

Towards a Historical Ecology  
of Halibut Fishing on the Northwest Coast

by

Jacob Ulrich Salmen-Hartley  
B.A. (Hons.), McGill University, 2014

A Thesis Submitted in Partial Fulfillment  
of the Requirements for the Degree of

MASTER OF ARTS

in the Department of Anthropology

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University of Victoria

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## **Supervisory Committee**

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## Abstract

### Supervisory Committee

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This thesis examines the enduring history of human interactions with Pacific halibut (*Hippoglossus stenolepis*) on the Northwest Coast of North America, through the framework of historical ecology, drawing on multiple lines of inference and diverse sources of archaeological, historical, and contemporary data. Morphometric analysis of traditional halibut fishing equipment, combined with analysis of halibut mouth structure, illuminates how this technology mediates the interactions between fishers and fish, and provides insight into the size of halibut targeted. Calculation of regression relationships to estimate halibut length from archaeological elements, and application of this method to nine archaeological sites, allows estimation of a pre-industrial Pacific halibut size baseline. Comparison of these data with industrially harvested size distributions from different time periods reveals significant differences between pre and post-industrially harvested populations. Historical written accounts, interviews with knowledgeable individuals, and experimental archaeology allow for further investigation into past halibut fishing practices.

## **Preface**

Chapter 3 is written as a manuscript for eventual single-authored publication.

Chapter 4 is written as a co-authored manuscript with significant knowledge contributions and editing from Dr. Iain McKechnie, as well as data and knowledge contributions from Dr. David Huelsbeck (Pacific Lutheran University).

Due to this structure there is a minor amount of redundancy between chapters.

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## Acknowledgments

I would first like to sincerely thank the Makah Tribe and the Heiltsuk and Wuikinuxv First Nations who trusted me with their archaeological materials. I hope that I can honour the importance of these fish.

Many individuals played important roles along the path of learning which has led to the production of this document. Thank you all for challenging, inspiring, teaching, helping, and putting up with me. A profound thanks to Dr. Iain McKechnie and Dr. Quentin Mackie. It has been an honour to learn from you both and I have enormous admiration for your wisdom, kindness, and passion. I would like to sincerely thank Eric Peterson and Christina Munck of the Tula Foundation for the financial support. Thanks to Janine Ludford and Rebekah Monette at the Makah Culture and Research Center for facilitating research requests and halibut measurement trips. Thanks to Jon Scordino and Joe Peterson at Makah Fisheries for a most excellent halibut hook think tank, and for inviting me to participate in the *čibu-d* fishing trials. Thank you to Rebecca Wigen for the freezer space and all the kind help. Thanks to Johnny Hunyh for the halibut wrangling and hook measuring help. Thank you to Brian Seymour at the Royal BC Museum. Thanks to Jennifer Walkus for being a teacher of cedar things. Thanks to Johnny Johnson and Fred Seiber for the fishing trips and wisdom. Thank you to the denizens of the UVic archaeology lab for friendship, support, and peer-review; Seonaid Duffield, Cal Abbott, Colton Vogelaar, Angela Dyck, Robert Gustas, Jenny Francoeur, and 'Frankie' C. Hebda. Thanks to Cathy Rzeplinski and Jindra Belanger for your help and kindness. Thank you to Dr. Iain Stewart, Dr. Josep Planas, Tracee Geernaert, and Eric Soderlund at the International Pacific Halibut Commission for providing data. Thanks to Gord and the

staff at Island Outfitters and all the halibut fishers who donated carcasses. Thanks to Jim Stafford and Tina Christensen for facilitating faunal samples. Thank you to Katie Luxa at the National Oceanic and Atmospheric Administration for organizing a fruitful research visit. An important thank you to Dr. Dave Huelsbeck for excellent record keeping, and your kind willingness to collaborate. Thank you to Harold C. Joe for the crucial archaeological edification. Thanks to Anne Tuominen for cheerfully helping with halibut measurement. Thanks to Denis St. Claire and Ted Knowles, for reminding me to listen, slow down, and cogitate. Finally, going back a few years I would like to thank Dr. Colin Wren for his mentorship, and many thanks are especially due to Dr. James Savelle for his mentorship, support, and love of fishing early on, and to Dr. Richard Mackie for key guidance and encouragement. Many thanks to Dr. Loren McClenachan for acting as an external examiner.

Finally, the following individuals are owed thanks for their thoughtfulness, guidance, support, and friendship (in chronological order): Myles Miller, Larissa Barry-Thibodeau, Sky Richards, Louis Grove, Sheina Lew-Levy, Al Mackie, Julie Smith, J Budd, David Wilson, Kerry Carter, J.J. Bailleaut, Dr. Dale Croes, Dr. Alan McMillan, Carla Pinelli, Dr. Gen Hill, Grant Keddie, Kenzie Jessome, Ashley Christensen-Pate, Nora Jessome, Dr. Chris Darimont, Maxwell Johnson, Rebecca Wigen, Dr. Brian Thom, Grant Callagari, and Bradley Clements. Crucially, a big thanks to Alex Lloyd and sorry for all those late dinners.

All mistakes are most certainty my own.

## **Dedication**

This thesis is dedicated to all those who love fish, and above all to Indigenous fishers who have fought and continue to fight for their fishing rights.

## Chapter 1: Introduction

### 1.1 Thesis Introduction

Fish and fishing have been fundamental components of human life in the North Pacific for more than 10,000 years (Moss 2011). The enduring importance of fish is seen in the superabundance of fish bones in coastal archaeological sites; fish typically make up 85% to 95% of all animal bones recovered (Moss and Cannon 2011). For many coastal First Nations in British Columbia and Native Americans in the US, fishing is a fundamental component of cultural identity (e.g., Claxton 2015:70; Cullon 2017:60; Newton and Moss 2005; Reid 2015; Wilkinson 2006), and the significance of some marine species cannot adequately be captured with terminology like 'food' or 'resource' but are better conceptualized as deeply familiar relations (e.g., Brown and Brown 2009; Claxton and Elliott 1994; Umek [Atleo] 2007).

Like many other global regions, the process of European colonization has drastically impacted Indigenous people's relationships with the marine environment on the Northwest Coast of North America (e.g., Boxberger 1989; Harris 2009b; Menzies 2016; Reid 2015). Despite constitutional affirmations of Indigenous rights to harvest fish in British Columbia and treaty rights in the US (Harris 2009a; Northwest Indian Fisheries Commission n.d.), access and control is reduced by many factors including non-Indigenous overfishing, pollution, climate change, policy favouring non-Indigenous fishers, and habitat degradation (Bennett et al. 2018; Haggan and Brown 2002; Harris 2001). A recent study of the projected effects of climate change on species important to coastal First Nations in British Columbia predicts that in the next 30 years average declines in abundance will be between 15% to 21% (Weatherdon et al. 2016). This is

projected to happen in conjunction with deteriorating marine ecosystems worldwide (Botsford 1997; Diaz and Rosenberg 2008; Golden et al. 2016; Halpern et al. 2012; Jackson et al. 2001; Worm et al. 2006).

