On Thin Ice: Comparing the Consistency of Highly Regarded Canadian Arctic Ringed Seal Population Studies

Written by Kacy Wycoff

Edited by Felicity Guajardo
Reviewed by Dr. Richard Dixon

As global warming has continued to affect the planet's biosphere, the future of vital organisms in the most vulnerable ecosystems has become less certain. The Canadian Arctic, one of the most susceptible regions to climate change, has experienced hundreds of primary and secondary populations becoming extinct or endangered as a result of warming temperatures and depleting sea ice. This article examines the results of two different investigations into the population density of ringed seals, Phoca (Pusa) hispida, an essential organism in the Arctic marine food web, as related to sea ice concentration. Each set of results was aligned with daily Arctic sea ice concentration satellite images from the National Snow and Ice Data Center to determine the credibility and accuracy of each article's findings. It is concluded that the articles share similar results with each other and with the NSIDC, though large lapses in time and restrictive season-based methodology prevent concrete conclusions to be made regarding reliability. These results provide a further outlook on the importance of source reliability and relevance.

Introduction:

In November of 2022, COP27, a worldwide climate change conference held by the United Nations, included a "biodiversity day," in which matters were discussed regarding the loss of animals and other organisms across the planet (COP27 2022). With many believing that protecting biodiversity would be directly correlated to protecting the Paris Agreement, the concept of protecting vital species became a new priority for the organization. As more extreme temperatures and weather events make their way into the biosphere because of climate change, the loss of these organisms becomes a greater concern for the future of the planet. The Arctic Ocean, serving as the life source for much of Canada and neighboring countries, has seen stark changes to its environment, including declining sea ice cover, acidification of water, and rapidly warming temperatures (Buchart et al. 2022; Chambellant et al. 2012; Ferguson et al. 2012; Glissenaar et al. 2021; Pernov et al. 2022; Ready, E., and P. Collings 2021; Young et al. 2014). These developments have seriously threatened many of the ocean's marine organisms and, in turn, have led to more issues for the environment in a positive feedback loop.

For example, the ringed seal (*Phoca (Pusa) hispida)* is the most abundant marine animal in the Canadian Arctic and serves as an important species for the marine food web (Born et al. 2004; Chambellant et al. 2012; COSEWIC 2020; Reeves 1998; Winsnes 2022; Young et al. 2014). The species is pagophilic, meaning that they require ice to live, and further, need very specific conditions of ice in order to thrive (COSEWIC 2020). Regions in the Canadian Arctic with abundant sea ice have seen sharp declines in the total amount and distribution of ice cover, which creates risks for ringed seals relying on ice cover.

Researchers studying sea ice concentration in the Canadian Arctic have utilized a wide variety of study methods with some overlapping techniques being used over the years. Observing the median levels of sea ice requires data to be collected over an extended period of time in order to find patterns or relationships that can help to draw results. Posdaljian et al. (2022) employed the use of 18 different recording devices all positioned at the same point on Baffin Bay from 2015 to 2019, which then recorded the concentration of sea ice within a 20km radius of their positions. N. Steiner et al. (2015) used a similar long-term method of gathering data from coupled ocean and sea ice models released 1977-1990 and 2000-2010 to determine sea ice concentrations. Though these methods were able to provide year-round information regarding sea ice, they suffered from limiting spatial barriers, as seen in the Posdaljian et al. (2022) study that failed to provide data outside of the radius of the recording sites. Some scholars have faced barriers in their research as seasonal fluctuations in weather and climate put restrictions on data-collecting methods like marine-based devices that are only able to capture data in temperate months. Zweng et al. (2006) used data from The U.S. National Oceanographic Data Center to find warming rates of Baffin Bay from the 1950s on, though estimates were only captured in the months of July, August, and September. Lapses in full-scale temporal analysis cause insufficient confidence in the results of the research and create a wide space for inferences to be made regarding the remaining months of the year.

