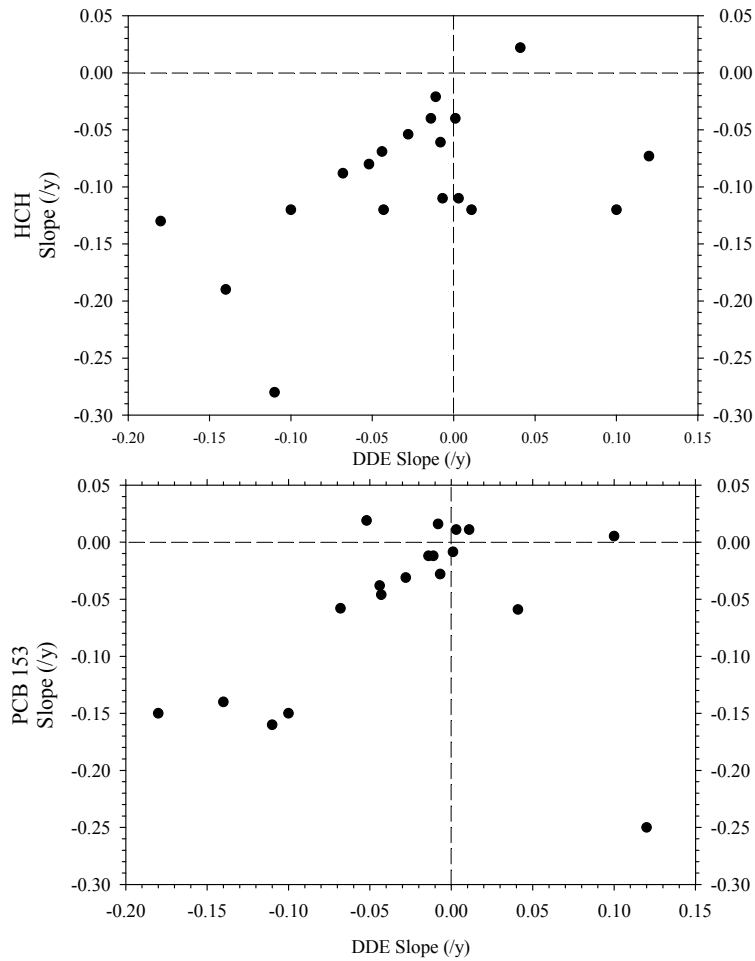



Figure 7 Graph of the slopes of the time series curves for PCB 153 and αHCH plotted against DDE showing the high correlation between the declines of the three POPs.

## 4.0 Observations and Conclusions

- The overall performance of the monitoring program in terms of the statistical power of the monitoring programs is variable, with some long-term time-series (e.g., beluga, seabirds) showing declining trends with high statistical power. The overall trends indicate that some compounds are declining in many traditional food species in some areas.

- However, this observation is not universal across the monitoring programs and there are examples of increasing legacy POPs in some monitoring programs, although the uncertainty in the trends is high.

- The highest statistical power tended to be in programs which could access archived samples back to the 1970's and 1980's when POPs concentrations were considerably higher. These trends generally show consistent declines in legacy POPs and also show an increase in BDE-47 since the 1990's (e.g., Hendrickson Island beluga). Some of the archived samples do not have matching age or corresponding data which weakens the calculation of trends.

- High variability in many freshwater fish monitoring programs makes detecting trends difficult, although trends for many compounds tend to show declining levels.

- Many programs indicate that the environmental concentrations of some POPs have reached a constant level and are not expected to decline further. These programs may be candidates for reduced sampling and/or analysis of some compounds.

- There are few consistent trends when the regression metrics for all programs are pooled. The large range in statistical power and trends indicates that no blanket conclusions are possible for any species or compound, however it may be possible to reduce sampling and analysis in some species and areas of the program. These should probably be examined on an individual basis.

- It was not possible to test whether there was a geographical component (e.g., west vs. east Arctic) that would help to interpret the trends observed.

- PFOS was used as one representative compound, however the data set was the weakest in terms of number of samples and the frequency of sampling. PFOS regression statistics were included in the pooled analysis, however, the results of the time series may have significantly affected the overall performance analysis.

- A large number of factors affect the trends observed in the monitoring programs and lead to high levels of uncertainty. These factors include changes in source output during the time-series, geographical location (east vs west Arctic), changes in the ecology and food web structure of the monitored species during the monitored time interval, and other factors related to climate change.

## 5.0 References

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# APPENDIX B

# REGRESSION METRICS FOR INDIVIDUAL SPECIES AND POPS

Table B1 Summary of regression results for representative POPs in beluga.

| | Co-factor | Number of samples | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Beluga** | | | | | | | | | | |
| αHCH | Age | Hendrickson Is. | $y=2.84 \times 10^3 \times e^{(-0.04\ Year)}$ | -4.0 | -5.9 to -2.0% | 4.1% | 94 | 15 | 0.57 $p<0.001^{***}$ | Age co-variate; lipid weight basis |
| | None | Sanikiluaq | $y= 3.85 \times 10^7 \times e^{(-0.12\ Year)}$ | -12 | -22 to -0.45 | >99% | 6.4 | 17 | 0.91 $p<0.055$ | No age co-variate, lipid weight basis |
| *p,p'*-DDE | Age | Hendrickson Is. | $y=1.91 \times 10^3 \times e^{(0.001\ Year)}$ | 0.11 | -3.2 to 3.5% | 7.0% | 54 | 20 | 0.00 $p<0.903$ | Age co-variate; lipid weight basis |
| | None | Sanikiluaq | $y=0.06 \times e^{(0.09\ Year)}$ | 10 | -9.3 to 33 | >99% | 6.0 | 23 | 0.69 $p<0.172$ | No age co-variate, lipid weight basis |
| PCB 153 | Age | Hendrickson Is. | $y=1.26 \times 10^3 \times e^{(-.01\ Year)}$ | -0.85 | -2.2 to 0.47 | 2.7% | 100 | 11 | 0.12 $p<0.184$ | Age co-variate; lipid weight basis |
| | None | Sanikiluaq | $y = 141 \times e^{(0.01\ Year)}$ | 0.53 | -16 to 21 | >99% | 6.1% | 22 | 0.01 $p<0.878$ | No age co-variate, lipid weight basis |
| BDE-47 | None | Hendrickson Is. | $y=0.029 \times e^{(0.05\ Year)}$ | 5.3 | 0.79 to 10 | 11% | 28 | 16 | 0.48 $p<0.026^{*}$ | No age co-covariate; wet weight basis |
| | None | Pangnirtung | No data available | | | | | | | |
| PFOS | None | Hendrickson Is. | $y=1.39 \times e^{(0.02\ Year)}$ | 1.98 | -0.86 to 4.9 | 7.6% | 48 | 17 | 0.17 $p<0.152$ | No age co-variate; wet weight basis |
| | None | Pangnirtung | $y=11.2 \times e^{(0.0035\ Year)}$ | 0.35 | -3.09 to 3.91 | 14% | 20 | 21 | 0.00 $p<0.812$ | No age co-variate; wet weight basis |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B2 Summary of regression results for representative POPs in polar bear.

| | Co-variate | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Polar Bear** | | | | | | | | | | |
| αHCH | None | West Hudson Bay | $y=5.5x10^{5} \times e^{(-0.08\ Year)}$ | -8.0 | -9.9 to -6.0 | 5.5% | 75% | 15 | 0.85 $p<0.001^{***}$ | No co-variate; lipid basis |
| | None | South Hudson Bay | $y=7.27 \times e^{(0.02\ Year)}$ | 2.2 | -10 to 16 | 28% | 10% | 12 | 0.09 $p<0.629$ | No co-variate; lipid basis |
| *p,p'*-DDE | None | West Hudson Bay | $y=3.8x10^{4} \times e^{(-0.05\ Year)}$ | -5.2 | -8.3 to -2.0 | 8.7% | 38% | 20 | 0.50 $p<0.005^{**}$ | No co-variate; lipid basis |
| | None | South Hudson Bay | $y=1.84 \times e^{(0.04\ Year)}$ | 4.1 | -11 to 22 | 37% | 8.6% | 13 | 0.18 $p<0.484$ | No co-variate; lipid basis |
| PCB 153 | None | West Hudson Bay | $y=257 \times e^{(0.02\ Year)}$ | 1.9 | -1.7 to 5.8 | 9.7% | 32% | 21 | 0.10 $p<0.278$ | No co-variate; lipid basis |
| | None | South Hudson Bay | $y=1.86x10^{6} \times e^{(-0.06\ Year)}$ | -5.9 | -31 to 28 | >99% | 6.1% | 20 | 0.12 $p<0.578$ | No co-variate; lipid basis |
| BDE-47 | None | West Hudson Bay | $y=3.25x10^{-04} \times e^{(0.10\ Year)}$ | 11 | 7.9 to 14 | 6.7% | 58% | 17 | 0.86 $p<0.001^{***}$ | No co-variate; lipid basis |
| | None | South Hudson Bay | $y=9.1x10^{-05} \times e^{(0.12\ Year)}$ | 13 | 1.2 to 26 | 23% | 12% | 11 | 0.81 $p<0.041^{*}$ | No co-variate; lipid basis |
| PFOS | None | West Hudson Bay | Insufficient data | | | | | | | |
| | None | South Hudson Bay | $y=2.5x10^{8} \times e^{(-0.10\ Year)}$ | -10 | -35 to 24 | >99% | 6.0% | 20 | 0.27 $p<0.369$ | No co-variate; wet basis |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B3 Summary of regression results for representative POPs in ringed seal.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ringed Seal** | | | | | | | | | | |
| αHCH | Age | Beaufort | $y=1.05 \times 10^3 \times e^{(-0.02\ Year)}$ | -2.14 | -4.03 to -0.22 | 14% | 19% | 13 | 0.62 $p<0.035^*$ | Age co-variate; lipid weight basis |
| | None | Lancaster Sound | $y=4.9 \times 10^3 \times e^{(-0.04\ Year)}$ | -4.0 | -5.8 to -2.2 | 6.6% | 59% | 21 | 0.57 $p<0.001^{***}$ | No age co-variate; lipid weight basis |
| | Age | Hudson Bay | $y=9.06 \times 10^5 \times e^{(-0.09\ Year)}$ | -8.8 | -17 to -0.29 | 95% | 5.9% | 25 | 0.67 $p<0.046^*$ | Age co-variate; lipid weight basis |
| *p,p'*-DDE | Age | Beaufort | $y=748 \times e^{(-0.01\ Year)}$ | -1.1 | -4.0 to 1.9 | 17% | 15% | 18 | 0.09 $p<0.430$ | Age co-variate; lipid weight basis |
| | None | Lancaster Sound | $y=669 \times e^{(-0.01\ Year)}$ | -1.4 | -2.8 to 0.79 | 5.1% | 81% | 18 | 0.20 $p<0.059$ | No age co-variate; lipid weight basis |
| | Age | Hudson Bay | $y=2.98 \times 10^5 \times e^{(-0.07\ Year)}$ | -6.8 | -12 to -15 | 32% | 8.4% | 22 | 0.62 $p<0.020^*$ | Age co-variate; lipid weight basis |
| PCB 153 | Age | Beaufort | $y=350 \times e^{(-0.01\ Year)}$ | -1.2 | -3.6 to 1.2 | 12% | 24% | 18 | 0.13 $p<0.282$ | Age co-variate; lipid weight basis |
| | Age | Lancaster Sound | $Y=171 \times e^{(-0.01\ Year)}$ | -1.2 | -2.4 to 0.08 | 4.5% | 89% | 16 | 0.21 $p<0.061$ | No age co-variate; lipid weight basis |
| | Age | Hudson Bay | $y=4.47 \times 10^4 \times e^{(-0.06\ Year)}$ | -5.8 | -8.7 to -2.9 | 9.7% | 32% | 19 | 0.63 $p<0.001^{***}$ | Age co-variate; lipid weight basis |
| BDE-47 | Age | Beaufort | $y=7.58 \times 10^{-4} \times e^{(0.08\ Year)}$ | 8.4 | 5.1 to 12 | 18% | 14% | 18 | 0.85 $p<0.001^{***}$ | Age co-variate; lipid weight basis |
| | Age | Lancaster Sound | $y=2.53 \times 10^{-3} \times e^{(0.07\ Year)}$ | 6.7 | 1.3 to 12 | 27% | 9.2% | 31 | 0.44 $p<0.019^*$ | No age co-variate; lipid weight basis |
| | Age | Hudson Bay | $y=132 \times e^{(-0.03\ Year)}$ | -2.6% | -11 to 6.2 | 19% | 13% | 21 | 0.06 $p<0.515$ | Age co-variate; lipid weight basis |
| PFOS | None | Beaufort | $y=0.57 \times e^{(0.03\ Year)}$ | 2.6% | -2.3 to 7.8 | 67% | 6.2% | 26 | 0.27 $p<0.233$ | No age co-variate; wet weight basis |
| | None | Lancaster Sound | $y=310 \times e^{(-0.04\ Year)}$ | -3.5% | -7.9 to 1.1 | 23% | 10% | 29 | 0.23 $p<0.116$ | No age co-variate; wet weight basis |
| | None | Hudson Bay | $Y=3.18 \times 10^6 \times e^{(-0.11\ Year)}$ | -11% | -19 to -1.6 | 21% | 12% | 22 | 0.47 $p<0.027$* | Age co-variate; wet weight basis |

Table B4 Summary of regression results for representative POPs in sea-run Arctic char.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination (r2) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sea run Arctic char** | | | | | | | | | | |
| αHCH | Fork Length | Pond Inlet | $y=1.15x10^{4} \times e^{(-0.06\ Year)}$ | -6.1 | -14 to 2.0 | 66% | 6.2% | 26 | 0.43 p<0.108 | Length corrected; lipid basis |
| | Total Length | Nain | $y=3.97x10^{6} \times e^{(-0.12\ Year)}$ | -11 | -20 to -1.2 | 61% | 6.9% | 16 | 0.81 p<0.041* | Length corrected; lipid basis |
| | Fork Length | Cambridge Bay | $y=7.53x10^{4} \times e^{(-0.08\ Year)}$ | -7.3 | -48 to 64 | >99% | 5.3% | 35 | 0.03 p<0.726 | Length corrected; lipid basis |
| *p,p'*-DDE | Fork Length | Pond Inlet | $y=17.8 \times e^{(-0.01\ Year)}$ | -0.81 | -5.7 to 4.3 | 33% | 8.4% | 19 | 0.03 p<0.694 | Length corrected; lipid basis |
| | Total Length | Nain | $y=35.2 \times e^{(-0.01\ Year)}$ | -0.68 | -16 to 17 | >99% | 5.9% | 21 | 0.01 p<0.871 | Length corrected; lipid basis |
| | Fork Length | Cambridge Bay | $y=3.8x10^{-5} \times e^{(0.12\ Year)}$ | 12% | -6.6 to 34 | 39% | 7.9% | 17 | 0.43 p<0.156 | Length corrected; lipid basis |
| PCB 153 | Fork Length | Pond Inlet | $y=0.58 \times e^{(0.02\ Year)}$ | -1.6 | -3.7 to 7.1 | 35% | 8.1% | 20 | 0.10 p<0.486 | Length corrected; lipid basis |
| | Total Length | Nain | $y=345 \times e^{(-0.03\ Year)}$ | -2.8 | -15 to 11 | 92% | 6.2% | 19 | 0.13 p<0.557 | Length corrected; lipid basis |
| | Fork Length | Cambridge Bay | $y=1.4x10^{14} \times e^{(-0.28\ Year)}$ | -25% | -52 to 17 | >99% | 5.5% | 30 | 0.44 p<0.149 | Length corrected; lipid basis |
| BDE-47 | Fork Length | Pond Inlet | $y=3.2x10^{11} \times e^{(-0.24\ Year)}$ | -21.7 | -54 to 32 | >99% | 5.5% | 30 | 0.29 p<0.266 | Length corrected; lipid basis |
| | Total Length | Nain | Insufficient data for trend analysis | | | | | | | |
| | Fork Length | Cambridge Bay | $Y=124 \times e^{(-0.04\ Year)}$ | -3.6 | -32 to 37 | >99% | 5.8% | 25 | 0.02 p<0.775 | Length corrected; lipid basis |
| PFOS | Fork Length | Pond Inlet | Insufficient data for trend analysis | | | | | | | |
| | Fork Length | Cambridge Bay | Insufficient data for trend analysis | | | | | | | |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Land Locked Arctic char** | | | | | | | | | | |
| αHCH | None | Amituk | $y=9.1x10^{7} \times e^{(-0.15\ Year)}$ | -15% | -17 to -13 | 7.3% | 50% | 15 | 0.95 $p<0.001^{***}$ | No co-variate; lipid basis |
| | Length | Resolute | $y=1.46x10^{4} \times e^{(-0.07\ Year)}$ | -7.1% | -9.7 to -4.4 | 4.2% | 93% | 14 | 0.71 $p<0.001^{***}$ | Length co-variate, lipid basis |
| | None | Char L. | $y=7.24x10^{6} \times e^{(-0.13\ Year)}$ | -13% | -15 to -9.8 | 7.4% | 49% | 15 | 0.90 $p<0.001^{***}$ | No co-variate; lipid basis |
| | Length | L. Hazen | $y=3.9x10^{5} \times e^{(-0.10\ Year)}$ | -9.5% | -12 to -6.6 | 9.0% | 37% | 17 | 0.84 $p<0.001^{***}$ | Length co-variate, lipid basis |
| *p,p'*-DDE | None | Amituk | $y=1.87 \times 10^{5} \times e^{(-0.07\ Year)}$ | -6.5% | -13 to 0.94 | 26% | 9.6% | 30 | 0.28 $p<0.076$ | No co-variate; lipid basis |
| | Length | Resolute | $y=5.63x10^{4} \times e^{(-0.06\ Year)}$ | -6.2% | -13 to 0.83 | 11% | 25% | 25 | 0.22 $p<0.075$ | Length co-variate; lipid basis |
| | None | Char L. | $y=1.75x10^{7} \times e^{(-0.098\ Year)}$ | -9.8% | -14 to -4.9 | 13% | 20% | 21 | 0.65 $p<0.002^{**}$ | No co-variate; lipid basis |
| | None | L. Hazen | $y=9.12x10^{3} \times e^{(-0.06\ Year)}$ | -5.5% | -14 to 3.3 | 30% | 8.5% | 33 | 0.17 $p<0.183$ | No co-variate; lipid basis |
| PCB 153 | None | Amituk | $y=2.37x10^{4} \times e^{(-0.05\ Year)}$ | -5.0% | -8.0 to -1.9 | 9.4% | 34% | 18 | 0.56 $p<0.005^{**}$ | No co-variate; lipid basis |
| | Length | Resolute | $y=1.45x10^{6} \times e^{(-0.08\ Year)}$ | -7.9% | -12 to -3.1 | 7.8% | 45% | 20 | 0.48 $p<0.004^{**}$ | Length co-variate; lipid basis |
| | None | Char L. | $y=3.53x10^{6} \times e^{(-0.086\ Year)}$ | -8.6% | -13 to -4.5 | 11% | 28% | 19 | 0.67 p<0.001*** | No co-variate, lipid basis |
| | None | L. Hazen | $y=1.5x10^{4} \times e^{(-0.06\ Year)}$ | -5.6% | -12 to 1.5 | 24% | 10% | 29 | 0.24 $p<0.105$ | No co-variate; lipid basis |
| BDE-47 | Length | Amituk | $y=1.54x10^{10} \times e^{(-17.7\ Year)}$ | -18% | -32 to -0.46 | 46% | 7.0% | 26 | 0.51 $p<0.045^{*}$ | Length co-variate; lipid basis |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Length | Resolute | $y=8.69x10^{-3} \times e^{(0.07\ Year)}$ | 7.7% | 1.4 to 15 | 9.5% | 33% | 21 | 0.37 p<0.020* | Length co-variate; lipid weight basis |
| | Length | Char L. | $y=3.25x10^{4} \times e^{(-0.06\ Year)}$ | -5.4% | -10 to -0.27 | 11% | 26% | 13 | 0.52 p<0.042* | Length co-variate; lipid weight basis |
| | Length | L. Hazen | $y=2.18x10^{-7} \times e^{(0.15\ Year)}$ | 16% | 5.4 to 27 | 30% | 8.7% | 27 | 0.62 p<0.007** | Length co-variate; lipid weight basis |
| PFOS | Length | Amituk | $y=1.02x10^{4} \times e^{(-0.10\ Year)}$ | -9.5% | -24 to 7.9 | 43% | 9.4% | 10 | 0.75 p<0.140 | Length co-variate; wet weight basis |
| | Length | Char L. | $y=0.13 \times e^{(0.01\ Year)}$ | 1.5% | -0.45 to 3.4 | 10% | 33% | 9 | 0.53 p<0.101 | No co-variate; wet weight basis |
| | Length | L. Hazen | $y=0.85x10^{-15} \times e^{(0.28\ Year)}$ | 32% | -3.8 to 81 | >99% | 5.6% | 26 | 0.72 p<0.070 | Length co-variate; wet weight basis |

Table B5 Summary of regression results for representative POPs in land-locked Arctic char.

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B6 Summary of regression results for representative POPs in burbot.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Burbot** | | | | | | | | | | |
| *a*HCH | Length | Fort Good Hope | $y=3.54x10^{6} \times e^{(-0.13\ Year)}$ | -12 | -17 to -7.9 | 10.0% | 0.29 | 23 | 0.72 $p<0.001^{***}$ | Length co-variate; lipid basis |
| | Total length | Great Slave Lake (W. Basin) | $y=8.3x10^{9} \times e^{(-0.21\ Year)}$ | -19 | -22 to -15 | 8.3% | 41% | 18 | 0.90 $p<0.001^{***}$ | Length co-variate; lipid basis |
| *p,p'*-DDE | Length | Fort Good Hope | $y=15.9 \times e^{(0.01Year)}$ | 1.1 | -6.4 to 9.1 | 10% | 0.15 | 30 | 0.01 $p<0.761$ | Length co-variate; lipid basis |
| | Total length | Great Slave Lake (W. Basin) | $y=1.4x10^{8} \times e^{(-0.15\ Year)}$ | -14 | -19 to -8.4 | 11% | 26% | 21 | 0.73 $p<0.001^{***}$ | Length co-variate; lipid basis |
| PCB 153 | Length | Fort Good Hope | $y=9.65 \times e^{(0.01Year)}$ | 1.1 | -6.5 to 9.4 | 17% | 0.14 | 31 | 0.01 $p<0.753$ | Length co-variate; lipid basis |
| | Total length | Great Slave Lake (W. Basin) | $y=2.32x10^{8} \times e^{(-0.15\ Year)}$ | -14 | -19 to -8.8 | 12% | 24% | 22 | 0.73 $p<0.001^{***}$ | Length co-variate; lipid basis |
| BDE-47 | Length | Fort Good Hope | $y=2.2x10^{-3} \times e^{(0.06\ Year)}$ | 5.8 | 1.9 to 9.9 | 10% | 0.30 | 18 | 0.53 $p<0.007^{**}$ | Length co-variate; wet weight basis |
| | Length | Fort Good Hope | $y=0.04 \times e^{(0.04\ Year)}$ | 4.3 | -2.4 to 11 | 19% | 0.13 | 26 | 0.17 $p<0.187$ | Length co-variate; lipid basis |
| | Total length | Great Slave Lake (W. Basin) | $y=3.15x10^{4} \times e^{(-0.07\ Year)}$ | -7.2 | -35 to 33 | 83% | 6.3% | 18 | 0.13 $p<0.555$ | Length co-variate; lipid basis |
| PFOS | Length | Fort Good Hope | $y=3.96x10^{5} \times e^{(-0.11\ Year)}$ | -11 | -18 to -2.4 | 21% | 0.12 | 22 | 0.52 $p<0.018^{*}$ | Length co-variate; wet weight basis |
| | | Great Slave Lake (W. Basin) | Insufficient data for trend analysis | | | | | | | |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B7 Summary of regression results for representative POPs in lake trout.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Lake trout** | | | | | | | | | | |
| αHCH | Length | L. Laberge | $y=7.58x10^6 \times e^{(-0.13\ Year)}$ | -12 | -17 to -7.0 | 11.0% | 28% | 23 | 0.65 $p<0.001^{***}$ | Length co-variate; lipid basis |
| | Length | L. Kusawa | $y=1.6x10^7 \times e^{(-0.14\ Year)}$ | -13 | -23 to -1.2 | 27% | 9.2% | 37 | 0.32 $p<0.032^{*}$ | Length co-variate; lipid basis |
| | Length | Great Slave L. West Basin | $y=1.16x10^{15} \times e^{(-0.32\ Year)}$ | -28 | -42 to -10 | 53% | 6.5% | 35 | 0.60 $p<0.009^{**}$ | Length co-variate; lipid basis |
| | Length | Great Slave L., East Arm | $y=2.58x10^6 \times e^{(-0.12\ Year)}$ | -11 | -16 to -6.2 | 12% | 24% | 22 | 0.67 $p<0.001^{***}$ | Length co-variate; lipid basis |
| *p,p'*-DDE | Length | L. Laberge | $y=1.83x10^6 \times e^{(-0.11\ Year)}$ | -10 | -19 to -0.15 | 22% | 11% | 35 | 0.27 $p<0.045^{*}$ | Length co-variate; wet basis |
| | Length | L. Kusawa | $y=1.98x10^9 \times e^{(-0.20\ Year)}$ | -18 | -35 to 4.6 | 67% | 6.0% | 56 | 0.21 $p<0.098$ | Length co-variate; wet basis |
| | Length | Great Slave L. West Basin | $y=1.26x10^6 \times e^{(-0.11\ Year)}$ | -11 | -32 to 17 | 70% | 6.0% | 44 | 0.09 $p<0.370$ | Length co-variate; lipid basis |
| | Length | Great Slave L., East Arm | $y=39.3 \times e^{(0.003\ Year)}$ | 0.30 | -14 to 17 | 39% | 7.3% | 41 | 0.00 $p<0.919$ | Length co-variate; lipid basis |
| PCB 153 | Length | L. Laberge | $y=1.01 \times 10^8 \times e^{(-0.005\ Year)}$ | -15 | -22 to -6.7 | 18% | 13% | 32 | 0.53 $p<0.002^{**}$ | Length co-variate; wet basis |
| | Length | L. Kusawa | $y=2.79x10^9 \times e^{(-0.16\ Year)}$ | -15 | -23 to -6 | 21% | 12% | 32 | 0.51 $p<0.004^{**}$ | Length co-variate; lipid basis |
| | Length | Great Slave L. West Basin | $y=1.4x10^9 \times e^{(-0.18\ Year)}$ | -16 | -37 to 10 | 75% | 5.9% | 45 | 0.19 $p<0.177$ | Length co-variate; lipid basis |
| | Length | Great Slave L., East Arm | $y=25.1 \times e^{(0.01\ Year)}$ | 1.1 | -4.3 to 6.8 | 11% | 25% | 21 | 0.02 $p<0.666$ | Length co-variate; lipid basis |

Table B7 (cont'd) Summary of regression results for representative POPs in lake trout.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Lake trout (cont'd)** | | | | | | | | | | |
| BDE-47 | Length | L. Laberge | $y=11.0 \times e^{(-0.01\ Year)}$ | -1.2 | -17 to 18 | 93 | 5.7% | 39 | 0.00 p<0.851 | Length co-variate; wet basis |
| | Length | L. Kusawa | $y=719 \times e^{(-0.06\ Year)}$ | -5.5 | -31 to 29 | >99% | 5.4% | 46 | 0.03 p<0.678 | Length co-variate; wet basis |
| | Length | Great Slave L. West Basin | $y=2.60 \times 10^{6} \times e^{(-0.13\ Year)}$ | -12 | -31 to 13 | 49% | 6.9% | 23 | 0.25 p<0.251 | Length co-variate; lipid basis |
| | Length | Great Slave L., East Arm | $y=140 \times e^{(-0.03\ Year)}$ | -2.5 | -30 to 36 | 77% | 6.0% | 27 | 0.01 p<0.829 | Length co-variate; lipid basis |
| PFOS | Length | L. Laberge | $y=4.72 \times 10^{8} \times e^{(-0.18\ Year)}$ | -16 | -67 to 113 | >99% | 5.1% | 48 | 0.06 p<0.630 | Length co-variate; wet basis |
| | Length | L. Kusawa | $y=1.06 \times 10^{14} \times e^{(-0.30\ Year)}$ | -26 | -49 to 7.7 | >99% | 5.7% | 27 | 0.55 p<0.090 | Length co-variate; wet basis |
| | Length | Great Slave L. West Basin | $y=5.9 \times 10^{7} \times e^{(-0.18\ Year)}$ | -17 | -22 to -11 | 12% | 27% | 9 | 0.94 p<0.002* | Length co-variate; wet weight basis |
| | Length | Great Slave L., East Arm | $y=19.1 \times e^{(-0.04\ Year)}$ | -3.8 | -22 to 19 | 69% | 6.0% | 48 | 0.02 p<0.690 | Length co-variate; wet weight basis |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B8 Summary of regression results for representative POPs in northern fulmar.

| | Co-factor | Location | Equation | Slope (%/y) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seabirds – Northern Fulmar** | | | | | | | | | | |
| *a*HCH | None | Prince Leopold Isl. | $y=5.12 \times e^{(-0.07\ Year)}$ | -6.9 | -9.8 to -3.8 | 16% | 16% | 29 | 0.64 $p<0.001^{***}$ | No co-factors, lipid basis |
| *p,p'*-DDE | None | Prince Leopold Isl. | $y=153 \times e^{(-0.05\ Year)}$ | -4.4 | -5.3 to -3.5 | 4.1% | 94% | 14 | 0.89 $p<0.001^{***}$ | No co-factors, lipid basis |
| PCB 153 | None | Prince Leopold Isl. | $y=36 \times e^{(-0.04\ Year)}$ | -3.8 | -4.7 to -2.9 | 4.2% | 93% | 14 | 0.86 $p<0.001^{***}$ | No co-factors, lipid basis |
| BDE-47 | None | Prince Leopold Isl. | $y=0.23 \times e^{(0.03\ Year)}$ | 2.6 | -0.79 to 6.2 | 15% | 17% | 25 | 0.21 $p<0.117$ | No co-factors, lipid basis |
| PFOS | None | Prince Leopold Isl. | $y=21.3 \times e^{(-0.00\ Year)}$ | -0.01 | -2.1 to 2.1 | 10% | 30% | 18 | 0.00 $p<0.938$ | No co-factors, wet weight basis |

Legend: * - significant at 95%; ** - significant at 99.0%; *** - significant at 99.9%.

Table B9 Summary of regression results for representative POPs in thick-billed murre.

| | Co-factor | Location | Equation | Slope (%) | Slope 95% Confidence Interval | Lowest detectable change in current data | Power to detect 5% change (with current data set) | Number of years required to detect 5% change | Coefficient of determination ($r^2$) | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| **Seabirds – Thick-billed Murre** | | | | | | | | | | |
| aHCH | None | Prince Leopold Isl. | $y=6.13 \times e^{(-0.06\ Year)}$ | -5.4 | -11 to 0.56 | 31% | 8.5% | 45 | 0.21 p<0.069 | No covariate; lipid basis |
| | None | Coats Isl. | $y=4.28 \times 10^3 \times e^{(-0.12\ Year)}$ | -12 | -30 to 11 | >99% | 5.4% | 49 | 0.16 p<0.253 | No covariate; lipid basis |
| *p,p'*-DDE | None | Prince Leopold Isl. | $y=15.2 \times e^{(-0.03\ Year)}$ | -2.8 | -3.8 to -1.7 | 4.4% | 91% | 15 | 0.69 p<0.001 | No covariate; lipid basis |
| | None | Coats Isl. | $y=119 \times e^{(-0.04\ Year)}$ | -4.3 | -7.7 to -0.83 | 10% | 31% | 15 | 0.50 p<0.021 | No covariate; lipid basis |
| PCB 153 | None | Prince Leopold Isl. | $y=4.23 \times e^{(-0.03\ Year)}$ | -3.1 | -4.1 to -2.1 | 4.3% | 92% | 15 | 0.74 p<0.001 | No covariate; lipid basis |
| | None | Coats Isl. | $y=29.7 \times e^{(-0.05\ Year)}$ | -4.6 | -6.8 to -2.4 | 6.4% | 62% | 12 | 0.73 p<0.002 | No covariate; lipid basis |
| BDE-47 | None | Prince Leopold Isl. | $y=0.63 \times e^{(0.02\ Year)}$ | 2.4 | -0.37 to 5.2 | 12% | 24% | 22 | 0.25 p<0.081 | No covariate; lipid basis |
| | None | Coats Isl. | $y=2.7 \times 10^3 \times e^{(-0.05\ Year)}$ | -5.0 | -11 to 1.7 | 27% | 9.5% | 20 | 0.36 p<0.112 | No covariate; lipid basis |
| PFOS | None | Prince Leopold Isl. | $y=34.2 \times e^{(-0.01\ Year)}$ | -0.51 | -2.9 to 2.0 | 12% | 23% | 20 | 0.02 p<0.659 | No covariate; wet basis |
| | None | Coats Isl. | No data available | | | | | | | |