Pacific halibut (*Hippoglossus stenolepis*) is a large and iconic predatory marine fish that has been the focus of sustained human use in the Northeastern Pacific since at least 10,700 years before present, or approximately 535 human generations<sup>1</sup> (Fedje et al. 2005; McKechnie and Moss 2016). Halibut is a culturally, ecologically, and economically important flatfish, that can grow to be over 250 cm, weigh in excess of 230 kg, and live for more than 50 years (Love 2011; Munk 2001). After millennia of sustained harvests and following recovery from early historical declines, halibut biomass (estimated weight of fish in the ocean), size-at-age<sup>2</sup> (growth), and recruitment (number of young fish entering the population) are now (as of 2018) greatly reduced from past levels (IPHC 2014; Stewart and Hicks 2018a). These observations have recently prompted significant harvest reductions, and further reductions are planned moving forward. These declines threaten Indigenous fishers' rights to continue their long-maintained relationships with halibut, as well as coastwide industry worth hundreds of millions of dollars annually (Agriservice B.C. 2017).

This thesis examines the deep history of halibut fishing on the Northwest Coast of North America, through the framework of historical ecology, at a broad geographic and temporal scale. Historical ecology seeks to examine long-term reciprocal interactions between people and their environments, using a wide scope of interdisciplinary methods to investigate change over time (Balée 1998, 2006; Beller et al. 2017; Crumley 1994,

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<sup>1</sup> Assuming human generators occur at 20-year intervals.




<sup>2</sup> Size at age is calculated from analysis of otolith grown rings from halibut of known size.

2003). In this thesis, I draw on multiple lines of inquiry including archaeological, historical, artifactual, ecological, experimental, interview, and ethnographic information, to gain insight into the long relationship between halibut and humans on the Northwest Coast. Specifically, I examine Indigenous fishing equipment and halibut mouth structure to better understand past fishing practices, and how traditional halibut fishing technology influences the size of halibut caught. I develop and apply a regression-based methodology to estimate halibut size from archaeological elements, and I compare these estimates with historical and present-day biological survey data to contextualize recent declines, with implications for present day management. To supplement this research, I conduct formal interviews and have informal conversations with knowledgeable individuals, which provides key pragmatic insight about halibut fishing, and I construct replicate traditional fishing equipment to further my own understanding of the technology.

### **Position and Objectives**

As a person of European descent who grew up in the unceded territory of Cowichan Hul'qumi'num' speaking people on Southern Vancouver Island, I recognise that I have benefited from the same colonial regime which drastically and intentionally impacted First Nations people's relationships with marine resources. Engaging with Indigenous heritage as an archaeologist, aware of the disciplinary baggage this entails (e.g., Deloria 1969:78; Simpson 2011; Starn 2011), I endeavour to use my privileged platform to work against colonial doctrine (e.g., Asch 2002; Harris 2004, 2009b), by highlighting the long pre-European history and celebrating the rich heritage of the territories on which I live and work. I draw inspiration from the efforts of anthropologists

such as Barbara Lane and others whose careful testimony was a crucial component of many legal decisions recognizing Indigenous fishing rights, particularly the Boldt decision in Washington State, and *Ahousaht et al. versus Canada*. Both of these decisions had profound implications for Indigenous relationships with fish (Boxberger 1989; Brown 1994; Harris 2008; Kirchner 2010; Wilkinson 2006). Accordingly, this thesis is motivated by the following objectives:

-  To emphasize the long history of human-halibut relationships in the North Pacific.
-  To examine the success of past management practices.
-  To contextualize the drastic changes in the halibut population brought about in the last 150 years.

## 1.2 Research Questions and Methods

Working towards these objectives, I explore the following three questions through an ecological, historical, and archaeological literature review (Chapter 2), a halibut hook morphology chapter (Chapter 3), an archaeological halibut size estimation chapter (Chapter 4), and four supplementary appendices: interviews with knowledgeable Indigenous fishers, experimental archaeology, halibut taphonomy, and halibut reference specimen preparation methodology (A,B,C,D). Questions 1 and 3 are the specific focus of Chapters 3 and 4, whereas question 2 is variously addressed in Chapters 2-4 and Appendix A from historical, archaeological, zooarchaeological, and interview methodologies respectively. Each question is briefly described here, with more substantial background information presented in Chapter 2. Chapter 5 revisits these questions, discusses findings, and proposes future directions.

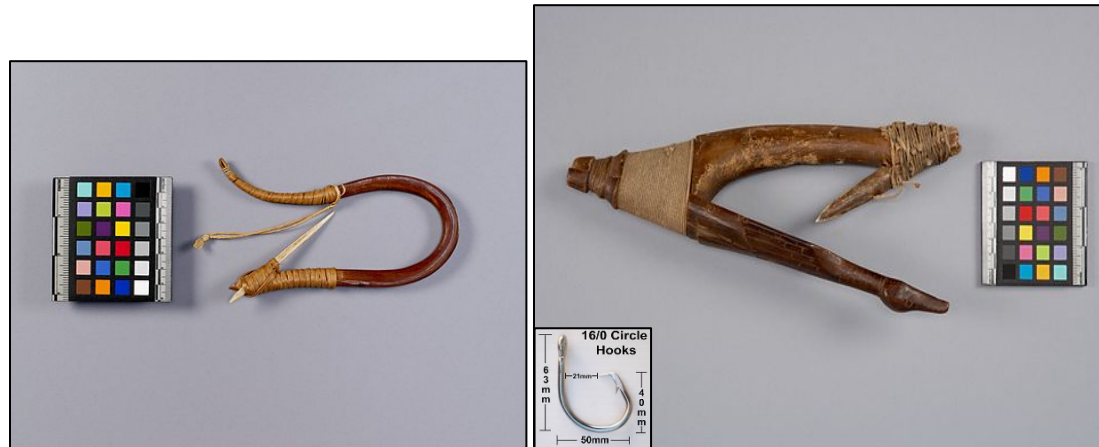
**Table 1:** Overview of research questions, sources of information, and methods.

| <b>Research Questions</b>   | <b>Related Sections</b>                               | <b>Sources of Information</b>  | <b>Methods</b>   |
|---|---|--|--|
| What can an archaeological analysis of Indigenous halibut fishing equipment reveal about past fishing practices and present-day implications? | -Chapter 3<br>-Appendix A<br>-Appendix B              | -Ethnographic Indigenous halibut fishing technology<br>-Halibut carcasses<br>-Interviews<br>-Ethnographic and historical information | -Morphometric analysis<br>-Qualitative observation<br>-Regression<br>-Spatial analysis<br>-Interviews<br>-Experimental archaeology |
| What was the size range of halibut caught in the past?  | -Chapter 2<br>-Chapter 3<br>-Chapter 4<br>-Appendix A | -Ethnographic and historical information<br>-Traditional Indigenous halibut fishing technology<br>-Archaeological halibut elements   | -Morphometric analysis<br>-Regression<br>-Interviews with knowledgeable Indigenous fishers   |
| Can archaeological halibut elements provide size data relevant for present-day management?  | -Chapter 4  | -Archaeological halibut elements<br>-IPHC setline survey data  | -Regression<br>-Inferential statistics   |

**Question 1: *What can an archaeological analysis of Indigenous halibut fishing equipment reveal about past fishing practices and present-day implications?***

Northwest Coast fishers traditionally targeted halibut with specialized technology designed with an intimate understanding of halibut character and biology (Stewart 1977). Traditional halibut hooks (Figure 1) have been shown to be species selective, catching significantly less unintended bycatch than the circle hooks now typically employed for halibut fishing (Scordino et al. 2017), and are broadly described as selective for a certain size range of fish (e.g., Malindine 2017). However, there is ambiguity about the size-selective properties of these hooks, with some authors arguing that they select for a wide range (e.g., Thompson and Weld 1961), and others a narrow range (e.g., Malindine 2017). There is also no clear consensus on the mechanisms which influence these size-selective properties, and they have never been substantially investigated. Because these

hooks are designed to catch only halibut (Waterman 1920), by examining their design, more can be learned about the interactions they mediate between fishers and fish.



**Figure 1:** Examples of U-shaped and V-shaped ethnographic halibut hooks compared to scale with a contemporary 16/0 circle hook commonly used for commercial halibut fishing. Hook on left (Museum of Anthropology: Nb626) dates to 1850 and has no cultural provenience. Hook on right (Museum of Anthropology: A2434) was collected from Tlingit territory but has no date.

Innovative approaches towards fishing gear are emerging as an important tool for present-day fisheries management (Valdemarsen and Suuronen 2003; Worm et al. 2009). Traditional halibut fishing technology, designed specifically for one species, using iterative knowledge gained through a long-term human relationship with that species, holds promise for providing lessons to improve fisheries catch and management efforts (Scordino et al. 2017).

In Chapter 3, I present a morphometric exploration of Northwest Coast halibut fishing technology. To better understand the functionality of traditional hooks, I examine and obtain measurements from 200 ethnographic halibut hooks from multiple museum and archival collections, as well as 63 Pacific halibut carcasses. Hook dimensions are combined with measurements of mouth structure to investigate how design elements mediate hook and mouth interactions. Next, halibut mouth morphology is related to body size (fork length) to estimate the size-selective properties of each hook examined.

Qualitative examination of fishing equipment and spatial analysis of hook typologies clarify understanding of this technology. Interviews with knowledgeable individuals (Appendix A), and experimental construction of traditional fishing equipment (Appendix B) also address this question.

**Question 2: *What was the size range of halibut caught in the past?***

The relative importance of different animal species found in archaeological assemblages is a fundamental component of zooarchaeological inquiry (Reitz and Wing 2008) and has implications for understanding the interactions between humans and their environments, and the sociocultural outcomes of these interactions. Much Northwest Coast archaeological literature has focused on this question and its spatial and temporal dynamics (e.g., Cannon 1991; Croes and Hackenberger 1988; Huelsbeck 1981; McKechnie and Moss 2016; McMillan et al. 2008; Moss 2012; Orchard and Clark 2005). However, unlike other culturally important species such as salmon, little archaeological scholarship to date has specifically examined pre-industrial<sup>3</sup> halibut use, and further investigation to explore its role in past Northwest Coast life is warranted. Additionally, due primarily to taphonomic factors, halibut is thought to be underrepresented in archaeological assemblages relative to its past importance (Orchard and Wigen 2016).

Estimation of the live body size of animals represented by archaeological material has long been a tool employed by zooarchaeologists to refine understanding of relative importance (Albarella 2002; Casteel 1974; Gifford-Gonzalez 2018:109). As a

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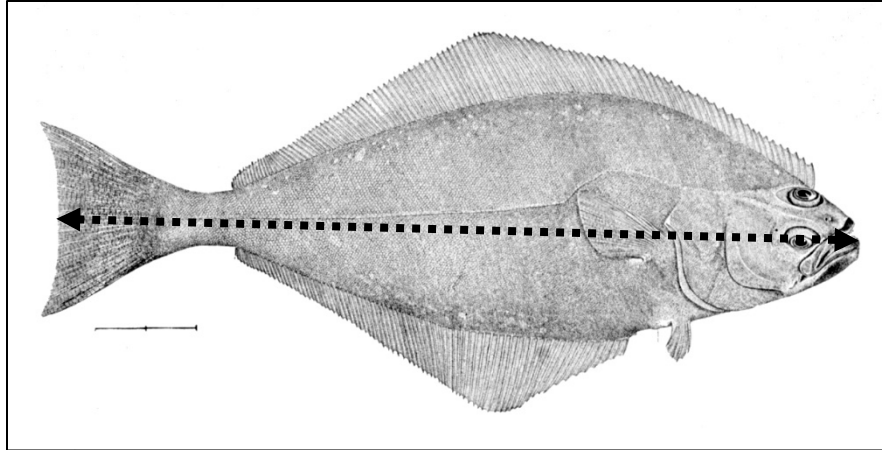
<sup>3</sup> I use the word ‘industrial’ to refer to the post-European contact commercial halibut fishery which began in the late 19<sup>th</sup> century. With this choice I do not intend to diminish the ‘industriousness’, scale, or significance of past Indigenous engagement with halibut. I also recognize the continuity of this engagement and significant participation within all aspects of the industrial fishery (Knight 1996; Lutz 2008; Menzies and Butler 2008; Reid 2015).

very large bodied fish, halibut grow considerably throughout their lifespan, and the size of halibut being caught in the past has social, cultural, and economic significance (e.g., Croes and Hackenberger 1988; Wigen and Stucki 1988).

The size range of fish caught by past harvesters can also act as a ‘fisheries dependent’ sample of the size structure of past halibut populations. Impacted both by human and natural factors, the size range of a species has important implications for the fitness both of that species and the broader ecosystem (Anderson et al. 2008; Barneche et al. 2018; Costa-Pereira et al. 2018; Stige et al. 2017).

In Chapter 4 I develop a regression-based methodology for estimating halibut fork length (Figure 2) from 43 different skeletal dimensions. This methodology is applied to 1,100 archaeological halibut elements from two coastal regions representing 3,000 years of late Holocene halibut fishing effort: seven sites in northwest Washington State in the territory of the Makah Tribe, and two sites on the Central Coast of British Columbia in the territory of the Heiltsuk and Wuikinuxv Nations. Development and application of this methodology provides an estimate of pre-industrial halibut harvest size profiles, with implications both for relative resource importance, and for contextualizing industrially harvested halibut populations.

Historical information reviewed in Chapter 2 provides information about past halibut size-at-harvest. The results of Chapter 3 additionally address the question of body size by providing estimates of the size-selective properties of traditional halibut hooks. Interviews with knowledgeable individuals summarized in Appendix A shed light on this topic as well.



**Figure 2:** Fork length measurement convention. Fork length is measured from the tip of the snout to the end of the middle caudal fin rays. Image from Wikimedia.

**Question 3: *Can archaeological halibut elements provide size data relevant for present-day management?***

Following disruption of longstanding Indigenous fishery management systems (Berkes et al. 2000; Menzies and Butler 2008; Reid 2015; Thornton et al. 2015; Trospen 2002), heavy unregulated industrial harvesting of Pacific halibut in the late 19<sup>th</sup> and early 20<sup>th</sup> century led to profound declines in abundance (Thistle 2004; Thompson and Freeman 1930). Harvest regulations enacted in the 1920's allowed for numbers to recover but abundance has fluctuated significantly (IPHC 2014). Following highs in the 1970's, size-at-age, a metric of halibut growth with important implications for abundance, has declined substantially (Sullivan 2016). Exploitable biomass (harvestable fish according to IPHC stock assessment models) declined by 60% from 2002 to 2013 (Stewart and Martell 2014b). Although these metrics were thought to be holding steady or slowly increasing, the most recent (2017) stock assessment showed further decreases in abundance and a pronounced lack of young halibut, which will cause further declines moving forward (Stewart and Hicks 2018a).

Despite much more retrospective survey data than exists for most species (Hilborn and Walters 1992:56), there is a considerable amount of uncertainty surrounding

the dynamics of the Pacific halibut population. Existing retrospective data only includes a population previously disturbed by heavy industrial fishing. Fish body size is a fundamental metric of fisheries management (Hilborn and Walters 1992), however it is currently unknown what length frequencies a non-industrially harvested population of Pacific halibut would display.

In Chapter 4, following development of regression methodology and estimation of archaeological halibut lengths, these data are compared with 11,636 historical (1914-1940) and 37,914 present-day (2014-2017) halibut lengths obtained from IPHC setline surveys. Archaeological length distributions contextualize historical and present-day industrial conditions and provide a pre-industrially harvested baseline from an entirely different management regime (cf. Lepofsky and Caldwell 2013; Morales et al. 2017).

## **Chapter 2: Background and Literature Review**

In this chapter I provide context and background for my thesis questions with a historical ecological review of halibut fishing on the Northwest Coast. To provide further theoretical grounding I first examine the general framework of historical ecology, and specifically conservation driven marine historical ecology. I then review Pacific halibut biology and the most recent (2017) IPHC stock assessment. To situate the approach taken in the rest of the thesis, I review previous zooarchaeological considerations of halibut, as well as various historically oriented examinations of halibut fishing. To better appreciate the varied Indigenous approaches towards harvesting and relating to halibut, I consider ethnographic and ethnohistoric writing containing descriptions of halibut procurement and consumption from Washington State to Alaska. I end this chapter by briefly reviewing the history of the industrial halibut fishery to connect ethnographic and archaeological understanding with the present day.

### **2.1 (Marine) Historical Ecology**

Historical ecology is a broad cross-disciplinary field of research concerned with the long-term interrelationships between humans and the natural world (Armstrong et al. 2017; Balée 1998, 2006; Beller et al. 2017; Crumley 1994, 2003). In anthropology, historical ecology has its philosophical roots in efforts to break down the nature/culture dualism (e.g., Latour 1993). Unlike approaches such as cultural ecology which seek to understand how humans react to their environments (Steward 1955), the framework of historical ecology postulates that much if not all of the natural biosphere has previously been affected by human activity, that humans are neither natural conservationists nor destructive by nature, that different types of human sociocultural systems will have

different effects on the biosphere, and that humans both purposefully shape and indirectly influence the environments that they inhabit (Balée 1998:14).

Researchers in a wide variety of fields including ecology, biology, archaeology, anthropology, history, geography, and ethnobiology, employ the concepts of historical ecology to engage with historical change in the service of knowledge, conservation, and management (Armstrong et al. 2017; Beller et al. 2017; Swetnam et al. 1999). Examples of diverse methodology and data include archaeological and zooarchaeological materials, dendrology, paleobotany, and ice core data, as well as restaurant menus, photographs, historical archives, and maps (Swetnam et al. 1999; Thurstan et al. 2015).

Conservation focused historical ecology aims to clarify past conditions to contextualize changes over time, and to provide management targets (Beller et al. 2017). Marine historical ecology seeks to extend often very short ecological records for marine species into the deeper past (Engelhard et al. 2016; Jackson et al. 2001; Kittinger et al. 2015; McClenachan et al. 2012; Pitcher 2001; Thurstan et al. 2015). Pauly (1995) first articulated the “shifting baseline syndrome” within fisheries management; species declines are unnoticed as successive generations of humans take increasingly degraded stocks as the status quo (also see Zeller and Pauly 2018). Pauly (1995) argues for the need to improve long-term data to situate ecosystem or population change over time. Within the context of ecological presentism, declining marine ecosystems worldwide, and a pervasive lack of long-term data (Jackson et al. 2001; Ludwig et al. 1993), marine historical ecology is uniquely positioned to provide such baseline data to put the effects of recent human-environmental interaction into sharper perspective (Pitcher 2001; Rick and Lockwood 2013).

In this thesis I employ a broad historical ecology framework to investigate human animal relationships, and change over time as driven by historical factors (as opposed to evolutionary etc.) (Balée 1998:13). Specifically, historical ecology frames my relational interdisciplinary approach wherein I use a variety of methods to explore long-term human-halibut interactions. In Chapter 3, I examine the relationship between humans and halibut as mediated by specific halibut fishing technology. Estimating past harvested size ranges in Chapters 3 and 4, I seek to understand past ecological states with implications for conservation. Finally, by using different historical management regimes (Indigenous, historical non-regulated, current IPHC science based) as points of comparison, I aim to better illuminate change over time for this important fishery.

## **2.2 Ecological Background**

Fossil evidence indicates that halibut have been present in the North Pacific for more than 100,000 years (Love 2011:574). Halibut are the largest flatfish and one of the largest teleost (bony) fish worldwide (Eschmeyer and Herald 1999). Adult Pacific halibut are found along the North Pacific continental shelf from Japan to northern California, and move widely along the North Pacific coast at all life stages (Skud 1977; Valero and Webster 2012; Webster et al. 2013). Halibut prefer cool deep water between 3-8 °C (Love 2011:571), and generally less jagged substrate than other commonly caught demersal species such as rockfish (*Sebastes spp.*) and lingcod (*Ophiodon elongatus*). Fisheries biologists have observed that halibut move seasonally to deep water in the winter to reproduce and shallower water in the summer to feed (Valero and Webster 2012). Present day halibut fishers often target the species on elevated underwater topography (banks) where they congregate to feed (Rudnick 2011). Halibut fishers

often find similar size halibut congregating in the same area (Rebekah Monette, Pers. Comm. Neah Bay April 2018; Joe Peterson, Pers. Comm. Neah Bay, Feb 2018). Halibut may travel more than 1,200 km to spawn and then typically return to the general area they were in prior to spawning (Valero and Webster 2012). Most spawning is now thought to occur north of Haida Gwaii, however it is recognized that unknown deep-water spawning locations may exist off the continental shelf. Halibut eggs and spawn drift with prevailing currents north and west. As juvenile halibut develop their eyes migrate to the right side, and they settle on the ocean floor. Young Halibut migrate clockwise countering earlier drift. As halibut grow they migrate less, but fish continue to move southeast throughout their lifespans (IPHC 2014; Webster et al. 2013). It is thought that the British Columbia Coast 'Area 2B' receives the most migration from other regions (Valero and Webster 2012:348). It is notable that current understanding of halibut migration patterns does not provide much explanation for the existence of halibut south of British Columbia. Indeed, most migration studies have focused on the northern management regions (Valero and Webster 2012:351). Their perceived high mobility is one of the reasons Pacific halibut are managed as a single stock by the IPHC.

Pacific halibut size-at-age, biomass, and recruitment, as well as corresponding catch allocations, have fluctuated since the end of the 19<sup>th</sup> century and have declined in the last 20 years (Stewart and Hicks 2016, 2018a; Stewart and Martell 2014b; Sullivan 2016). The productivity of the Pacific halibut population is thought to be strongly dependent on its rates of growth and recruitment (modulated by climate, competition, and habitat) as well as fishing pressure (Clark and Hare 2002; Stawitz 2017).

Following the catastrophic overexploitations of the early 20<sup>th</sup> century, coastwide halibut growth rates (size-at-age) varied widely, from lows in the 1920s, to a peak around 1970, then by the 1990s they returned to the lows seen in the 1920s (Clark et al. 1999; Clark and Hare 2002; Sullivan 2016). Following this, halibut size-at-age was observed to be decreasing steadily over the past 25 years, but has recently stabilized (Stewart and Hicks 2016, 2018a). For instance, the average weight of a 20-year-old female halibut decreased from 55 kg in 1988 to 20 kg in 2014, a 64% reduction (Sullivan 2016). Fisheries scientists have attributed fluctuations in halibut size-at-age to a variety of environmental and anthropogenic factors, such as the Pacific Decadal Oscillation, and interspecies competition with Arrowtooth flounder (*Atheresthes stomias* another flatfish), as well as density dependence (the effects of competition from other halibut), and the cumulative effects of intensive size-selective (using a minimum size limit) industrial and recreational fishing (Clark et al. 1999; Clark and Hare 2002; Sullivan 2016). Notably, using population modelling, fishing pressure (size-selective-harvesting) has been estimated to explain 30% to 65% of observed size-at-age declines since the 1980s in the Gulf of Alaska, and up to 100% of the declines in Southeast Alaska and British Columbia, areas with high harvest rates in the 1990s and 2000s (Sullivan 2016). Pacific halibut are thought to be particularly sensitive to size-selective harvesting because of their variability in size-at-age (Sullivan 2016:72).

Low size-at-age in the modern commercial fishery impacts the number of halibut that can be retained given the minimum size limit of 81.3 cm. Discard mortality for longline caught Pacific halibut has been estimated at around 30% (Myhre 1974). Low size-at-age also causes sex-selective harvesting because female halibut grow faster (IPHC

2014; Loher et al. 2016). Because of this natural growth disparity, the commercial halibut fishery is thought to catch predominantly female fish (ibid). However, quantifying the sex of the commercial harvest is difficult and this research is ongoing (Drinan et al. 2018; Loher et al. 2016). Decreased size-at-age also is thought to increase the species vulnerability to being caught as bycatch in other commercial fisheries (Adlerstein and Trumble 1998). Size, regardless of age is exponentially linked to the number of eggs released by female halibut (IPHC 2014). Recent scholarship has emphasized the dire reproductive consequences of decreasing fish size, and the paramount importance of large fecund 'old growth' females (Barneche et al. 2018; Barnett et al. 2017; Berkeley, Chapman, et al. 2004; Berkeley, Hixon, et al. 2004; Birkeland and Dayton 2005). However, because of the large commercial minimum size limit for halibut (81.3 cm), there is deemed to be enough productivity below the limit to compensate for the removal of larger females (Parma 1999). Given these confluences of factors, it is not surprising that minimum size limits are currently under review by the IPHC (Stewart and Hicks 2018b).

### **2017 Stock Assessment**

The most recent (2017) IPHC stock assessment (see Stewart and Hicks 2018a) observed a 24% decrease in halibut caught per unit effort<sup>4</sup> in the setline survey since 2016. Commercial weight per unit effort also declined by 3-5%. Size-at-age remains very low in relation to the rest of the time series with little change over the last few years. Pacific halibut biomass is estimated to have declined continuously from the late 1990s to around 2010. This is thought to be a result of decreasing size-at-age, as well as weaker

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<sup>4</sup> A measure of how many fish are caught with the same setline gear fished for the same amount of time in the same location each year.

recruitment strengths than observed in the previous decade. In 2010, estimated female spawning biomass appeared to have stabilized, and had been increasing gradually since then. Current recruitment estimates show the largest recent cohorts in 1999 and 2005, with fewer fish younger than the 2005 cohort signaling diminishing recruitment (Stewart and Hicks 2018a). The IPHC have projected a high likelihood of population decline moving forward. Notably, due to disagreements about allocating needed harvest reductions, for the first time in its 100-year history IPHC commissioners were unable to agree on harvest limits for 2018. Canada and the USA eventually independently reduced commercial quotas by approximately 15 and 9 percent respectively. Further reductions are expected next year.

### **2.3 Archaeological and Anthropological Background**

Previous archaeological and anthropological investigations into halibut fishing have generally focused on relative abundance, taphonomy, and fishing technology. Ethnographic descriptions of halibut fishing are reviewed in Section 2.4.

#### **Zooarchaeology**

Past Northwest Coast fishers caught a wide and variable (Orchard and Clark 2014) range of fish, from large bluefin tuna (*Thunnus orientalis*) (Crockford 1997), to small forage fish such as smelts (*Osmeridae*) (Moss et al. 2017), alongside many different marine and terrestrial species. Fishers employed a remarkable diversity of technologically sophisticated methods, ranging from elaborate estuarian traps to spinning lingcod lures (Stewart 1977).

Pacific Herring (*Clupea pallasii*) and Pacific Salmon (*Oncorhynchus sp.*) appear to have been especially important to past fishers, and are present in 98.2 and 95.9 percent

of all available (222) late Holocene fine screened ( $\leq 3.2$  mm) coastal assemblages from Oregon to Alaska (McKechnie and Moss 2016). However, more than 100 unique taxa were represented, and many of these genera or family designations include multiple species. Additionally, recent research has demonstrated that important small bodied fish such as anchovies (*Engraulis mordax*) and smelts can be missed unless matrix is screened with 1 mm mesh (Moss et al. 2017).

Attesting to the antiquity of fishing in the region, fourteen different families of marine fish were observed in an overview of five early Holocene coastal sites (Butler and Campbell 2004). The earliest evidence of human halibut utilization comes from Haida Gwaii; four halibut elements and many other marine fish were identified from Kilgii Gwaay, a 10,700 calBP wet-site (Fedje et al. 2005). Additionally, the Richardson Island Site dating to 10,500 calBP contained one tentatively identified calcined halibut vertebra (Steffen 2006:63). Following this, evidence for halibut consumption (and faunal remains in general) are somewhat rare throughout the early Holocene. Halibut were present at the Chuck Lake site (~8,500 calBP) on Hecata Island in Southern Alaska (Ackerman et al. 1985; Maschner 2012), as well as the Coho Creek Site (~7,000 calBP) in Haida Gwaii (Ham 1990; Wigen and Christensen 2001), and a small number of elements were found in Period Two strata (~7,000 calBP) from the extensively excavated Namu site on the Central Coast (Cannon 1991). Halibut have also been identified from mid-Holocene deposits at EkTb-9 on Triquet Island with a basal date of ~14,000 calBP (Fargo 2013; Gauvreau and McLaren 2017).

Flatfish, the third most ubiquitous late holocene taxon seen by McKechnie and Moss (2016), are present in 67.6% of assemblages. Halibut are the single most commonly

occurring flatfish across the coast, present in 19% of assemblages. Despite this persistence of presence, very little scholarship to date has directly investigated Indigenous halibut fishing on the Northwest Coast.

### Taphonomy

To examine past halibut utilization and to reconcile ethnographically and ethnohistorically reported levels of halibut use with zooarchaeological data, Orchard and Wigen (2016) reviewed eight late Holocene archaeological assemblages from Haida Gwaii, finding that the percent of all identified elements which are halibut (%NISP) ranges from 0.2% to 9.8% with an average of 2.2%. They also reviewed seven archeological sites in Makah territory on the NW Washington Coast where the %NISP of halibut ranges from absent to 25% with an average of 5.8%. They note that these values suggest a lower level of importance than their review of ethnographic and ethnohistoric accounts of Makah and Haida subsistence.

Orchard and Wigen (2016) examine potential biases in both sources of information. Taphonomic factors include differential butchering, storage, and consumption practices due to halibut's large size relative to other prey. For instance, halibut were likely treated differently than other fish taxa and may have been butchered on the beach or near a fishing location which would reduce the likelihood of bones ending up in central archaeological contexts. Boiling of the bones, their unique chemistry and distinctive structure may also have reduced their preservation (Orchard and Wigen 2016:52). To investigate density mediated survivorship, following Smith (2008), Orchard and Wigen (2016) compare halibut element density values with the relative representation of different elements from three sites with sufficient information. They

find that only one site (FaTt-28) out of three with enough information for comparison showed a significant correlation between halibut element density and representation. This suggests the influence of additional taphonomic factors besides element density.

Ethnographic and ethnohistoric biases are thought to arise from the season and location of early European presence corresponding to summer halibut fishing in exposed outer coast locations (Orchard and Wigen 2016). This may have given some early Europeans a myopic understanding of broader resource use. Orchard and Wigen conclude that the relative importance of halibut is currently difficult to discern in these two study areas. Halibut is likely slightly overrepresented in ethnographic and historical accounts, and due to various natural and cultural taphonomic factors, somewhat underrepresented in archaeological contexts. Although they examine two groups known for high levels of halibut use, Orchard and Wigen (2016:53) conclude that this pattern likely extends to other groups with a focus on halibut and other outer coast resources. Orchard and Wigen (2016), and McKechnie and Moss (2016) argue further investigation into the natural and cultural taphonomy of halibut use is warranted.

Smith (2008) examines the bone density of Pacific halibut and Pacific cod (*Gadus macrocephalus*), and its taphonomic implications. A review of ethnohistoric accounts of halibut processing leads Smith to conclude that fishing and butchering location, size of halibut, and quantity of other fish being processed at the same time, all influence the deposition of halibut bones in archaeological contexts. The type of archaeological setting (i.e., house floor or processing location) will also influence halibut presence. Smith (2008:39) observes that descriptions of preparing halibut for storage involve cutting it into long, thin, bone-free filets, which may contrast with the treatment of other fish, and

reduce the number of halibut bones transported to consumption areas. Smith (2008:40) notes a relationship in ethnohistoric accounts between fish element fat content and intensity of processing prior to or during consumption. Halibut cranial and vertebral elements are reported to contain high concentrations of fat, and these parts were described as prepared and consumed selectively in ways which break up bony structures to extract fatty tissues, such as boiling or chewing etc.

Smith (2008:60) finds that both salmon and halibut have similar average bone densities, both of which are less than Pacific cod, and that halibut maxilla, dentary, quadrate, and articular have the highest density followed closely by vertebrae. Smith (2008:65) notes a correlation between bone density and halibut total length. He compares halibut element density with abundance in five North Pacific archaeological assemblages, however only one (Amaknak Bridge, Unalaska) displayed a significant density/abundance relationship.

As seen here, much of the limited zooarchaeological examination of halibut use has focused on taphonomy, and it is clearly an important line of inquiry to further understand past halibut utilization. Taphonomy was not a direct focus of my investigations into fishing technology and archaeological size estimation; however, three components of this thesis can provide further taphonomic insight. In Section 2.5 of this chapter, I review ethnographic and ethnohistoric accounts of halibut use ranging from Washington to Alaska (Table 2). This expands previously limited ethnographic reviews of the historical treatment of halibut elements. Additionally, a broader idea of relative element survivorship can be obtained by comparing the skeletal position of each of the 1,100 halibut elements used for size estimation in Chapter 4. Neither Smith (2008) nor

Orchard and Wigen (2016) consider the relative representation of different vertebral elements. Additionally, my interviews with knowledgeable fishers specifically addressed the cultural taphonomy of halibut. These three sources of insight are brought together in Appendix C.

### **Traditional Fishing technology**

In the following section I chronologically review previous anthropological investigations into traditional Northwest Coast halibut fishing. These accounts are particularly relevant for the analysis of fishing technology carried out in Chapter 3.

To investigate past halibut fishing practices and the mechanics of traditional hooks, Thompson and Weld (1961) went fishing with Tulalip fishermen<sup>5</sup> Charles James, Landy James, and Wilbur “Daddy” James on a small bank 300 yards north of Tatoosh Island west of Neah Bay (NW Washington State). They used octopus for bait and describe catching and skinning octopi, then de-sliming and cutting the tentacles so they are the correct white colour. Although they did not catch many halibut, Thompson and Weld (1961) recorded important considerations of traditional Tulalip (northern Puget Sound) halibut fishing. For example, it is best not to speak badly about halibut when you are out fishing, or you will not catch any; and metal hooks are best when highly polished as they are less visible to halibut. Thompson and Weld (1961) note that when fishers made hooks, they shaped them to select for the approximate size they wished to catch, although all sizes can be hooked with traditional hooks. They also note that traditional hooks are said to turn away other ‘scrap fish’, selecting primarily for halibut (1961:4).

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<sup>5</sup> It is notable that Thompson and Weld went fishing with Tulalip fishermen at the Makah reservation which perhaps indicates the importance of productive halibut fishing banks in Makah territory.

During the late 1970s Ricky Hoff successfully replicated and tested small composite wooden hooks recovered from the Hoko River Wetsite (45CA213) as part of the archaeological research conducted at the Hoko River archaeological complex, (see Croes 1995, 1997, 2005). He and project director Dale Croes hypothesized that these hooks would have been used to catch the large number of flatfish (soles, flounders etc., i.e., *Pleuronectiformes*) including small halibut recovered from the site. Hoff's experimentation confirmed that it was indeed possible to catch medium sized flatfish with these hooks.

Stewart (1977) presents an encyclopedic reference of past Northwest Coast fishing methods. Stewart's attention to detail, thoroughness, and skilled illustrations, allow her books to stand as enduring points of reference. Stewart's work is based on analysis of museum specimens, previously published ethnographic data, her own conversations with practitioners, and personal reproduction and experimentation. She describes V-shaped and bent U-shaped halibut hooks used by fishers in the northern and southern portions of the Northwest Coast respectively, and she outlines a variety of peripheral equipment such as lines, leaders, spreaders, weights, etc. Stewart tested the functionality of a composite V-hook on aquarium housed halibut at the Pacific Environment Institute in Vancouver, concluding that because her first hook was too large for the small halibut at the aquarium, the size of the hook and barb plays a role in the size of halibut caught (1977:48). Stewart also presents the results of an experiment conducted with Don Abbott, then archaeological curator of the now Royal British Columbia Museum. Abbott tested the floating characteristics of a bentwood U-shaped hook from the museum collection, made from a fir knot (*Abies sp.*); he dove 40 feet underwater with

the baited hook and found that the hook sunk, floating barb down when attached to a line. The floating direction of the hook importantly impacts the way the hook will interact with a halibut's mouth. Hook floating direct is discussed further in Chapter 3.

Following Stewart's (1977) descriptions of traditional fishing line, physicist Michael LaBarbera (1985) performed a detailed material analysis on fishing line made from bull kelp (*Nereocystis luetkeana*). Performing a series of strength and elasticity tests LaBarbera concluded that, through careful processing, kelp can be made into a fishing line with a "test" of 128 lbs. This is significantly stronger than the line typically used for recreational halibut fishing ~80 lbs. Notably, each step documented by Stewart (1977) soaking in fresh water, stretching, etc., iteratively made the line stronger.

Croes (1997) uses stylistic analysis of basketry and wooden fish hooks recovered from wet site excavations to inform an analysis of 'central' versus 'northern' Northwest Coast groups, and to explore the development of cultural differences over time. As a component of this analysis he outlines three categories of wooden fish hooks. 'Type A' are V-shaped composite fishhooks made from three pieces, one of which is a barb. The small composite hooks recovered from the Hoko River excavations as well as the much larger V-shaped halibut hooks commonly associated with the Tlingit and other northern groups (e.g., de Laguna 1972) both belong to this category (Croes 1997:603). 'Type B' fishhooks are the self-barbed variety commonly thought to be used for 'cod' (e.g., Waterman 1920). 'Type C' are the steam bent halibut hooks recovered from the Ozette excavations, ethnographically associated with halibut fishing (e.g., Arima 1975; Waterman 1920). This is the only artifact typology developed for complete Northwest Coast fishhooks besides the vernacular 'V-shaped', 'U-shaped' 'northern halibut hook'

etc. In Chapter 3 I augment this bifurcated typology by attempting to consider overlapping regional styles and variation.

In a recent consideration of traditional halibut fishing equipment, Malindine (2017) reviewed ethnographic data (primarily from Tlingit peoples in Alaska) interviewed knowledgeable fishers and conducted morphometric analysis of 143 halibut hooks housed in museum and private collections. Between what Malindine calls the ‘early period’ CE 1867-1963 (n=118) and a ‘late period’; CE 1970-2015 (n=25), halibut hooks increased significantly in length as they shifted from functional fishing technology towards decorative art objects (2017:11). He finds that hooks from Alaska are slightly longer than those from British Columbia, attributing this difference to a greater need for larger, leaner, and therefore more storable fish in Alaska’s colder climate. Notably, and relevant to the second central question of this thesis, Malindine posits that traditional halibut hooks targeted a range of halibut between 20 and 100 pounds (90 to 148 cm)<sup>6</sup>. However, he gives no explanation for this number rather citing “archival data, peer-reviewed literature, and ethnographic interviews with contemporary carvers and fishers” (Malindine 2017:1).

Scordino et al. (2017) performed an evaluation of *čibu-d* (traditional Makah halibut hooks) to test their usefulness as a tool for reducing recreational by-catch, and to evaluate how they catch fish. Through recreational fishing trials comparing *čibu-d* with 8/0 circle hooks, the authors determined that *čibu-d* are effective at significantly reducing bycatch of non-target species (*čibu-d* were 7.4 times more likely than circle hooks to

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<sup>6</sup> Weight converted to fork length using the standard 1926 Pacific halibut length/round weight relationship:  $W_R = (9.205 \times 10^{-6})L^{3.25}$  (Clark 1991; Courcelles 2011). It should be noted that this conversion is thought to have a 10 to 20% error range which has been shown to change over time.

catch a halibut than a non-target fish species), but that they did not catch a significantly difference size range than circle hooks (Scordino et al. 2017:5). In a forthcoming paper Scordino and Makah fisheries colleagues test the functionality of *čibu-d* in a commercial longline application (Jon Scordino Pers. Comm. Neah Bay January 2018).

Building on this previous work which contained only limited detail of the actual construction process from an experimental perspective; to further understand materials and methods I document my own experimental replication of traditional halibut hooks and fishing line in Appendix B.

## **2.4 Ethnographic and Ethnohistoric Background**

Halibut are pervasive in ethnographic and ethnohistoric descriptions of Northwest Coast groups, from the Eyak of Alaska to the Southwestern Coast Salish, particularly in descriptions of outer coast groups such as the Makah (Orchard and Wigen 2016:38). Here, ethnographic and ethnohistoric writing is reviewed to provide information about Indigenous halibut fishing practices. I pay specific attention to the treatment of halibut bones with a focus on taphonomic implications. Summarized information dealing with destructive treatment of halibut bones is presented in Table 2 at the end of this section. Notably, these accounts represent written observations from the post-European contact era, where some technological and material attributes may have changed significantly from pre-contact times (cf. Carlson 2007; Grier 2007; McMillan et al. 2008). I do not consider these texts authoritative cultural snapshots, but rather recognise the presence of innovation, fluidity, and change before and after these observations (cf. Moss 2011; Starn 2011; Wobst 1978). This review moves from south to north separated by ethnographer

but is not intended to be comprehensive. Only select information from particularly detailed accounts about halibut fishing is included.

Historian Joshua Reid (2015) compiled extensive archival research into a detailed history of the Makah tribe. Reid describes Makah ancestors discovering Swiftsure Bank<sup>7</sup> off the Olympic Peninsula while returning home from a whaling trip: “The whalers spotted sea lions feeding on halibut, so they took cross-bearings on Tatoosh Island, Waadah Island in Neah Bay, and the highest peak visible on Vancouver Island. The next day they returned with their gear and filled the canoe with halibut in a little while, and came home happy and shouting from far out to sea (Reid 2015:213).” Over time these fishers learned the specific ocean currents to swiftly take their canoes back and forth from the bank. This account both speaks both to the profound understanding of the landscape generated through many generations of interaction, and the mechanism wherein a new marine species, typically dwelling deep underwater can be discovered.

James Swan, US government Indian agent who lived on the Makah reservation in the late 19<sup>th</sup> century (1868:22) describes halibut as the staple food of the Cape Flattery Makah, “[halibut] is cut into thin slices and dried, if possible, in the open air without smoke”. This long-lasting dried halibut was dipped into whale oil and eaten. Swan (1868:22) describes halibut being caught most frequently on “banks fifteen or twenty miles [~27km] west from Tatooshe (sic) light”. Using a conservative paddling speed estimate of 3 km/hr, not considering wind or swell (Ames 2002:30), these fishing trips could take the better part of 18 hours roundtrip. However, sails which were used on Makah canoes during this period (Swan 1868:30) would decrease this travel time. Swan

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<sup>7</sup> Although often spoken of as specific locations Swiftsure and La Perouse banks include large areas of the continental shelf.

is likely describing trips to Swiftsure Bank (using a modern chart Swiftsure Bank is approximately 25 km from Tatoosh) which continues to be an important halibut fishing location, although many other specific banks were also important (Reid 2015). Swan (1868:23) describes the use of bull kelp line to catch halibut on banks “from twenty to thirty fathoms [45 m] in depth”. Bentwood hooks made from “splints of hemlock” (*Tsuga sp.*) and baited with ‘squid’ (common octopus) were used either as setlines (setlines involve gear anchored to the ocean floor and attached to a float at the surface), or handlines with stone sinkers. Hooked fish were hauled to the surface and clubbed. Fish were wiped and gutted on the beach then carried indoors (Swan 1868). Halibut heads were separated and kept while flesh was removed with a halibut specific ground-stone knife. Flesh was cut thin, dried in the manner previously described, then stored wrapped in the dried skin. Vertebrae were dried and stored, and vertebra and heads were boiled for consumption (1868:23). Swan (1868:30) describes halibut as available year-round: “on any day in the year when the weather will permit, they can procure, in a few hours, provisions enough to last them for several days”.

Anthropologist Thomas Waterman (1920) compiled notes on Makah fishing equipment in the early 20<sup>th</sup> century. He interviewed C. Peterson a Makah fisherman, and conducted field research at the Neah Bay reservation. Waterman (1920) writes that the Makah used bent U-shaped wooden hooks made from steamed hemlock knots, and that these hooks caught medium sized halibut 25 pounds or less (<97 cm). According to Waterman this style of hook was used as far north as Haida and Tsimshian territories, but Makah community members constructed hooks of the finest quality. These hooks were intended only to catch halibut and were “very carefully designed with a view to the

anatomy of the halibut's jaws... construed so that there is just enough room between the tip of the barb and the top of the frame, for the halibut's nose to slip in (one finger's width is the proper distance)" (Waterman 1920:11). Waterman reports that halibut were also sometimes caught on the large straight shanked hooks used for "bull heads and lingcod" and that octopus made the best halibut bait (1920:4).

In a review chapter on the Central Coast Salish in the *Handbook of North American Indians*, anthropologist Wayne Suttles (1990:457) writes that the "Central Coast Salish" (Skwxwú7mesh, Hul'q'umi'num', Nooksack, Northern Straits, and Clallam) caught halibut "in almost every village on the saltwater". Halibut were caught at depths of 30-70 m using bentwood hooks and octopus as bait.

Suttles (1974:114) based on interviews with Straits Salish community members in the 1940's and 1950's, recorded that halibut were once numerous near southern Vancouver Island and Haro and Rosario Straits, and that besides salmon they were the most important food in the past. Bentwood hooks were made from fir (*Abies sp.*), hemlock (*Tsuga heterophylla*), or yew (*Taxus brevifolia*) with a deer or elk bone barb. Fishing line was made from nettle (*Urtica dioica*), kelp stipes (*Nereocystis*), or willow bark (*Salix lucida*) (1974:116), and fishing was either done by hand or with an anchored setline with a float. Salish community members from inland villages on Vancouver Island processed their catches at temporary fishing stations, while those from smaller islands such as Discovery and Chatham and the Saanich Peninsula, processed them at home (1974:116). Halibut meat was cut thinly and dried, and halibut vertebrae were cooked and eaten.

Anthropologist Homer Barnett conducted extensive fieldwork among the Coast Salish between 1935 and 1939. Barnett (1955) describes how halibut were frequently caught on banks in the southern Strait of Georgia but were not common elsewhere. Barnett (1955:20) describes how “East Saanich” (Tsawout) caught halibut off Saturna Island near East Point. Cowichan (Hul’qumi’num’) people described catching halibut off Mayne, Prevost, and North Pender Islands (Barnett, 1955:22). Halibut flesh was dried for winter use with tails, fins and other bones retained for roasting or boiling (Barnett 1955:62). According to Barnett, no halibut were fished by the Tsawwassen, Skwxwú7mesh, or Klahoose (1955:67-68). Furthermore, halibut were said to be scarce in Powell River, