HISTORICAL ECOLOGY AND SHIFTING BASELINE SYNDROME IN THE KAWARTHA LAKES, ONTARIO

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Abstract

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Archaeological faunal data, historic records and documents and recent biological data are used to construct a historical ecology for Pigeon Lake, Ontario, focusing on fish exploitation. The faunal collections of twelve archaeological sites in the Kawartha Lakes are reviewed to examine pre-contact Indigenous fishing trends and comment on the historic presence, abundance and range of a number of indigenous fish species. A review of historic documents outlines environmental, industrial, and social changes that have played a role in changing the community structure of fish species in Pigeon Lake since the arrival of European settlers in the area. Additionally, interviews were undertaken with local anglers to explore evidence of shifting baseline syndrome (SBS) in modern populations. Finally, statistical tests were performed on the interview data to explore evidence of SBS, and found that SBS is effecting modern anglers perception of ecological change in Pigeon Lake.

Key Words: Historical Ecology, Ontario Archaeology, Kawartha Lakes, Shifting Baseline Syndrome, Fish Exploitation, Ecological Baselines, Environmental Archaeology

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Chapter 1: Introduction

1.1 Context

The relationship between culture and the environment is a primary focus of archaeological inquiry in North America. Each system affects the other in profound ways and the state of one can often be dependent on the other. Environmental factors have been shown to influence cultural behaviour, and cultural behaviour can also cause changes in the environment. In some cases these changes are premeditated and purposefully carried out with the intention of expanding humans' niche within the ecosystem (Smith 2009), while in other cases they may be the unintentional outcomes of other anthropogenic processes (Boivin et al. 2016). In a great deal of the world these changes have occurred over tens of thousands of years, and determining ecological baselines absent of anthropogenic modification is difficult. In North America, however, large-scale cultural modification of the environment was rare prior to the arrival of Europeans, most has largely taken place over the last two hundred years, and is relatively well documented.

During the early years of European colonization, the relationship between the settlers and the environment was one of large scale exploitation; forests were rapidly cleared for fuel, lumber and farming, the land was mined for its mineral wealth, the rivers were dammed to supply power to mills, and the wildlife was hunted for their furs or to provide nourishment for the droves of colonists arriving to tame their own plot of this vast wilderness. The effects of these rapid, large-scale environmental alterations are most evident in the changes in the wildlife that have occurred since European arrival. Early European settlers marvelled at the relatively unspoilt wilderness, and most of all at the abundance of wildlife. Louis Nicolas an early Jesuit missionary in 1664 wrote "The

amazing thing seen in the…New World concerning eels has made me resolve to tell you that there are so many of them that it is a miracle, or rather a marvelous divine providence" (Gagnon 2011) and the explorer Réne Bréhant de Galinée, wrote that in 1669 he encountered "[Rapids] so teeming with…whitefish…that the Indians could easily catch enough to feed 10,000 men" (Coyne 1903)

There is little question that before the arrival of Europeans and the subsequent changes to the environment, most of Ontario's Indigenous inhabitants extensively exploited fish. Some of the earliest archaeological sites in Ontario show evidence of fishing (Rostlund 1952). It is also evident that Indigenous peoples discovered that the environment could be modified to aid in the capture of fish. During his travels Champlain wrote of the fish weirs at Atherly narrows between lakes Simcoe and Couchiching which he described as "a large number of stakes which almost close the strait, only some little openings being left where they place their nets, in which the fish are caught" (Champlain 1882). The inundated structures still exist today and archaeological investigation has dated them to at least the Laurentian Archaic period, approximately 5500-4500 BP (Johnson & Cassavoy 1978, Ellis et al. 1990).

While it is clear that indigenous groups have exploited fish over thousands of years in Ontario, there has been a marked collapse in fish populations since the arrival of Europeans. Lake Ontario and its tributaries were brimming with Atlantic salmon (Guiry et al. 2016), American eel (Riley 2014), herring (Christie 1973) and sturgeon (Golder 2011, Harkness & Dymond 1961), all of which were pushed to the brink of extinction shortly after the arrival of Europeans due to overexploitation (Christie 1973). In addition, environmental changes brought upon by European development and industry exacerbated and caused further changes in fish species diversity, abundance and range. For example,

the blocking of American eel migrations has been attributed to the damming of the St. Lawrence River, and has slowed the recovery of eel populations in Lake Ontario (MacGregor 2009).

The goals of this thesis are to review these types of settler-caused impacts and changes, and to construct a historical ecology for the fish species in Pigeon Lake. In doing so, this thesis forms a critical review of archaeological data, historical documents and recent biological data, and explores historic patterns in fish species presence, abundance, composition, range, and exploitation by humans.

Additionally, this research seeks to explore the presence of Shifting Baseline Syndrome (SBS) in modern angler populations at Pigeon Lake, Ontario through a series of semi-structured interviews and statistical analysis. SBS is a psychosocial phenomenon responsible for altering individuals' perception of ecological changes (Pauly 1995). It occurs when individual perceptions of ecological baselines are formulated based on personal experience rather than ecological data or the experience of older generations. This results in the perpetual updating of individual perception of ecological baselines, and as such is of primary concern to those involved in ecological restoration efforts.

1.2 Thesis Structure

Chapter two begins by providing a review of recent literature relating to the study of shifting baseline syndrome, and outlines the criteria that must be met in order to confirm its existence. It then moves on to a review of the archaeological evidence for pre-contact Indigenous fishing in Ontario and the methods used, and inherent problems involved in archaeological faunal examination. The chapter concludes with a brief overview of archaeological evidence of fishing in Ontario.

Chapter three discusses the effects of European colonization on the ecosystem around Pigeon Lake. It opens with a brief history of the settlement in the area, before moving onto a review of early settler accounts relating to fish and fishing. Modification of the waterways, such as the raising of water levels, the damming of rivers and linking of isolated watersheds is addressed, as well as changes in land use in the area around Pigeon Lake, and the ways that these changes may have effected the fish populations. This chapter also reviews historical, social, and political factors that may have influenced fish exploitation, such as commercial fishing, tourism, shoreline development, and government control of the resource through licencing, limits on catch, fish stocking, and regulation of Indigenous fishing.

Chapter four provides a brief summary of the biology, behaviour, and relationship with humans for each fish species present in Pigeon Lake, and also seeks to establish the origins of introduced species. Additionally, it provides further information relating to the historic range, abundance, and species diversity for fish in Pigeon Lake, and also social factors relating to fish exploitation since the arrival of European settlers.

Chapter five seeks to further extend our knowledge of the exploitation of past fish populations in the Kawartha Lakes through a review and critical assessment of the faunal collection from eleven archaeological sites in the Kawartha Lakes. It examines patterns in fish taxa presence and abundance and makes inferences based on the collections regarding their exploitation by pre-contact Indigenous communities.

Chapter six outlines the methods applied for the examination of shifting baseline syndrome in modern angler populations at Pigeon Lake. It begins with a description of the survey questions and methodology and explains how the data was then interpreted and assigned numeric values for statistical analysis, and also describes the statistical tests

used. The chapter contains a brief description of the survey methods used by the Ontario Ministry of Natural Resources and Forestry to assess fish communities at Pigeon Lake, and summarizes the results of these tests. Furthermore, the hypothesis that angler behaviour operates in a manner similar to anthropological foraging theory is explored through statistical analysis of creel survey data, and OMNRF net survey data. Through a comparison of the statistical data obtained from the interviews and the biological data collected by the OMNRF, it concludes that SBS, in terms of changes in the fish community, is present in angler populations at Pigeon Lake.

Finally, chapter seven discusses the conclusions of the research and discusses the implications of these findings. It concludes by suggesting future avenues of research related to the topic of historical ecology and shifting baseline syndrome.

Chapter 2: Shifting Baseline Syndrome and Archeological Fishing

2.1 Shifting Baseline Syndrome

Globally, we are in the midst of rapid ecological changes that will pose significant challenges to both the human race, and the ecosystems we interact with. To measure ecological change researchers typically compare current conditions to past conditions, referring to remnant landscapes that closely resemble past ecological conditions in a given area as a source for attaining historical ecological data. This technique is referred to as space-for-time substitution, but is problematic in that it treats environments as static entities when in reality they are quite dynamic. To address this problem, researchers often approach the study of past ecosystems by using a concept called historical range of variability, determined by back-casting, a mathematical modeling technique that uses current demographic data in different types of environments to estimate past populations (Wiersma 2011). In environments that are considered to have been significantly altered, ecologists often utilize a method called sensitivity analysis that simulates inter-annual variation in survivability and reproduction through time to show the variation in baseline estimates and arrive at a probable range of values for baseline populations (Wiersma 2011). Recent efforts have been made to assess environmental change through an examination of human perceptions of change (Fernandez Llamazeres et. al 2015, Patt & Schroeder 2008, Turvey 2010), however, this can be problematic as the environmental baseline one uses to measure changes is likely to not accurately represent the environmental 'starting point', but rather their own personal perception of it. This condition is known as Shifting Baseline Syndrome.

The term Shifting Baseline Syndrome (SBS) was first coined in 1995 in a paper by Pauly, when he made the observation that each successive generation of researchers tends to accept the species composition and stock size that was present at the beginning of their careers as a baseline against which to evaluate changes. The next generation does the same, resulting in an accommodating of the gradual disappearance of species as well as providing inappropriate reference points for evaluating ecological data. The same year Kahn and Friedman (1995) also suggested this phenomenon as a possible explanation for the results of their research assessing the degree to which economically impoverished inner-city children consider their environment degraded, and the extent of their awareness of environmental issues. They observed a much lower incidence of children calling their environment degraded than they had expected, suggesting that despite the environmental degradation that was obvious to the authors, the children saw their environment as normal. Instead of SBS, however, they called the phenomenon *Generational Amnesia*.

Papworth et al. (2009) consider that two different phenomena should be incorporated into SBS, as it is currently understood: *Generational Amnesia*, which occurs due to newer generations not having knowledge about past conditions, and *Personal Amnesia*, where an individual forgets their own experiences thus altering their own perception of past conditions. Generational amnesia often occurs in situations where there is scarce intergenerational communication resulting in less transfer of local ecological knowledge from older to younger generations. As a result, younger generations tend to assess environmental change based on their own experiences. It is important to note that SBS differs from the typical use of shifting baseline in that they are referring to human perception of change rather than the change itself.

Hayashida (2005) outlines three cases that show evidence of shifting human

perceptions of ecosystems. The first is a study of grassland decline in Sweden attributed to lack of anthropogenic burning and herd grazing. In this case the forest is retaking much of the grassland, as what was assumed to be a natural landscape of vast grasslands was actually a constructed landscape that had been modified by humans for thousands of years, and required anthropogenic intervention to be maintained. The next case discussed by Hayashida is about the Solomon Islands. Upon the arrival of Europeans many of the Indigenous people moved to the coastal regions from the interior of the islands. This resulted in the abandonment of the interior, an area that had been heavily modified by the indigenous people. This in turn resulted in a natural reforestation of the interior of the islands. Within 200 years all memory of anthropogenic modification of the interior ecosystem had been forgotten, and the area was assumed to be a pristine forest until archaeological research showed otherwise. The final example is of the Lowland Maya, where large-scale deforestation occurred, then within a short time was allowed to grow back, however, with a much different composition of taxa (Hayashida 2005).

A more recent example is the study by McCune et al. (2013) who discuss an ecosystem on Vancouver Island called Garry Oak Savannah that was experiencing rapid decline due to urban sprawl around Victoria. Conservation efforts were undertaken to protect the remaining patches of the Garry Oak Savannah ecosystem and a number of areas featuring the characteristics of this unique landscape were declared protected. The issue is that when the areas were allowed to re-naturalize, it became apparent that they were not going to remain Garry Oak Savannah without human interference and maintenance. This was due to the Garry Oak Savannah ecosystem only existing as a result of hundreds of years of ecosystem maintenance, namely small scale burning, by local First Nations. In this case, despite being heavily anthropogenically modified in the past, it

came to be perceived by current residents as the ‘natural state’ of the ecosystem.

Another recent example is a 2014 study by McKechnie et al. that examined archeological data spanning the past 10,000 years from Washington State to southern Alaska to better understand the natural baseline for herring populations, and to show the effects of modern commercial fisheries on herring populations. Over the last century, Pacific herring populations have declined in abundance over much of their range. Modern herring populations can be irregular and sometimes experience catastrophic declines, however, McKechnie et al. found that the archaeological record indicates a pattern of consistent abundance. They reject the hypothesis that archaeological data over estimates abundance and downplays variability, and interpret these findings as direct evidence of the effects of commercial fishing and industrial harvesting (McKechnie et al. 2014). This is consistent with the earlier findings of a study by Thomas Thornton (2010) that examined local and traditional knowledge through ethnographic research and interviews with Tlingit fishermen in the area relating to decreasing herring populations and variability attributed to commercial fishing.

There have been relatively few studies dealing with shifting baseline syndrome since the term was first coined in Pauly’s 1995 paper. As such there is little literature on which to base a conceptual framework for studying its existence. Earlier studies in SBS such as that of Ainsworth et al. (2008) and Saenz Arroyo et al. (2005) aimed to show that there are age related differences in the perception of ecological baselines. Saenz Arroyo et al. (2005) conducted surveys with three generations of fishers from Gulf of California to investigate how their perceptions of environmental baselines are shifting. They found that compared to younger respondents, older fishers named “five times as many species and

four times as many fishing sites as once being abundant/productive but now depleted" (Saenz Arroyo et al. 2005). Ainsworth et al. (2008) conducted a similar study in eastern Indonesia and also came to the conclusion that older fishers reported larger catches in their childhood than in modern times. Despite both these studies' findings, that reported fish catches differed by age group, they both make the assumption that fish stocks have been in steady decline without referencing ecological data.

Papworth et al. (2009) note that in addition to age related differences in perception of environmental change, an observed environmental change must be confirmed through examination of biological data. In two of the three cases presented in their paper, evidence of shifting baseline syndrome cannot be proven as they lack the biological data to show consistency between individual perception and actual ecosystem change, however, in the final study the biological data exists to confirm shifting baseline syndrome in bird watchers in the UK.

A similar study by Ulman and Pauly (2016) documented the degree of changes in the coastal fisheries in the Bosphorous Straight, both in terms of measured catch per unit effort and perceived change in resource abundance, and compared the responses by age of respondent. If the changes in both perceived and measured catch were significant over time, and not noticed by younger fishers, then SBS is likely present. They found that in most cases, more experienced fishers noted more significant changes in both measures of resource productivity than those with less experience. Moreover, those with fewer than two years of experience were largely unaware of changes in the ecosystem and reported satisfaction with their catches. Fernandez Llamazeres et al. (2015) propose that to prove the existence of shifting baseline syndrome, in addition to the conditions outlined by

Papworth et al, scarce intergenerational transfer of knowledge must also be shown. Their research found evidence of shifting baseline syndrome, including scarce intergenerational transmission of knowledge, in an Indigenous group in the Bolivian rainforest, however it was limited by a lack of detailed biological data.

It is important to note that while anthropogenic modification is typically thought to decrease biodiversity and species abundance, this is not always the case; Steen and Jachowski (2012) argue that Shifting Baseline Syndrome can also be applied to overabundant representation of some species. Examples of anthropogenic activity that increases the number of certain species include removal of predators and the resulting spike in prey species, establishment of exotic or invasive species, and increases in species that are habitat generalists in response to the reduction of specific habitats. The authors note that shifting perceptions of reference conditions may erode public support for ecological restoration programs, thus our conceptualization of shifting baseline syndrome should consider that anthropogenic activity can play a more complicated role in an ecosystem than simply a decrease in species abundance and diversity. This phenomenon is supported by a recent example where researchers found that despite an overall decrease in catch per unit effort of nearly 400% from 1967 to 2010 in the coastal region of the Bosphorous Straight, fishers practicing purse-siene netting did not experience significant declines due to an increase in small species brought on by a decline in predator species (Ulman & Pauly 2016).

Shifting Baseline Syndrome can contribute to problems in ecological restoration efforts by changing human perceptions of the environment, and thus altering restoration goals. Wu (2011) discusses a case in which efforts are being made to curb the frequency

of high intensity forest fires in Ponderosa Pine forests in the SW United States. Historically, the pine forests were less dense due to frequent low intensity burning. Since the arrival of Europeans, burning has been discouraged and the forest became much more dense than it was naturally. Current local residents who were accustomed to this type of dense forest had a difficult time accepting that it was not natural, and were actively opposed to efforts to thin out the vegetation. In this case the public misunderstood the ecological history of the region due to shifting baseline syndrome, hindering ecological restoration efforts. Another example is discussed by Leather et al., (2010) in which a community in Scotland was opposed to the planting of a municipal forest, stating that it would ruin dog walking areas and scenery. Fifty years later when it came time to harvest the forest, the community was again upset, but this time because cutting the forest down would ruin the scenery and dog walking areas. In this case a lack of intergenerational knowledge still exists despite the increased access to references available to current generations.

Archaeological data can be particularly useful in countering the effects of shifting baseline syndrome on ecological restoration efforts as it allows for significant time depth in researching human-ecosystem interaction. Most ecological studies span only decades, at most, and fail to take into account the fact that the ecosystems have often been significantly modified by anthropogenic activities for centuries. Rick and Lockwood (2013) use a case study of the eastern oyster fishery in Chesapeake Bay to show how researchers can integrate approaches with different temporal scales of study to provide a fuller picture of the changes in the ecosystem over time, and the effects that external factors such as environmental change and anthropogenic exploitation can have on animal populations. Human activity such as fishing can have long lasting impacts on ecosystem

trajectories, therefore knowledge of past human impacts is important for setting restoration goals and also distinguishing natural processes from those that are anthropogenically driven. In a 2016 article, Barak et al. discuss ways that researchers can use contemporary analogy, paleoecological data, historical research and archaeological artifacts, plant and animal remains, and physical and chemical data to inform ecological restoration goals.

Fish abundance and species diversity and range is subject to major transformations over time, a trend that was hastened in areas subject to colonial settler development, such as the Americas. This suggests that in these rapidly changing ecosystems, individuals may be particularly susceptible to the effects of SBS. The focus of the remainder of this chapter is to examine how these trends can be observed in the deep past through the incorporation of archaeological data on fishing practices.

2.2 Fishing in the Archaeological Record

For periods for which we have no ethnographic information, archaeological data can be useful for inferring long term fish population and exploitation trends (McKechnie et al. 2014). The first aspect involved in understanding past exploitation of fish species from archaeological remains is to identify the relative abundance of different species of fish in the archaeological record. Ideally these would consist of remains that allow us to differentiate between species, and are consistently preserved and recovered (Needs-Howarth 2001). For saltwater species dentary, articular, quadrate, premaxilla and maxilla are the most useful elements to distinguish species, however, Wheeler and Jones (1989) suggest that for freshwater species otoliths, vertebrae, prevomer, basioccipital and

opercular should also be included, as well as the posttemporal, ceratohyal epihyal, hyomandibular, supracleithrum, and cleithrum in some cases.

Suzanne Needs-Howarth (2001) reveals a number of interesting trends in archaeological recovery and identification of fish remains in a temperate environment. The purpose of the study was to identify which of the diagnostic elements are most useful for intra-site analysis of fish remains in Ontario. She found that bones from the cranial and pectoral girdle are "neither consistently recovered nor consistently identified to genus or species [and]…may not necessarily result in the most bias-free dataset for the purpose of inter-taxa comparisons of relative taxonomic abundance" (Needs-Howarth 2001). She concludes that the most useful elements for consistently and reliably identifying the common species in Ontario are the articular, ceratohyal, cleithrum, dentary, hyomandibular, operculum, preoperculum and quadrate. Her findings indicate that the other diagnostic elements are problematic due to differential preservation between species associated with osteological difference, varying robustness, and other taphonomic factors. For example, the Salmonidae family exhibits especially poor preservation of the cranium, but not the maxilla, dentary, articular and vertebrae. She also notes that it is important to identify and quantify vertebrae when calculating MNI to account for headless fish. This study, however, does not apply to osteologically dissimilar fish such as long-nose gar and lake sturgeon, for which different techniques may be required (Needs-Howarth 2001).

Live fish size can often be inferred from examination of archaeological remains, however, due to a number of contributing factors such as health, season, etc. length is more strongly related to bone size than live weight. According to Wheeler and Jones (1989), the best way to estimate fish size is to compare the remains to a specimen of a known size. Recent efforts have been made to apply statistical techniques to estimation of

live size from remains, including regression analysis of vertebrae and jawbones (Wheeler & Jones, 1989). This can be useful as vertebrae are often heavily represented compared to other bones, however, it can also be difficult as vertebrae are often indistinguishable both between species and other vertebra, aside from the first and penultimate which are typically used for this type of study. Otolith size and weight has also been shown to be associated with fish size, however, this is less useful in archaeological contexts as there are a number of other factors such as growth rate and sex, and loss of mass through taphonomy, that can take effect (Wheeler & Jones 1989). Additionally, scale-size can be used to estimate the size and age of fish, as they increase in size, but not number, over the fishes lifetime. However, this is less useful in an archaeological context as scale size can vary widely on individual fish. A final method for estimating the size of live fish from archaeological remains is by using diagnostic parts of the skeleton to estimate age, then extrapolate size by comparing the remains to complete specimens of a similar age (Wheeler & Jones 1989).

The two methods that are typically used to quantify faunal specimens in archaeozoology are Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI). NISP is the most basic measure of faunal quantification and represents the total number of identified/individual specimens identified to a particular taxon. It involves counting every faunal specimen, such as a bone, tooth or scale and is used to determine relative abundance of each taxon. This approach can be problematic as it can result in an overrepresentation of taxa with greater bone fragmentation, greater chance of recovery due to size or preservation, and those with a greater number of bones overall due to this method of quantifications' treatment of each individual bone as an independent unit (Sutton & Arkush 2009).