The results of research completed by scholars regarding sea ice concentration have also formed similarities in future projections of sea ice density. Kwok et al. (2020) concluded through three different datasets that 50% of former multi-year ice regions in the Canadian Arctic have now been labeled as seasonal ice regions, seeing less consistent ice per year. The N. Steiner et al. (2015) study used similar methods of multi-source analyzation by using multiple Representative Concentration Pathways to conclude a 13.8% decrease in sea ice concentration within Baffin Bay from 2005 to 2017, further supporting the previously found decline from the Kwok et al. (2020) research.

The relations between sea ice concentration and ringed seal population in the Arctic have been researched through a variety of methods as well. There has been great reliance on tracking marine populations through aerial observation as shown in the Chambellant et al. (2012) study. In doing so, scholars used data from aerial surveys completed in three different time periods, from 1995–1997, 1999–2000, and 2007–2008 to take note of the number of ringed and bearded seals in the Canadian Arctic. A Young et al. (2014) study, similar to the Chambellant study, utilized aerial surveys in their data gathering. The Argos satellite system was used to detect the movement and spatial distribution of ringed seals spotted in the Canadian Arctic over a period of 18 years which helped researchers to draw conclusions on the number of seals present in the area. Similar to the lapses in time seen in the research of sea ice concentration in Baffin Bay, there is a large gap in data offered for months of the year outside of spring and summer months. The Chambellant et al. (2012) and Young et al. (2014) studies have both been extensively referenced in research regarding ringed seal populations in the Canadian Arctic. Though their influence has continued to remain relevant in the field, their results have yet to be cross-referenced with reliable year-round data on sea ice concentration, therefore raising questions regarding the reliability of the sources themselves. By utilizing archived daily sea ice concentration data from the National Snow and Ice Data Center (NSIDC), the results found in each study can be compared to those found from NASA satellites which serves as a form of comparison between the two studies. Implementing this technique of temporal analysis allowed gaps in time to be filled with information that supports the claims made in this research.

Methods:

The methods implemented for this research employed both quantitative and qualitative analyses of reputable datasets. Information regarding sea ice concentration was gathered from The NSIDC archives to include a primary source of information with data relevant to the study (NSIDC 2022). The NSIDC uses NASA satellites to produce daily images of sea ice distribution in the Canadian Arctic (NSIDC 2022). As of now, the organization is the first of its kind to include data on such a small scale and is, therefore, the most reliable source for this information given the temporal and technological advances that it provides.

In the analysis of the spatial distribution of ringed seals, two of the most referenced and highly regarded studies on the species were consulted, those being the Chambellant et al. 2012 study and the Young et al. 2014 study. Through gathering data on the number of times each article was referenced was recorded it was found that the two articles were referenced by nearly 75 percent of all articles, journals, and websites that researched ringed seal populations in the Canadian Arctic. In both referenced studies, the population density of ringed seals was consistently kept as the main focus and surveys were completed in the spring and summer months (Chambellant et al. 2012; Young et al. 2014). Each study provided their results in the form of charts with some distributional maps of Hudson Bay used to visualize their findings. In this study, the two articles' results regarding ringed seal population density were input into Microsoft Excel. A line graph was then created with this data representing the shared results. The results of the referenced two studies were compared with the NSIDC's daily sea ice concentration measurements to determine the overlap of the ringed seal population and sea ice concentration at the time the data were collected.

Results:

The comparison of Chambellant et al. (2012) and Young et al. (2014) ringed seal density findings revealed an almost identical correlation in numbers, with slight variability in 1995 and 1997. As Figure 1 shows, the Young et al. (2014) study conducted three more recent surveys in 2009, 2010, and 2011, as opposed to the Chambellant et al. (2012) study which ended in 2008.

To create a three-variable bar graph, sea ice concentration data found through the NSIDC NASA satellite database were used. Nimbus SMMR and SSM/I-SSMIS satellite images from the NSIDC database provided rounded averages for the percentage of sea ice in the Hudson Bay area, which created the reference point for the additional two sources to be compared to. Sea ice concentration data as provided by the

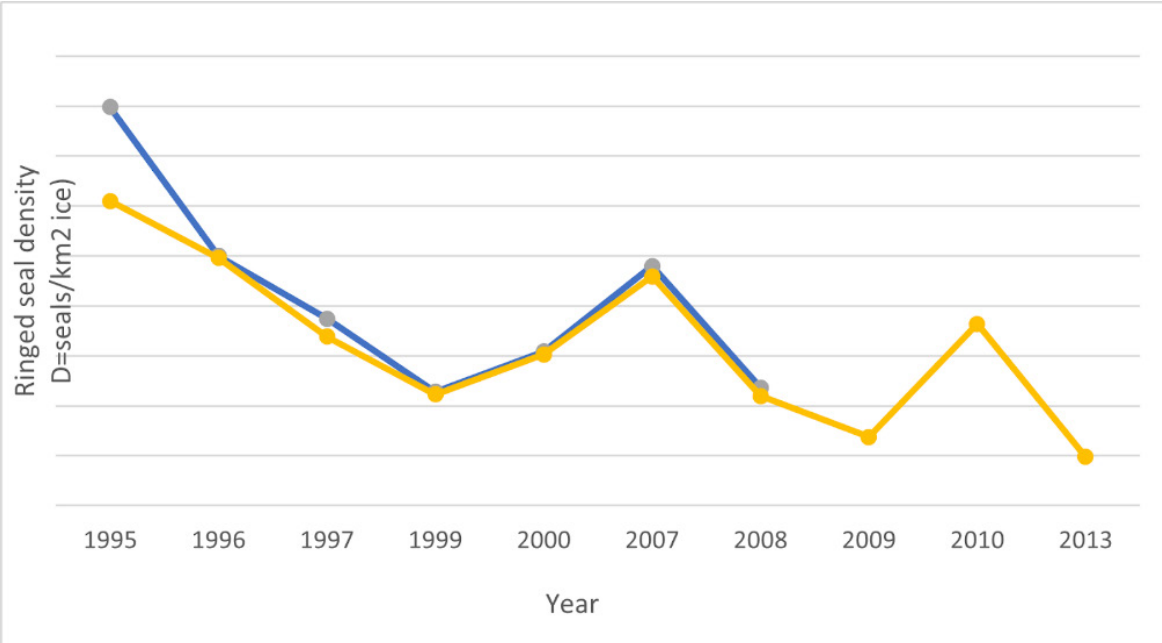

Figure 1 *Ringed Seal Density per Year Recorded*

Note. Ringed seal (Pusa hispida) density (D=seals/km2 ice) results from Chambellant et al. (2012) and Young et al. (2014) studies for all years that surveys were recorded.

Chambellant et al. (2012) and Young et al. (2014) studies were input into this dataset along with sea ice concentration data from the Nimbus satellites. All three data sources shared similar results in sea ice coverage as shown in Figure 2, with the NSIDC finding higher percentages in 1995 and 2009.

Discussion:

Figure 1 reveals the highest spike seen in ringed seal density between 1999 and 2007, with another similar rise in density between 2009 and 2010. For all survey years, results remained consistent with one another and formed a correlation between the Chambellant et al. (2012) and Young et al. (2014) studies. Reasons for this strong association could be attributed to the identical geographic location, data collection during the same season, and similar methodology with which each survey was completed (Chambellant et al. 2012; Young et al. 2014). Significant deviations in results between the two studies were infrequent, with only two evident disagreements in 1995 and 1997 (Figure 1), possibly due to harsher weather in the Arctic for these years (Chambellant et al. 2012; Higdon, J.W., and S.H. Ferguson 2009; Luque et al. 2014; Posdaljian et al. 2022; Steiner et al. 2015; Young et al. 2014). In verifying the accuracy of ringed seal density based on sea ice concentration, results were compared to data from the NSIDC satellite projections. Daily images taken from the Nimbus SMMR and SSM/I-SSMIS satellites

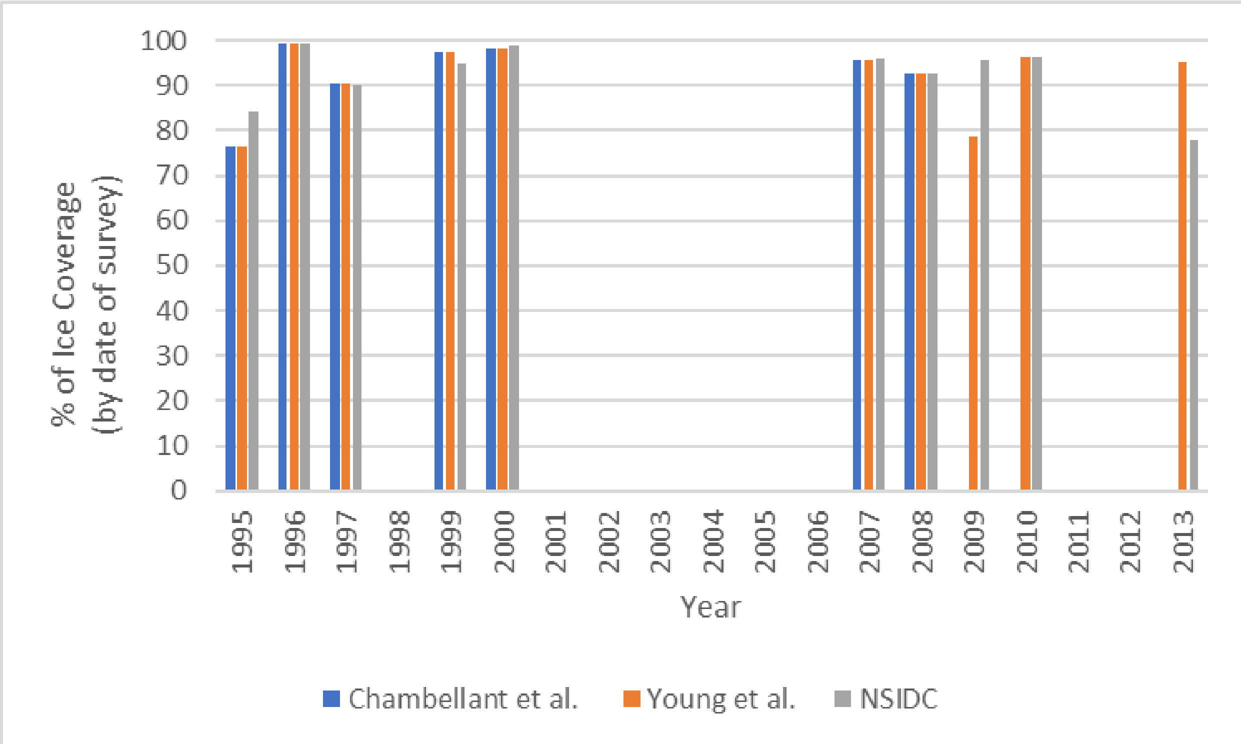

Figure 2 *Sea Ice Concentration per Year Recorded*

Note. Percent of ice coverage by date of survey for Chambellant et al. (2012), Young et al. (2014), and NSIDC Nimbus 7 SMMR and SSM/I-SSMIS results (NASA).

averaged consistent percentages that related strongly with those from Chambellant et al. (2012) and Young et al. (2014). Figure 2 displays this relationship, with significant differences in sea ice concentration for the years 1995, 2009, and 2013. Regardless of these inconsistencies, a nearly 65 percent similarity score was calculated through the analysis of all sea ice concentration levels to build credibility in the Chambellant et al. (2012) and Young et al. (2014) results. Further, the comparison of these studies to a hyper temporal-specific database such as the NSIDC contributes to the reliability of the results and verifies their authenticity.

Results in Arctic marine life research vary based upon the methods utilized, though there is a general consensus that larger Arctic marine animals tend to be sighted more frequently when ice concentrations are low (Born et al. 2004; Chambellant et. al 2012; COSEWIC 2020; Higdon, J.W., and S.H. Ferguson 2009; Luque et al. 2014; Reeves 1998; Wenzel, G. W. 2009; Seguin et al. 2022). This negative correlation between sea ice concentrations and large Arctic marine animal sightings is supported by many arctic sea ice concentration researchers and government databases alike (Luque et al. 2014; Chambellant et al. 2012; Ferguson et al. 2012; NSIDC 2022; Posdaljian et al. 2022; Steiner et al. 2015). According to these sources, spring and summer months have the lowest concentrations of sea ice. Both the Chambellant et al. (2012) study and the Young et al. (2014) study sought to support the hypothesis that sea ice concentrations are negatively correlated with ringed seal populations. this notion. Low sea ice concentrations in 1995 seem to correlate with increased ringed seal populations (Figure 2), which supports the notion of a negative correlation between the two variables. Surveys completed in the following years generally continue to justify this correlation as increases in sea ice concentration lead to lower populations of ringed seals, though data from 2007 and 2010 display the opposite. Figure 2 provides evidence of consistent sea ice concentration levels for both years, whereas data from Figure 1 displays sharp increases in the number of ringed seal populations. This discrepancy raises questions regarding the consistency of ringed seal surveys completed by both Chambellant et al. (2012) and Young et al. (2014). This discrepancy could be attributed to multiple issues such as weather interference or inconsistencies in the survey equipment used. Despite these variabilities, the generally strong relationship in results from all three sets of data as shown in Figure 2 affirms the reliability of the Chambellant et al. (2012) and Young et al. (2014) studies.

In formulating research, it is vital to ensure that the sources used are accurate and comparable to other forms of reputable information. Results from this study supported the reliance on the 2012 Chambellant et al. (2012) and Young et al. (2014) studies through multiple strong correlations in information and comparisons to an outside reputable government database, the NSIDC. Multiple limitations, however, prevented strong conclusions being made from this research. Despite accurate data, missing surveys for 2009, 2010, and 2013 from the 2012 Chambellant et al. (2012) study created a large gap in the data and decreased the reliance on the results. Further, restricting surveys to only spring and summer months failed to provide data for year-round ringed seal populations. Including these factors in future research attempts on the matter may result in more certain results, though it may be difficult to do so due to weather patterns commonly placing constraints on marine research (Chambellant et al. 2012; Higdon, J.W., and S.H. Ferguson 2009; Luque et al. 2014; Posdaljian et al. 2022; Steiner et al. 2015; Young et al. 2014). Though the molting and reproductive phases of ringed seals take place in the late spring and early summer months, completing surveys during all calendar months can help to reveal unknown patterns in the distribution of ringed seals outside of the normal observation periods (Chambellant et al. 2012; Luque et al. 2014; Moreland et al. 2013; Young et al. 2014). Performing surveys of all months could provide more opportunity for research to be completed analyzing population patterns during times that are typically overlooked by researchers.

Completing this research provided the opportunity to view heavily referenced resources in a new light. Recognizing the limitations of the studies analyzed helped to show new considerations for future research choosing to investigate areas with similar climate conditions as the Canadian Arctic. Though the results of this research did not provide the opportunity for a concrete conclusion, the information gathered has illuminated more gaps to be filled through the ethical and informed gathering of data. Cross-examining sources rather than relying solely on their results can show contradictions to information and may extend the opportunities of future research projects. Cross-examining sources will expand the world of research and put emphasis on maintaining a transparent and trustworthy dataset available to the public for further use.

Future research endeavors should consider the use of weatherproofed satellites similar to the Nimbus 7 SMMR used by the NSIDC for the measuring of sea ice concentration. Doing so will not only provide more accurate year-round results but will also create an easier form of data collection so that researchers will not be required to participate in aerial surveying. This is not to say that aerial surveying should be entirely phased out, however, as it can provide another step to the result confirmation process by comparing the outcomes of the satellite surveys to those from alternate forms of data collection. Acquiring new data in this field of study will allow awareness to be spread regarding sea ice concentration in some of the world's most sensitive marine environments. Putting focus on this will hopefully create new opportunities for researchers to gain a better understanding of marine life and ecosystem health.

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