STATE OF KNOWLEDGE REPORT:

CONSUMPTION PATTERNS OF WILD PROTEIN IN NORTH AMERICA

A Literature Review
in support of the Wild Harvest Initiative

April 2016

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INTRODUCTION

THE WILD HARVEST INITIATIVE

The harvest and consumption of wildlife is an integral part of human evolution and cultural history that continues to make important contributions to diet, culture, livelihoods, and economies around the world. The commercial harvest of wild fish is acknowledged as critical to modern society, yet recreational hunting and fishing have often been considered unimportant from health, nutrition, and economic perspectives. Thus, the impacts of recreational hunting are rarely fully described and fully valued; consequently, these impacts are not fully considered in wildlife conservation policy-making.

In June 2015, Conservation Visions Inc. launched The Wild Harvest Initiative (WHI). This multi-year, multi-partnered initiative aims to quantify the importance of recreationally harvested protein in Canada and the United States of America (U.S.). The WHI is the first scientific study designed to assess the biomass, economic value, and hypothetical economic and ecologic replacement cost of wild animal protein that is harvested annually, at a continental scale, by recreational hunters and anglers. One component of the implementation plan for the WHI involves a compilation and review of existing information relevant to wild harvest and its benefits.

Undertaking a compilation and evaluation of currently available information related to recreational hunting and fishing in North America will be crucial for identifying data sources, detecting significant themes, recognizing critical knowledge gaps, and providing context for the WHI. Attention to information sources will be useful in project planning as it can help reveal regions where information is abundant or deficient, and help identify potential partnerships (organizations and individuals already demonstrating similar research interests).

In the U.S. and Canada combined, more than 15 million citizens participate annually in recreational hunting and nearly 30 million participate in recreational fishing. The Wild Harvest Initiative's first task involves cataloguing a comprehensive list of hunted and fished species and, subsequently, compilating statistics to determine how many individual animals of each species are harvested

annually. In order to provide an estimate of the amount of protein harvested from these animals, the Initiative must be informed as to what quantity of meat or fish is typically retained from an average specimen (that is, what is, on average, the edible portion). To effectively describe the importance of wild-harvested protein to the North American diet, the Initiative must also communicate how this retained harvest is used: how much and how often wild game and fish is typically eaten, how wild harvests are shared, and the geographic, demographic and cultural correlates for these consumption patterns. The utility of the WHI for informing wildlife management and conservation policy will be maximized if estimates relating to consumption are informed by geographic, demographic, and socio-economic factors.

This report is intended to describe and assess the state of knowledge related to consumption patterns of wild game and fish harvested for non-commercial purposes. This report supports the objectives of the WHI and is intended to provide both context and guidance to the program.

The goals of this review, therefore, are:

- *To describe common methods and best practices for collecting data on consumption patterns;*
- *To identify and summarize the existing literature on consumption patterns;*
- *To evaluate the quality of existing information including knowledge gaps; and,*
- *To identify opportunities for the Wild Harvest Initiative to meaningfully contribute to the understanding of North American wild protein consumption.*

What is Meant by Consumption Patterns

For the purposes of this review, the phrase "consumption patterns" is used broadly to reference information that describes the typical use of wild game and fish as food. The state of knowledge regarding consumption patterns is described for multiple aspects related to understanding the use of wild protein as a food source. This includes describing trends or correlates that are related to direct participation in harvesting, biomass retention, food sharing, and inclusion in diet.

Direct participation in harvesting refers to engagement in the act of harvesting through hunting or fishing. Patterns of direct participation may vary by country, region, demographic characteristics, and socio-economic class. Motivations for hunting or fishing may influence the extent of participation.

Biomass retention refers to the quantity of a harvested animal that is kept. In the case of recreational fishing, the first stage of retention is generally equivalent to the number of fish kept (as in, not released back into the environment). Hunters are typically obliged by law to retain the entire edible portion of their harvest, but what constitutes the edible portion may vary legally across

jurisdictions. The edible portion of individual species may be further influenced by cultural and socio-economic values, as well as normative behaviours.

Food sharing refers to how retained biomass is gifted by a harvester, whether a hunter or an angler, to other individuals. Food sharing patterns may depend upon the species harvested and be influenced by kinship structures, social status, indirect participation in harvest and demographic characteristics of the sharing community. Cultural and socio-economic values and normative behaviours are likely to have a large influence on sharing.

Inclusion in diet refers to identifiable patterns in how much or how often wild game and fish are consumed. This includes, where possible, quantitative metrics that describe consumption rates by frequency,,proportional representation in the diet, or total consumption by weight or volume over a specified time period. Inclusion of wild protein in diet may be influenced by region, demographic characteristics, motivations, cultural expectations, and socio-economic status.

METHODS

A primary literature search was conducted using Google Scholar, the Directory of Open Access Journals, and JSTOR archives. State and provincial data were viewed from government web sites. General Google searches were also conducted to identify blogs, message boards, and other websites relevant to the topic, though relatively little time was spent on this type of search.

Search terms included "wild game", "wild meat", "game meat", "country food", "wild food", "hunting", "recreational hunting", "angling", and "recreational fishing", combined with qualifiers for nutrition, food security, motivation, food sharing, and other aspects of human ecology. Finally, the search was filtered to exclude papers not relevant to Canada and the United States. The top 20-160 search results for each combination of terms were scanned, depending on relevancy. The giving up point for each combination of search terms was relatively subjective; however, when 2-3 sequential search results pages failed to contain relevant results, the search was generally abandoned.

The websites of all national, state, and provincial agencies responsible for fish and wildlife were searched for publications, technical reports, and web resources relevant to fish and game consumption.

For relevant titles, abstracts were read. If the abstract confirmed relevancy of the paper, the citation was recorded and/or the full text article was downloaded. For the most relevant of these reports and

papers, the literature cited was examined and a citation index search was conducted to identify additional relevant sources.

In general, sources published prior to 1990 were not included due to the tendency for food patterns to change over time. Changes in regulatory control (Magdanz et al 2002) and local economic models are known to influence the consumption patterns related to wild protein (Tsuji and Nieboer 1999, Collings 2011). Changing social values may affect motivations for participation in hunting or fishing which, in turn, may affect consumption (Schill 1997 compared to Reid 1989). Although 1990 (25 years) is somewhat arbitrary as a boundary, the last quarter century has been associated with rapid technological advances and economic globalization, phenomena that may have had profound influence on outdoor recreation, availability of commercial foods, and reliance on wilderness for sustenance.

RESULTS

OVERVIEW OF LITERATURE

Aside from national, provincial, territorial, and state reporting on participation in hunting and fishing activities, the bulk of literature related to consumption patterns is community-based or highly local in nature. The traditional reliance on wild fish and meat for subsistence by aboriginal people throughout the continent and non-Aboriginal people, particularly in the north, is evidenced as the majority of reports describe wild game and fish consumption for subpopulations of these people (e.g. school children within a particular community). Some attention has been given to disenfranchised groups (e.g. migrant farm workers) as part of larger investigations into food security and insecurity. A few studies describe use and consumption by self-identified outdoor enthusiasts, such as people attending outdoor shows or members of rod and gun clubs. Studies related to wild protein consumption patterns exist for all major regions of the U.S. and Canada, but geographic coverage is patchy, both within and between regions.

There is a vast literature on hunting and angling behaviour, factors related to participation, and social values related to wildlife and conservation that is indirectly related to consumptions; literature on participation with direct relevance for consumption patterns is less common. However, of the aspects of consumption patterns considered in this review, studies of participation rates, motivations, and barriers are the best represented across regions. In addition to the federal-scale documents discussed in sections below, most individual provinces, territories, and states produce reports on hunting and fishing participation and success. Information regarding retention and

estimates of edible portions of harvested animals were less commonly found, and more unevenly distributed geographically., though the information that is available provides substantial detail. Twenty-nine studies that report quantitatively on food sharing and diet inclusion were found. Geographically, these studies are concentrated in northern Canada and Alaska. There are some studies in other regions, but not all regions are represented.

Data Collection Methods and Best Practices

Of the 29 identified studies which report quantitatively on aspects of consumption patterns, most investigated harvester behaviour (12), and examined harvester motivations and barriers, values associated with hunting or angling, harvest success, and harvest retention. Diet studies examined the relative importance of wild and cultivated/manufactured foods in the entire diet, and quantified wild food item frequency (6), proportion (3), or both (3). Other studies examined the inclusion or use of specific wild foods in the diet, but not relative to the entire diet. These included studies which used binomial classification for diet item inclusion or not (6), examined food preparation methods (1), or described food sharing practices (3). Table 1 summarizes this literature with respect to data collection methods, sampling methods, the unit of study, and metrics derived from the data.

Quantifying and describing consumption patterns are studies of human behaviour and employ methods common to medical and sociological research. Typically, these require reporting by research subjects rather than direct observation by researchers. Surveys and interviews were therefore the most common methods of data collection. Surveys generally took the form of questionnaires with open responses (i.e. numeric or descriptive data supplied by the subject) or with limited response options (i.e. options provided by the researcher for the subject to choose from). Limited responses were provided in the form of discrete-choices, Likert scales, or ranked or ordered response sets. Interviews used pre-defined questions, but allowed for unstructured answers. Most studies using interviews conducted individual interviews, but focus groups were also used to inform the development of research questions and as a method of collecting data.

Harvester motivations, barriers, and values were assessed through focus group discussions, mail-out surveys, and web-based surveys (Table 1). The mail and web-based surveys were aimed at answering specific questions (e.g. to rank the importance of a set of motivations for hunting or angling participation, or to describe how important food acquisition is to the participant when deciding whether to hunt or fish). Focus groups are mediated discussions, but allow researchers to explore themes emerging from the discussion, encounter novel ideas or topics not previously known to be important. Focus groups also allow participants to control their own responses to questions and topics.

Table 1. Summary of methods and metrics for collecting and assessing data on wildlife and fish consumption, harvest, sharing or donation rates.

Data Collection	Sampling Method	Unit	Consumption Metric	Notes	State/Province; Reference
Diet history, diet recall, harvester behaviour; existing government data	*Stratified random sampling*	*Household*	*Number of fish*	*Compiled permit data, harvest diaries and recall surveys*	*Alaska; Busher and Hamazaki 2007*
Diet history, diet recall, harvester behaviour; existing government data	*Mandatory and non-mandatory reports from harvesters*	*Individual*	*Weight*	*Subsistence and recreational harvesters included.*	*Alaska; Titus et al. 2009*
Diet history, diet recall; existing government survey data	*Use of data already collected for the Quebec Health Survey on Nutrition*	*Household*	*Weight*	*Food frequency and 24-hr recall surveys*	*Quebec; Duhaime et al. 2002*
Diet history; interviews administered in person	*Small number of individuals recruited from community to represent different economic strategies*	*Individual*	*N/A*	*Researcher made an effort to gain trust with a small number of individuals in order to maximize detail and reliability of information. Interviews conducted biweekly.*	*Northwest Territories; Collings 2011*
Diet history; survey administered in person	*All households invited to participate*	*Household*	*Frequency of use*	*Interviewed female head of household.*	*Alberta/Northwest Territories; Wein et al. 1991*
Diet history; survey administered by telephone	*Stratified random sampling*	*Individual*	*Volume*	*Letter of introduction and description of study mailed-out prior to telephone contact.*	*British Columbia; Jin et al. 1998*
Diet history; survey administered in person	*All community residents 10 years and older invited to participate*	*Individual*	*Frequency of use*	*3-month diet history. Frequency recalled as daily, weekly, monthly, less than monthly or often, sometimes, rarely, never.*	*Ontario; Gittelsohn et al. 1998*
Diet history; web-based survey	*Survey administered at school to all adolescents consenting to participate.*	*Individual*	*Frequency of use*		*Ontario; Hlimi et al. 2012*
Diet history; web-based survey	*Invited all members affiliated with locavore entities or organizations.*	*Individual*	*Frequency of use*	*Invitation by email to subscribers or members of selected organizations promoting locavore behaviour*	*New York; Tidball et al. 2014*
Food inclusion; survey administered in person	*Invite attendees of rodeo to participate*	*Individual*	*Percent of individuals*	*Approached individuals attending event.*	*Idaho; Burger 1999*
Food inclusion; survey administered in person	*Invite attendees of outdoor show to participate*	*Individual*	*Percent of individuals*	*Approached individuals attending event.*	*South Carolina; Burger and Gochfeld 2001*
Food inclusion; survey administered in person	*Fishers at docks in target area invited to participate*	*Household*	*Number of fish*	*Approached individuals seen fishing.*	*New York; Corburn 2002*
Food inclusion; survey administered in person	*Fishers at docks in target area invited to participate*	*Individual*	*Weight*	*Approached individuals seen fishing.*	*New Jersey; Burger 2002*
Diet recall; survey administered in person	*All households invited to participate; member of household normally responsible for food preparation selected as participant.*	*Household*	*Percent of households*	*24-hr diet recall. Two weekday and one weekend day recall; food models, dishes and utensils were used to estimate serving sizes.*	*Nunavut; Hopping et al. 2010*
Diet recall; survey administered in person	*All individuals of participating households invited.*	*Individual*	*Weight*	*24-hr diet recall. Use of food models to estimate serving sizes. Interviews with elders informed development of survey (list of foods).*	*Alberta/Northwest Territories; Wein et al. 1991*
Food preparation; survey administered in person	*All community households invited to participate*	*Household*	*Method of preparation*	*Main food preparer in household interviewed specifically on methods of preparation to estimate types and amounts of fat added to foods.*	*Ontario; Gittelsohn et al. 1998*

Data Collection	Sampling Method	Unit	Consumption Metric	Notes	State/Province; Reference
Food inclusion; survey administered in person	Site-based sampling to recruit representative sample	Household	Percent participation	In-depth interviews to improve understanding of correlates with and coping mechanisms for food insecurity, including inclusion of wild foods in diet.	North Carolina; Quandt et al. 2004
Food sharing, food inclusion, diet history; survey administered in person	All households invited to participate	Household	Percent participation; weight.	Food sharing networks and change over time relative to government regulation is an important theme of this study; also presents very detailed information on types of wild food included in diet, harvester participation and food processing	Alaska; Magdanz et al. 2002
Food sharing; interview administered in person	After time for food sharing to occur following a hunt, harvesters were recruited to participate	Individual	N/A	Interviews were not highly structured, but intended to determine how each harvester distributed meat and any additional knowledge about secondary sharing.	Northwest Territories; McMillan and Parlee 2013
Food sharing; mail-out survey	All recipient organizations identified were invited to participate	Organization	Weight	Focus on organizations receiving wild game donations, not harvesters	Canada and U.S.A.; Avery and Watson 2009
Harvester behaviour; catch diary	Fishers that participated in diet recall survey invited to use catch diaries	Individual	N/A	Catch diary method unsuccessful	Ontario; Hopper and Power 1991
Harvester behaviour; existing government data	N/A	Household	Weight	License returns.	Alaska; Henderson et al. 1999
Harvester behaviour; focus group discussions	Focus group moderators recruited from minority communities; moderators then recruited individual participants through advertising within communities	Individual	N/A	Study aimed at uncovering barriers to participation in recreational fishery	Minnesota; Schroeder et al. 2008
Harvester behaviour; literature search	N/A	Community	Number of whales	Literature, harvest reports permit allocation data	Nunavut; Hoover et al 2013
Harvester behaviour; literature search	N/A	Various	Various	Meta-analysis	Canada; Berkes 1990
Harvester behaviour; mail-out survey	Randomly selected anglers	Individual	N/A	Survey of values associated with recreational fishing	Minnesota; Bruskotter and Fulton 2008
Harvester behaviour; mail-out survey	Stratified random sampling of anglers	Individual	Number of fish retained		Canada; Fisheries and Oceans Canada 2012
Harvester behaviour; mail-out survey	Random sample of previous year sport fishing license holders	Individual	Number of fish retained		Saskatchewan; Government of Saskatchewan 2011
Harvester behaviour; mail-out survey	Random samples of residents in target region	Individual	N/A	Investigation of factors that motivate participation in recreational fishing	Idaho; Reid 1989
Harvester behaviour; mail-out survey	All anglers that attended regulation development meetings seven years previous	Individual	N/A	Survey on angler behaviour, not consumption rates.	Idaho; Schill 1997
Harvester behaviour; survey administered by telephone	Random stratification from within individuals registered for a 2013 hunter education course	Individual	N/A	Identified groups of non-traditional hunters based on data available from online course participation to inform stratification.	New York; Larson et al. 2014
Harvester behaviour; survey administered in person	Stratified sampling based on level of fishing activity	Individual	Weight	3-month catch recall of amount and species.	Ontario; Hopper and Power 1991

Harvest success, including total harvest during a defined period of time, and harvest retention were measured through mandatory reporting as a license condition, mandatory catch diaries, in-person catch recall surveys, and mail-out surveys. One attempt at the utilisation of voluntary catch diaries was unsuccessful, but this may have been due to participant-fatigue (Hopper and Power 1991). Requiring mandatory reporting for license holders constitutes an inexpensive survey method that can be administered to large numbers of hunting and angling participants, yields a high return of data, and has the capacity to provide lengthy time-series, which is useful for analysing trends. Most fish and wildlife management agencies routinely collect harvest data through mandatory license reporting, thus datasets related to harvest effort and success, estimates or proxies for harvested biomass, and other items of specific interest to management agencies already exist. The utility of license-return surveys, however, is limited to relatively simple information. Increases in complexity or length may result in decreased compliance. Surveys administered in-person are relatively expensive, time consuming, and inefficient for large sample sizes; however, they can yield very detailed information. In-person surveys may also be more accurate as researchers have the opportunity to build trust and comradery, and participants demonstrate a higher reluctance to lie. For example, rural Alaskan communities underreport moose harvest on license returns as compared to household surveys; harvest tickets report only 42% of moose reported by households (Schmidt and Chapin 2014).

Wolfe and Utermohle (2000) provide guidance on survey question development, calculation of consumption rate estimates, and assumptions and potential sources for error relevant to measuring wild food consumption rates in Alaska. Although specific to Alaska, much of the content is applicable more broadly and is easily adapted. Survey questions are simple and address harvest, use, and sharing of wild food.

Studies quantifying the frequency and/or amount of all foods in the diet were used to estimate the prevalence of wild foods in the diet relative to food obtained from other sources (commercially purchased or non-commercially cultivated). Diet studies were conducted by using diet history and diet recall questionnaires; both types of survey were based on standard surveys used in medical and nutritional research, and were adapted to include locally relevant wild food sources. Up to date standard dietary assessment protocols and tools are available from the National Cancer Institute online Dietary Assessment Research Resources http://epi.grants.cancer.gov/dietary-assessment/resources.html. Diet history studies in the literature reviewed collected data at the scale of households or individuals; diet recall studies collected data at the scale of individuals.

Diet history questionnaires measure frequency of food items in the diet over an extended period of time, but normally not longer than the 12 months previous to survey administration. Diet history studies describe the usual diet of subjects in terms of how often the foods are consumed, but do not

typically describe the actual quantities of intake. Diet recall questionnaires measure quantities of food consumed (weight, volume, and/or number of serving sizes), but are only accurate over short time frames, and are typically used for 24-hour recall. Diet recall does not describe usual diets of individual subjects, but is useful for describing average food intake for a population and can aid in assessing the nutritional value of a sample population's diet. As these relate to the WHI, diet history studies are useful for surveying how often wild foods are included in household meals or individual diets; diet recall studies are useful for assessing the proportion of a population diet that is comprised of wild protein, and the nutritional contribution to the diet. Both types of diet assessment tools can be administered in person, over the phone, or through web-based surveys.

Food inclusion surveys determined whether or not foods of interest were consumed by the subject; some studies also incorporated a metric of inclusion, such as frequency or quantity over a period of time. Although some of the food inclusion surveys reviewed collected data on inclusion of several foods (e.g. wild game and commercial meat; self-caught fish and store-bought fish), the total diet was not assessed. Food inclusion surveys were typically administered in the form of questionnaires or polls. Since these typically do not assess total diet, the surveys are not time consuming or complex, making them useful for collecting large amounts of data within a short period of time. This is an ideal way, for example, to collect data from event attendees (Burger and Gochfeld 2001, Burger 1999).

One food preparation study used personal interviews to determine how the household member normally responsible for food preparation used specific items. Gittlesohn et al. (1998) were interested in the amount of fat typically used to cook various dishes; this type of interview has potential application for understanding carcass utilization, consumable weight, and associations between foods. Another study used interviews in order to identify household and community members responsible for processing of wild foods before use (Magdanz et al. 2002).

Identified food sharing studies accessed information in two ways: harvester surveys on sharing behaviour and recipient surveys. Harvester surveys were administered in the form of personal interviews to determine quantities of wild food retained and shared, as well as factors that influence sharing decisions (e.g. motivation, social structure, geography). The recipient survey inlcuded in this report was designed to estimate the quantity of wild game donated to food banks and soup kitchens. This was conducted through a mail-out survey targeting charitable organizations.

Food sharing and food inclusion studies have the potential to identify the reach of wild protein beyond those who participate directly in harvesting. This is critical information for fully describing the importance of the wild harvest. Food sharing studies have the advantage of providing detailed information on decisions regarding sharing, and how much food is shared in what way. Food

inclusion studies can be conducted quickly and inexpensively, but have the disadvantage of not containing very much contextual information.

PARTICIPATION RATES, MOTIVATION AND BARRIERS

DIRECT PARTICIPATION IN NON-COMMERCIAL HUNTING AND FISHING

The literature contains numerous reports on participation rates in recreational and subsistence hunting and angling over many decades. The most comprehensive regular reports on the state of game and fish harvest are those published, at a federal level, by the U.S. Fish and Wildlife Service (USFWS), Federal/ Provincial/ Territorial Governments (FPT) of Canada, and the Canadian Department of Fisheries and Oceans (DFO). For the purposes of this review, the most recent versions of these reports have been relied upon. Should the WHI decide to pursue questions of change over time, or require detailed information about provincial/ territorial/ state or finer scale participation rates, reports are readily available online for most jurisdictions.

Annually, about 13.7 million Americans 16 years and older (*U.S. Fish and Wildlife Service and U.S. Census Bureau 2014****) and 2.1 million Canadians 18 years and older (****Federal, Provincial, and Territorial Governments of Canada 2014****) participate directly in non-commercial hunting. This represents approximately 4.4% and 6.1% of the population respectively; of these, approximately eight percent are women, which is comparable to female participation rates in Europe (Heberlein et. al 2006).***

Although hunting participation in the U.S. has declined substantially since the 1990s when about 9% of Americans hunted (Duda et al. 1995), the number of participants increased between 2006 and 2010 (*U.S. Fish and Wildlife Service and U.S. Census Bureau 2014****) despite increasing urbanization. Expanded interest in local, natural, and humanely raised meat may be encouraging increased participation among population segments not traditionally engaged in hunting (****Arnett and Southwick 2015, Larson et al. 2014, Tidball et al. 2014****).***

About 25 million individuals participate annually in the recreational fishery in the U.S. (Cooke and Murchie 2013). In Canada, about 2.7 million individuals fish recreationally each year (Fisheries and Oceans Canada 2012). This means that about 8% of Americans and Canadians fish recreationally, a rate lower than, but comparable to, those found in the industrialised countries of Europe and Oceania where about 10.5% of the population participates in recreational fishing (Arlinghaus et al. 2015). Rates of non-commercial fishing participation appear fairly stable over time, but this does not necessarily indicate that harvest for consumption remains stable. In Saskatchewan, for example, there is no trend in the number of sport fishing licenses sold from 1985 to 2010, nor is there

a trend in the number of fish caught annually (variable between 8 and 10 million fish). However, the number of fish kept by anglers has been declining since 1985 (Government of Saskatchewan 2011).

Participation in hunting and fishing is not evenly distributed across North America. Recreational hunting and fishing tends to be more prevalent in rural areas (Arnett and Southwick 2015). In the far north (Alaska and the Canadian territories), participation in hunting and fishing is much higher than national averages. In 2009, there were 84,000 licensed hunters in Alaska, representing about 12% of population. However, many Alaskan hunters are not licensed; 60% of households in rural Alaska have at least one member directly participating in game harvest (Titus et al. 2009).

Participation in angling declines with increased urbanization, age, unemployment, and family size, but increases with the cultural importance placed on fish and the perceived need for leisure activities (Arlinghaus et al. 2015). Anglers living in Ontario and Quebec account for 60% of Canada's recreational anglers (Fisheries and Oceans Canada 2012).

For most managed wildlife resources, licenses are allocated to individuals and individual license holders are harvest participants. In some circumstances, a group of individuals may be the direct participant, such as in regions where party hunting is allowed for some big game species, or where subsistence harvests are conducted by households or communities. In other cases, the resource is most effectively harvested by a group because of the effort and equipment required. As an example, participation in the personal use and subsistence fishery on Alaska's Copper River is reported by household, with about 6,000 household crews taking part each year (Henderson et al. 1999). In other cases, cultural traditions demand a collective effort. This occurs, for example, in community-sponsored hunting activities by aboriginal groups, where large amounts of game are harvested in one trip and provided to the entire community. Such efforts help ensure access to wild game for individuals not capable of hunting for themselves. In communities that conduct Aboriginal Subsistence Whale Hunting, permissions are granted to communities rather than individuals; this reflects traditional practice, but is also the practical given the size of the harvested animals. Studies reviewed in this document indicate that in recent decades whale hunting participation included 12 communities in the Bristol Bay area of Alaska (Chythlook and Coiley 1994) and seven communities in Hudson Bay (Hoover et al. 2013).

Food as Motivation to Participate in Hunting and Fishing

Human dimensions research on motivations for hunting and fishing is frequently conducted, but these studies are generally demographically and/or geographically restricted, or are otherwise narrow in scope.

Motivations cited for hunting and fishing are commonly related to the enjoyment and conservation of nature, social or cultural traditions, leisure, and food acquisition. In the U.S., hunters are more highly food-motivated than anglers, and anglers are more often motivated by relaxation (Duda et al. 1995).

Recreational anglers in the Midwestern U.S. associate recreational fishing with utilitarian, protectionist, and dominance values (Bruskotter and Fulton 2008). This suggests that fish are valued largely in accordance with their benefit to people, or in terms of their natural habitat, where people go to fish despite being only minimally motivated to obtain fish for consumption. Urban and suburban anglers in Minnesota are, on average, neutral about food acquisition as a motivation for fishing (Schroeder et al. 2008); that is, fishing activity is neither motivated nor deterred by food value.

The practice of averaging responses to surveys focused on angler motivations, however, may obscure the importance of food as a motivating factor in recreational fishery participation for a portion of anglers. In Idaho, anglers that preferentially fish with bait report fishing primarily for food; conversely, anglers that primarily fish with flies and lures report fishing for pleasure (Schill 1997). Recreational anglers may exist in two distinct groups defined both by motivation and by fishing behaviour, which are likely related. Motivations can also change over time; the same survey administered in 1987 indicated that anglers in Idaho placed a high value on relaxation and experiencing nature, but little to no value on fishing for consumption (Reid 1989), though sampling methods varied somewhat which may have introduced some bias.

Food-motivated participation in hunting comes in many forms. In remote areas, particularly those primarily inhabited by indigenous communities, wild food resources are an integral component of the local culture and often a substantial component of the local economy. Along the southern shores of Hudson and James Bays, about half of the total local economy is driven by wild food and other wild materials (Berkes et al. 1994).

Cultural expectations regarding food also result in food preferences that contribute to motivations for hunting and fishing. Both adults (Campbell et al. 1997) and children (Hlimi et al. 2012) in Cree communities in northern Manitoba and Ontario express a desire to eat more wild food. Many Alaskans report a dislike of commercial chicken, beef, and pork, citing a preference for wild meat as a motivation for hunting (Titus et al. 2009).

In remote, especially northern, areas, food insecurity resulting from the extremely high costs and low availability of commercial food is partly mitigated through wild food collection and harvest (Power 2008). High food insecurity results in the inclusion of wild game and fish in the diet of socially marginalized communities such as migrant and seasonal farmworkers in North Carolina

(Quandt et al. 2004), and immigrants in Brooklyn, New York (Corburn 2002). Similarly, in Europe, hunting is more popular in low-income countries as a result of relatively high food insecurity (Schulp et al. 2014).

By contrast, affluence has a positive effect on food-motivated participation in hunting and fishing. Why affluence is positively correlated with hunting participation has not been explicitly examined. It may be related to the financial capacity to participate in relatively expensive hunts, such as those for big game (Burger 2002, Burger and Gochfeld 2001), and/or the likelihood of having sufficient leisure time to participate in hunting. From an evolutionary perspective, there may also be some attraction to the capacity to demonstrate status by sharing meat (Gurven 2004). Additionally, current trends toward local, organic, and ethically raised meat are driven primarily by privileged (wealthy and/or highly educated) consumers. New York state locavores, primarily wealthy, middle class women, report an interest in increased consumption of wild protein, though few harvest their own fish or game. Despite relatively low participation, non-traditional hunters (women, racial-ethnic minorities, urban or suburban individuals) that do actively harvest wild food in New York state cite food as the primary reason for hunting due to perceived benefits for health, self-sufficiency, and ecological sustainability (Larson et al. 2014).

Barriers to Participation in Wild Harvest

Studies investigating barriers to participation in hunting and fishing are generally localized geographically and/or are narrow in demographic or cultural scope. As with motivations for participating in hunting and fishing, barriers appear to vary geographically, demographically, and socially.

Generally, hunters require a positive support system to initiate and maintain hunting, but anglers are less affected by the extent of support (Duda 1995).

In northern and aboriginal communities, increased participation in the modern wage-based economy negatively influences the consumption of wild fish and game due to a reduction in the number of active hunters, trappers, or fishers in a greater number of households (Tsuji and Nieboer 1999, Campbell et al. 1997, Fast and Berkes 1994). Despite this, a lack of access to a cash-based economy can also be a barrier to individuals in northern communities (Duhaime et al. 2002).

Women, despite expressed interest in hunting or fishing, often cite a lack of knowledge and/or skill development as a barrier to participation regardless of geographic location or socio-economic status. The presence of a male head of household in an Inuit community in northern Quebec positively affects the proportion of wild foods in a household diet (Duhaime et al. 2002). Caucasian, middle-

class women in New York State who are interested in harvesting wild food report a lack of outdoor skills as a barrier (Tidball et al. 2014), but education can be a successful tool in addressing this (Larson et al. 2014).

Minorities may be reluctant to participate in recreational hunting and angling due to expectations or experiences (real or perceived) of bias by enforcement, or fear that language barriers may exacerbate interactions with officers (Schroeder et al. 2008). Perceived complexity or poor communication of regulations can be a general barrier to participation; in Europe, hunting participation is higher where regulation is lower (Schulp et al. 2014).

Of particular interest, none of the studies found cited requirements to retain meat from hunted animals as a barrier to participation, whereas a lack of knowledge regarding handling and preparation of wild food was identified (Tidball et al. 2014). Fear of food safety may be a barrier to retention and consumption of caught fish, but is not a barrier to participation (Burger 2002).

BIOMASS RETENTION

Quantification of the harvested wild biomass, its economic value, and the cost to replace this harvest with agricultural substitutes are goals of the WHI and all rely on understanding the retention of wild game and fish by harvesters. The literature contains some rich sources of information on edible weights of both fish and game, particularly in the north and the northwest regions of the U.S. and Canada.

Edible weight, even within a species, may be highly variable throughout North America. The mean size of individuals within a species can vary geographically (e.g. latitudinal and altitudinal gradients or gigantism and dwarfism of island populations) and should be accounted for in any evaluation of the biomass contribution of wild harvest to the North American diet. Cultural practices and taste preferences also affect the edible weight of harvested species (Ashley 2002). Even within a geographic region and within a culture, edible weight can change over time, sometimes as quickly as within a few generations (Tsuji and Nieboer 1999). It is important to be cautious when estimating the edible portion of a wild-harvested animal.

RECREATIONAL AND SUBSISTENCE FISHING RETENTION

The popularity of catch-and-release fishing, whether by choice or by regulation, and the mixed use of subsistence catches for food and for bait, make catch rates a poor proxy for fish consumption. For recreational and subsistence fisheries, retention is typically reported by the number or the weight of

fish retained (Table 1). Retention in recreational and subsistence fisheries needs to be examined by the catch that is kept and the portion of that which is edible and consumed.

Resident Canadian recreational anglers, on average, retain 37% of their catch, while non-resident anglers retain, on average, 15% of their catch (Fisheries and Oceans Canada 2012). Retention rates vary considerably across the country; for example, recreational anglers in Newfoundland and Labrador retain 76% of caught fish, while recreational anglers in Alberta keep only 14% (Fisheries and Oceans Canada 2012). Retention rates in Canada's north are very low, but this may be partly due to the exclusion of subsistence fisheries in the analysis. The federal survey on recreational fishing (Fisheries and Oceans Canada 2012) contains detailed data on catch and retention. Data accessible directly from government agencies and jurisdictional reports may report retained numbers by major species (e.g. Government of Saskatchewan 2011).

A similar statistic at the national level could not be found for the U.S., although the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation included questions on the catch and release behaviour of anglers (U.S. Fish and Wildlife Service and U.S. Census Bureau 2014). Localized information is reported in various sources (Table 1). As expected, considerable variation in fish retention exists. Most anglers in the Greenspoint/Williamsburg neighbourhood of Brooklyn, New York, reported fishing specifically for food and keeping everything they caught for consumption (Corburn 2002), whereas in Newark, New Jersey, 30% of recreational anglers (fish and crab) reported not consuming any of their catch (Burger 2002). Even within a jurisdictional boundary or community there may be considerable variation in retention. Despite the large numbers of anglers in Newark that do not retain any fish, 8-25% retain and consume 1.5 kg of fish or crab monthly (Burger 2002). Recreational anglers in Idaho that fish primarily for food retain a high proportion of their catch, but anglers that primarily fish for pleasure rarely retain their catch for consumption (Schill 1997).

Subsistence fisheries are conducted specifically for food, but the total catch is not a reliable measure of biomass retained for consumption. Subsistence fishers in an Ojibwa community of northern Ontario reported consuming 95% of fish caught, retaining preferred fish (mainly whitefish and walleye) for consumption and using less preferred fish for bait (Hopper and Power 1991).

In Washington and California, there are provisions for commercial fishers to retain some catch for personal use. The retention is considered subsistence fishing and totals about 1.7 million kg of fish per year, 85% of which is retained from tribal landings (Poe et al 2015). Retention by species is not related to the commercial value of fish (i.e. fishers are not maximizing profit by retaining the lowest-price fish), suggesting retention may be based on food preferences (Poe et al. 2015).

The total weight of fish can be used to estimate economic and agricultural replacement values for recreational and subsistence fisheries since fish are often bought and sold whole. Mean weight for harvested species was not specifically searched for in this exercise, but some statistics were reported for some species in the literature found. For example, Henderson et al. (1999) reported the weight for multiple salmon species of the north Pacific. To understand the nutritional contribution of wild fish, however, an understanding of usual processing and preparation methods is required to determine the portion available for consumption. Ashley (2002) reports the edible weight of 16 fish species harvested in the Canadian north.

Hunted Game Retention

Strict meat salvage requirements exist in North American jurisdictions, requiring hunters to retain the edible meat from kills. However, what is considered edible by law can vary between and within jurisdictions. For example, in Alaska, all edible meat must be salvaged from a hunted moose, but the heart and liver are only considered edible meat in some regions (Titus et al. 2009).

For narwhal and beluga harvested in Hudson Bay, Nunavut, 30-35% of the carcass is retained for blubber and 5-25% is retained for consumption (muktaaq and meat); in addition, some teeth and narwhal tusk are retained for carving (Hoover et al. 2013). The remainder of the carcass is left for wild animals to scavenge. In contrast, Chythlook and Coiley (1994) report that the whales harvested in Bristol Bay, Alaska, are nearly completely used; muktaaq, blubber, flippers, and back strap meat are harvested for consumption, and there is a high use of the remaining carcass for dog food.

Aboriginal Canadians in northern Alberta report using all parts of large mammals, including marrow, fat, and organ meat (Wein et al. 1991). Ashley (2002) compiled a review of the edible weight of common species harvested in the north and based primarily on use by indigenous cultures; this review reports on 13 ungulates, 8 marine mammals, 7 small mammals, 4 carnivores, 16 water birds, and 5 land birds.

Little information is available in the primary literature regarding non-indigenous harvests, but numerous calculators are available online to help hunters predict the yield of meat from their harvest; venison calculators are particularly abundant. According to butcher-packer.com, about 60% of the dressed weight of venison is wasted during processing, compared to 43% waste for Holstein steer and only 20% waste for hog and lamb; huntfishsport.com reports wastage from field dressed venison at about 44% weight. The discrepancy is large, but may reflect differences in cultural practices informing the numbers or may just represent a normal range of variation in

salvageable meat. Consistent with that range, quebecoutfitters.com reports 48% of the dressed weight of moose is wasted during processing.

Sharing Wild Fish and Game

Patterns of human food sharing are uniquely complex relative to other social animals, and yet are so common as to be taken for granted; thus, systematic studies are scarce (Kaplan et al. 2001). Most of the literature available exists for what are seen as anomalous food systems, such as modern hunter-gatherer and pastoral cultures; little information is available for industrial and post-industrial cultures.

In an overview of the anthropological literature pertaining to hunter-gatherer and hunter-agrarian populations, Gurven (2004) made the following observations which may be relevant to modern hunter-industrialized and hunter-post-industrialized populations:

- ***Food sharing tends to be biased toward the nuclear family, household, and geographically close kin.***
- ***Hunters demonstrate or express a desire to share food and do not hoard excessively, even when technology exists to preserve and store food.***
- ***Larger families are gifted larger portions of food than smaller families. Hunters keep the largest portions regardless of family size.***
- ***Sharing tends to decrease during times of general scarcity, but individuals and families most in need or least capable of acquiring their own food tend to receive larger gifts.***
- ***When hunting cooperatively, participants divide shares first, and then individuals make sharing decisions for further distribution.***

The sale, trade, or barter of wild fish and game is not legal in North America except where it may be allowed by special permit; wild meat and fish are therefore typically unavailable to those who do not participate directly in hunting or fishing, except through gifts. A recent study in Sweden found that even though wild game is readily available commercially, most non-hunting households acquire game meat from close friends who hunt (Ljung et al. 2012). Further, Ljung et al. (2012) reported that positive attitudes toward hunting were correlated with participating in the sharing of game. Consumption and sharing of wild meat are potentially important factors for retaining social support for hunting; thus, social networks may be especially important for establishing and maintaining support for wild harvests in North America (Arnett and Southwick 2015).

Most jurisdictions acknowledge that the sharing of wild-harvested food is a social-normative behaviour through formal regulation of wild game and fish. Usually these regulations limit the quantity of gifts of game, and also require receipts for these, a cumbersome and potentially complex process which may result in giving and receiving being viewed as difficult or unattractive. The legislation and regulation surrounding the sharing of wild-harvested food appears to inadvertently reduce this sharing (Kaplan et al. 2001). Traditional food-sharing practices of the indigenous people of the north can be efficient at the scale of feeding a community, but government regulations favour individuals rather than social groups, and the prescriptive nature of regulation can disrupt networks and create inefficiency in subsistence provisioning (Magdanz et al. 2002), potentially increasing the risk of food insecurity for less productive harvesters.

In northern regions, the sharing of wild game and fish remains extensive. Dene subsistence hunters share about 37% of the raw meat they harvest; one hunter may feed seven households (McMillan and Parlee 2013). Organized community hunting trips result in an immediate sharing of about 30% of the meat with multiple households, and the probable additional sharing among the individual hunters who took part in trip (McMillan and Parlee 2013). Whale hunting in Bristol Bay, Alaska, is associated with very liberal sharing of whale products within the community, and this sharing extends to other communities that do not have easy access to whale (Chythlook and Coiley 1994).

Sharing food in contemporary Inuit societies is normally not associated with any expectation of reciprocity (Kishigami 2000); examination of food networks will generally identify individuals or households that are high providers and likely do not receive many gifts of food. In the Inuit communities of Wales and Deering, Alaska, about 30% of households account for 70% of wild food consumed in the communities (Magdanz et al. 2002). In rural Alaska, 60% of households actively harvest game, but 86% of households consume game meat (Titus et al. 2009).

The extent of food sharing and the reach of individual hunters in other North American regions are not well-documented.

Wild Protein Sharing in Contemporary North America

In the literature describing food sharing patterns, some common themes arise. As expected, sharing primarily takes place within the immediate family or household, and secondarily with extended family. It is also not uncommon to use wild game and fish to feed working or companion animals. Individuals contributing directly or indirectly to a hunt are rewarded with a portion of the take. Need is a factor in decision-making and thus charity is an important aspect of sharing.

The non-indigenous recreational fishery in North America is primarily for food for private consumption (Cooke and Murchie 2013), and is thus not widely shared outside of the household. How much this is influenced by the relatively small size of the harvest, or by daily bag limits, is not

reported. In contrast, Newfoundland residents participating in the food fishery (recreational cod fishery) often share small portions of their catch with friends and unrelated neighbours, and commonly offer the service of a vessel, and the loan of related equipment, to community members with poor access to the fishery (pers. obs.). Subsistence fishers in an Ojibwa community in northern Ontario share fish primarily with family, but also with sick and elderly community members (Hopper and Power 1991).

In Ulukhaktok, Northwest Territories, game and fish are most commonly shared from parent to child and from child to parent, and less commonly with distant relatives and unrelated individuals (Collings 2011). Alaska's Inuit show a high degree of cooperation in food acquisition, processing, and distribution, and tend to share food through networks primarily comprised of extended family (Magdanz et al. 2002).

Inuit in northern Quebec share harvested meat initially within the hunting party, and individual hunters subsequently share primarily with kin and secondarily with members of their social network (Kishigami 2000). In the Dene community of Fort Good Hope, Northwest Territories, anyone who contributes to the effort of the hunt (direct participation, loaning of equipment or fuel), or processing of the meat, is assured a portion of meat in return (McMillan and Parlee 2013). Similarly, participants in the huntingbc.ca web forums generally agree that when hunting on a party license, harvested meat is normally shared equally to all individuals of the hunting party, regardless of varying individual effort (http://www.huntingbc.ca/forum/showthread.php?85334-How-does-your-hunting-party-split-the-meat).

In Aboriginal communities, changes in technology and the relatively recent increase in participation in a wage-based economy, relative to the traditional economy, has had implications for wild harvests and how wild-harvested food is shared. In Ulukhaktok, Northwest Territories, individuals who identify as hunters shared more broadly with distant relatives than individuals who identify as wage-earners (Collings 2011). In the Hudson Bay region, increased participation in a wage-based economy combined with the loss of opportunities to transfer traditional knowledge, resulted in a reduction in the average edible portion of a carcass, as well as a reduction in food sharing (Tsuji and Nieboer 1999).

The accessibility and ease of freezing may result in reduced sharing, as there is no imminent danger of spoilage and fewer individuals are likely to be involved in processing. The availability of freezers resulted in decreases in the use of other preservation techniques, such as smoking and drying (Tsuji and Nieboer 1999). Wein et al. (1991) found that despite preservation technology and use, wild food consumption adheres to striking seasonal patterns reflective of seasonal availability; however, Tsuji and Nieboer (1999) reported a change in the seasonal nature of local diets as a result of freezer technology.

Formal Charitable Sharing

Traditional food sharing patterns include the provision of food to the sick, the elderly, and the otherwise marginalized within a community. However, increased regulation of gifting and decreased participation in subsistence harvesting can disrupt these patterns. Food insecurity has become a major policy challenge, particularly for remote aboriginal communities in the far north. Community freezers are a common solution in northern communities to increase access to wild food for individuals who are unable to hunt or fish and/or do not have access to reliable kinship, or social networks, where wild foods are shared. In the Inuit community of Nunavik, community freezers play a significant role in improving access to wild foods, but do not fully compensate for the lack of a hunter in the household (Duhaime et al. 2002). Community-sponsored hunts ensure distribution to community members that do not have strong kinship or social networks that would provide meat and fish, and community freezers provide an additional manner of access to wild food for marginalized and food-insecure members of the community (Kishigami 2000).

Throughout North America, formal programs for charitable sharing of wild game primarily consist of venison donation programs. Wild game is accepted by charities that provide meals to food-insecure individuals in at least 46 states and 4 provinces (Avery and Watson 2009). Approximately 15,875 kg of venison is donated through these programs annually, contributing to more than 10 million meals, reaching an estimated 44 million individuals (Avery and Watson 2009).

Working and Companion Animals

Not all retained fish and meat is consumed by humans. The literature contains several references to the sharing of fish to both working animals and household pets. It is difficult to assess how significant this portion of the harvest is, but may be useful to determine as the WHI is conducted.

The primary value of whales to communities in Hudson Bay is the food value of muktaaq and blubber, but muscle harvested from narwhal and beluga in Hudson Bay is predominately used as dog food (Hoover et al. 2013). The extent to which wild food is fed to dogs in the Northwest Territories and Nunavut is unknown, but low-preference and highly abundant species are most commonly used (Ashley 2002).

Salmon are commonly distributed to dogs as food in communities of the Alaska portion of the Yukon River drainage basin, but the amount of fish used as dog food varies substantially between communities (Busher and Hamazaki 2007). Hopper and Power (1991) report that pets are commonly fed less desirable and highly abundant species of fish caught in a northern Ontario subsistence fishery.

The recent replacement of working dogs with snowmobiles in the North has likely resulted in a decrease in distribution of retained food to dogs and an increase in wastage (Ashley 2002)

Diet Inclusion and Consumption Rates

Inclusion of non-commercially harvested wild game and fish in the diet is reported quantitatively with consumption rates (Table 2), and qualitatively by describing geographic, demographic, and social correlates with diet inclusion.

Annual per capita consumption by weight estimates and estimates regarding the portion of diet comprised of wild foods are valuable statistics for the WHI, and also support goals associated with estimating the contribution of wild game and fish to total protein consumption, estimating economic value, and estimating agricultural replacement costs. Although weight is the most common metric in use, consumption is also reported by volume and by number, both of which should allow for weight approximation. Rates, presented as frequency of consumption or the portion of a population that consumes wild food, provide very insightful information, but may not lend well to biomass-related calculations.

Table 2 summarizes the consumption rate statistics found during this literature review. The country, region, and study group are described for context. Notes related to the depth or breadth of information available from the study, or to the utility of the study, are also included.

Wild food consumption is not evenly distributed. Of North Americans who do consume wild meat or fish, consumption rates vary considerably from as little as 10 kg per year per person to as much as 350 kg per year per person. Even within a local geographic region, individual variation in wild food consumption can be substantial. High-end consumers in South Carolina eat wild proteins at nearly 10 times the population's average rate (Burger 2002). The frequency and quantity of wild food consumed within an aboriginal territory can vary substantially between communities (Hlimi et al. 2012). In the Hudson Bay region, there is a general trend that the further north a community, the higher the rate of consumption of wild protein (Fast and Berkes 1994). This may be attributable to the observation that aboriginal communities tend to experience a reduction in wild food consumption and increase in commercial food consumption following industrial development (Campbell et al. 1997) and/or economic pressure to perform wage-paying work rather than traditional work such as hunting and trapping (Collings 2011, Tsuji and Nieboer 1999).

Table 2. Summary of reported consumption rates of recreationally harvested wildlife and fish in Canada and the United States.

Food Type	Consumption Rate	Country	Region	Community / Study Group	Reference	Notes
*Country food**	*68.7 kg/year per person; 58.3% of meat and 24.4% of total diet*	*Canada*	*North*	*Inuit community of Nunavik, Quebec*	*Duhaime et al. 2002*	
Whale (muktaaq)	*30-450 kg per whale harvested, shared*	*Canada*	*North*	*Aboriginal communities of Hudson Bay, Nunavut*	*Hoover et al. 2013*	*Sufficient information exists to calculate mean per capita consumption rate.*
Wild fish or game	*≥64% of population*	*Canada*	*North*	*Inuit of Nunavut*	*Hopping et al. 2010*	*The authors present consumption rates by percent of population for caribou (64%), fish (47%), seal (21%), and whale (17%)*
Game meat (large and small game)	*170 kg/person/year*	*USA*	*North*	*Rural Alaska*	*Titus et al. 2009*	*The authors present consumption rates for 11 harvested species compared across eight communities.*
Game meat (large and small game)	*10 kg/person/year*	*USA*	*North*	*Urban Alaska*	*Titus et al. 2009*	
Wild fish	*49.4 kg/year per household*	*USA*	*North*	*Personal use and subsistence licensed households, Alaska's Copper River.*	*Henderson et al. 1999*	*Report contains data on numbers of each species caught.*
Wild salmon	*N/A*	*USA*	*North*	*Communities in the Alaska portion of the Yukon River drainage*	*Busher and Hamazaki 2007*	*Difficult to extract summary consumption rate but report contains rich data on salmon and other fish by species caught, by community, by year; consumption rates can be calculated.*
*Country food**	*>90% of respondents consume wild food; 305-337 kg/year per person*	*USA*	*North*	*Residents of aboriginal communities of Wales and Deering, Alaska.*	*Magdanz et al. 2002*	
*Country food**	*319 occasions/year per household; 26 kg/year per person*	*Canada*	*North/ Central*	*Aboriginal (first nations and metis) communities near Wood Buffalo National Park*	*Wein et al. 1991*	
Wild fish or game	*50-350 kg/year per person*	*Canada*	*North/ Central/ Eastern*	*Aboriginal communities (7) of Hudson Bay*	*Fast and Berkes 1994*	*The authors present consumption rates for edible portions of harvested species compared across seven communities.*
Wild fish or game	*7.3 litres/year per person*	*Canada*	*Western*	*Aboriginal reserve residents coastal British Columbia*	*Jin et al 1998*	

Food Type	Consumption Rate	Country	Region	Community / Study Group	Reference	Notes
Wild fish or game	20 litres/year per person	Canada	Western	Non-reserve residents coastal British Columbia	Jin et al 1998	
Wild fish	1.5 fish/angler	Canada	Central	Non-resident anglers, Saskatchewan	Government of Saskatchewan 2011	Report contains data on numbers of each species caught.
Wild fish	13.7 fish/angler	Canada	Central	Resident anglers, Saskatchewan	Government of Saskatchewan 2011	Report contains data on numbers of each species caught.
Wild fish or game	147 kg/year per person	Canada	Eastern	Aboriginal communities of the Cree Mushkegowuk territory, Ontario	Berkes et al. 1994	
Country food*	Less than commercial food	Canada	Eastern	Aboriginal community in northwest Ontario	Gittelsohn et al. 1998	The study is primarily interested in correlates of diet with diabetes and actual consumption rates are not reported.
Wild fish or game	>52 occasions/year for 90% of children	Canada	Eastern	Children in aboriginal communities of the Cree Mushkegowuk territory, Ontario	Hlimi et al. 2012	
Wild fish	118 kg/year per person	Canada	Eastern	Ojibwa community in northern Ontario	Hopper and Power 1991	
Wild fish	21 fish/year per angler	Canada	Canada-wide	Active recreational fishery participants, Canada	Fisheries and Oceans Canada 2012	Report contains data on numbers of each species caught and retained, described by province. Valuable source for regional summary data.
Wild fish	60 kg/year per person	Canada	Canada-wide	Aboriginal communities	Berkes 1990	Author presents kg/year per capita harvest for ten regions and 96 communities.
Wild fish or venison	70% of individuals	USA	Northwest	Rodeo attendees, Idaho	Burger 1999	
Moose, grouse, waterfowl	30-50% of individuals	USA	Northwest	Rodeo attendees, Idaho	Burger 1999	
Wild fish or game	Not on a regular basis	USA	Northeast	Self-selected "locavores" of New York state	Tidball et al. 2014	
Wild fish	494 fish/year	USA	Northeast	Persons actively fishing in target neighbourhoods, Brooklyn, New York	Corburn 2002	Species counted include finfish and crustaceans
Wild fish	18 kg/year per high-use angler; 0 kg/year per low-use angler	USA	Northeast	Recreational anglers in New Jersey	Burger 2002	
Wild fish or game	70.2% of families without children and 40% of families with children	USA	Southeast	Migrant and seasonal Latino farm workers in North Carolina	Quandt et al. 2004	
Wild fish or game	≥79% of respondents	USA	Southeast	Hunting, fishing and outdoor show attendees, South Carolina	Burger and Gochfeld 2001	79% of respondents consume wild fish; 79% consume deer; 25-47% consume various small game and birds; 11% consume racoon

*Includes wild berries and other wild plant materials

Culture can have a large influence on consumption, even in adjacent communities. For example, in coastal British Columbia, aboriginal residents on-reserve consume less than half of the wild protein by volume, but less rabbit, less fish and seafood, coupled with more roe, fish grease, smoked salmon, clams, and sea urchin than neighbouring residents not on-reserve (Jin et al. 1998). Although both Caucasian and minority anglers in Minnesota perceive food as an important benefit of fishing, there are cultural differences which influence the primary motivation for fishing among anglers; Latino anglers are motivated primarily by food, while African-American anglers are motivated by comradery and food, and caucasian anglers are perceived to be motivated by sport and competition (Schroeder et al. 2008)

Seasonality has the ability to affect diet inclusion patterns throughout the year. In a northern Ontario Ojibwa community, subsistence fishing efforts vary seasonally with the availability of other wild protein sources such as waterfowl, and these shifts in effort are reflected in their seasonal inclusion in the diet (Hopper and Power 1991).

Affiliation with demographic classifications and demographic interactions with cultural expectations are often cited as correlates with consumption rates, or the likelihood of consuming wild foods at all. In aboriginal communities of northern Alberta, older people tend to consume more wild foods than younger people (Wein et al. 1991). Even within households where wild meat is consumed, men consume more wild game and fish than women (Burger 2002, Burger and Gochfeld 2001). Although women are less likely to eat wild game and consume wild fish less frequently than men, they are equally likely to consume commercial foods of all types (Burger 2000).

Demographic characteristics associated with food insecurity, such as poverty, may also influence the inclusion of wild food in the diet. Among seasonal and migrant farmworkers in the southeastern U.S., households without children are more likely to consume wild fish and game because they are less likely to be able to access social programs (Quandt et al. 2004).

Affluence and its absence have implications for consumption rates. Wild-caught fish and small game are eaten disproportionately more by low-income African-American respondents in the Southeastern U.S., while more deer was consumed by higher-income African-American respondents (Burger and Gochfeld 2001). The results of a survey conducted at a popular outdoor show in South Carolina, demonstrated that wild-caught fish and game made up 50% of the meat and fish diet of African-American attendees, but only 32% for Caucasians (Burger and Gochfeld 2001). In the Southeastern U.S., men consume more wild game and fish than women; Caucasian men consume more deer than African-American men, and African-American men consume more fish than caucasian men (Burger 2002, Burger and Gochfeld 2001).

SUMMARY OF THE STATE OF KNOWLEDGE

METHODS OF INVESTIGATION

In general, data collection methods are well described and are limited in variety. The lack of variety is a sign of consistent use across studies, and is indicative that best practices are employed.

Hunting and angling participation and success rates are collected through mandatory reporting as a condition of the license to hunt or fish. Many aboriginal communities are exempt from mandatory reporting, though independent records may be available. Interviews and questionnaires have been used to fill this gap in some instances.

Determination of edible weight requires knowledge of use and, although various methods have been employed, there is no clear best practice for deriving estimates. What is clear from the literature is that caution must be exercised when estimating edible weight because the size of species varies geographically, and what is considered edible varies culturally. In much of North America, large game is butchered professionally, thus there may be professional standards of practice that would allow for a consistent formula to be applied to certain species.

Data collection methods and analysis of consumption rates are well-established. Standard tools such as 24-hour diet recall surveys and diet history (food frequency) surveys are used across disciplines such as medicine, nutrition, and anthropology, and are available online. These tools are appropriate to collect information on quantities and frequencies of foods consumed and are adaptable to include specific foods, such as wild fish and game species.

Food sharing studies are not as common, but consistently rely on personal interviews which allow the researcher to probe answers and uncover relevant information that may not have been considered on an a priori basis. If surveys are conducted such that they sample a population rather than target harvesters, gifting and receiving questions could both be posed to gain a better understanding of food distribution networks.

PARTICIPATION

Very good data is available by national survey summaries and through provincial, territorial, and state reports regarding direct participation rates in recreational hunting and fishing. Subsistence hunting and fishing is documented but likely underestimated, and survey methods to address this are outlined by Wolfe and Utermohle (2000).

Motivations and barriers to participation in hunting and fishing are well-studied, but are geographically patchy across North America. The influence of motivation on consumption appears to be more important directly to angling than to hunting, but food preference as motivation likely influences the type of hunting or fishing engaged in, and thus indirectly influences consumption patterns. Although a few good studies exist, the role of food insecurity as a motivation for hunting and fishing and, conversely, the role of wild-harvested protein in the management of food insecurity are issues not well-explored

Barriers, by definition, exert a strong influence on the capacity to participate in hunting or fishing; of those discussed in the literature reviewed, it is notable that a lack of knowledge regarding the handling and preparation of wild food is sometimes cited as a barrier and has a direct relationship to consumption.

Biomass Retention

As with some other components of wild game and fish consumption patterns, available information regarding biomass retained and consumed varies in quality, and most of the high-quality information is from the Canadian North and Alaska.

Good data exists on retention rates for recreational fishing in Canada, but is less geographically consistent for the U.S. Relevant U.S.-wide data may have been collected during the last national survey, but is not reported in the results (U.S. Fish and Wildlife Service and U.S. Census Bureau 2014).

The edible weight of hunted species is thoroughly reported for the north, and there are numerous calculators available online to help hunters estimate meat yield based on dressed weights of large ungulate game. As indicated in the summary of methods, considerable caution should be exercised in using reported edible weights considering the geographic variation in size within a species and the influence of local culture on what is considered edible.

Food Sharing

Food sharing patterns are not well-documented outside of localized studies of sharing networks in indigenous communities of the north. Sharing harvested meat is commonplace enough that most jurisdictions have a formal regulatory structure for the conduct of sharing. Where studies have been done, some common patterns emerge which influence the likelihood of receiving gifted, wild-harvested meat. These include kinship, need, and contribution to the hunt The literature is not

strong enough, however, to estimate the full North American reach of fish and game through informal sharing networks.

CONSUMPTION RATES

Consumption rates are defined in multiple ways (frequency of consumption, proportion of diet, inclusion or not) and with varying metrics (weight, volume, number), depending on the objective of the individual studies. Consumption rates are well-reported for individual regions and communities, particularly in the Canadian North and Alaska. North American geographic coverage is, however, generally poor.

What is evident from the studies that do exist is that consumption rates vary considerably. The extent to which wild game and fish are included in the diet varies between regions, and even between communities within a region. Further, consumption rates appear to be influenced by cultural expectation, socioeconomic factors, and demographic categories.

Considering both the inconsistent availability of data and the multiple factors influencing consumption rates, extrapolation to a North American scale is currently not feasible.

GAPS IN THE STATE OF KNOWLEDGE

Prior to the WHI there has been no known attempt to quantify food contribution of non-commercial harvest of wild game and fish at a North American scale. Not surprisingly then, there are numerous gaps in the state of knowledge related to the patterns of consumption of this wild harvest.

These gaps present opportunities for the WHI to contribute to a more fulsome understanding of the importance of wild-harvested protein to the contemporary North American diet. The major knowledge gaps that became evident during this literature review, related to consumption patterns, include:

- ***Geographic gaps: With the exception of participation rates, knowledge of consumption patterns is largely concentrated in Alaska and the Canadian north. Outside of the northern part of the continent, information tends to be localized sufficiently that broad-scale regional comparisons in consumption patterns are not practicable. Recreational fisheries, particularly in the US, are difficult to quantify because data availability is poor (Cooke and Murchie 2013).***
- ***Species bias: Some studies, particularly food frequency and diet history research, identify the full range of species consumed by the studied population. Most studies, however, focus on a***

defined set of species and not all species contributing to the North American diet have been the subject of evaluation. Compared to large game, studies that include measures of small game, waterfowl, and upland bird consumption are not common. Despite the known use of turtles, alligators, and frogs in North America as sources of protein (Klemens et al. 1995), no studies reporting on consumption patterns of reptiles or amphibians were found.

- *Use of harvested protein is poorly documented: With some exceptions noted in this paper, little data is available from recent (post-1990) research documenting the handling and use of harvested animals from which to estimate edible portions.*
- *Food sharing is poorly documented: Primarily an interest of human evolution research, the global study of wild-harvested meat and fish food sharing networks is overwhelmingly associated with cultures which are perceived to maintain a traditional hunter-gatherer lifestyle. Consequently, the available North American literature is focussed primarily on aboriginal people, particularly Inuit communities. Aside from quantifying venison donations to food banks, there were no studies found describing how non-aboriginal cultures in North America share wild meat or fish.*

IMPLICATIONS FOR THE WILD HARVEST INITIATIVE

The main objectives of the WHI are to quantify the biomass, economic value, and replacement cost of wild protein that is harvested outside of the commercial economy. There are several options for meeting these objectives.

Provincial, territorial, state and indigenous harvest rates can be combined with knowledge of retention and edible weights to develop appropriate estimates. This may be the simplest approach to meet the program objectives. The resulting information would add a great deal of new value to the existing knowledge base, and would be a welcome analysis to policy-makers as it would provide a much deeper understanding of the role of wild protein than currently exists. It may, however, underestimate the economic value by not reflecting what portion of consumed protein is wild-sourced or what portion of the diet this represents. Additionally, the reach of wild protein is much broader than direct participation statistics would indicate, and could not be accurately represented solely by the edible weight of harvest analysis.

Regardless of the depth or breadth of analyses pursued, the inconsistencies in geographic representation and the bias of previous study toward large ungulate game present both a challenge and an opportunity for the WHI. The existing literature clearly indicates that there is substantial geographic, cultural, socioeconomic, and demographic variation in the consumption of wild game and fish; capturing and evaluating this will pose strategic and logistic challenges. The same weaknesses in the existing literature present several opportunities for the WHI to contribute new

knowledge and novel analysis to the existing body of research related to wild-harvested meat and fish consumption. To meet the basic requirements of the Initiative's stated goals, geographic knowledge gaps need to be addressed through the establishment of an understanding of harvest use (retention and edible portion) representative of geographic regions and the cultural landscape of the continent. Quantitative descriptions of diet reference lesser-reported species (small game, birds, reptiles, amphibians), which is also necessary to fully meet the objectives of the WHI and would contribute further new analyses to the literature.

Few efforts outside of the study of the diet of aboriginal people have attempted to quantify the significance of wild protein in the North American diet or the significance of wild game and fish as a social or cultural currency. Pursuit of either, or both, of these lines of inquiry would contribute novel analyses to the evaluation of the importance of the wild harvest in contemporary North America. To extend the analysis to include the human-population impacts of the wild harvest, the Initiative might consider quantifying importance by pursuing either, or both, diet analyses and food-sharing studies. Diet quantification would allow for evaluation of the nutritional contribution of wild game and fish to North Americans; food-sharing studies would provide insight into the social importance of wild proteins. There is substantial theoretical and policy-oriented value to both of these directions, and this approach may be particularly suitable for research partnerships with academic institutions through graduate studies.

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Conservation Visions Inc. will educate and inspire the general public and sustainable use community on why conservation matters; promote sustainable use as a conservation mechanism worldwide; reestablish conservation as a social movement by promoting the concept of 'citizen conservation'; build strong and diverse conservation coalitions by building upon shared ideals; encourage and enable stakeholders to take action for wildlife and human heritage protection; reinvigorate the idea that wildlife belongs to everyone, and ultimately effect positive change for wildlife and humanity.

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Conservation Visions Inc. is dedicated to:

- a world where conservation matters
- a world where biodiversity is safeguarded, including the diversity of human cultural experience
- a world where conservation and citizenship are viewed as inseparable, and where a global responsibility to nature is recognized
- a world where the sustainable use of natural resources is safeguarded through knowledge
- a world where governments make sound decisions concerning conservation and biodiversity, based on scientific and traditional wisdom

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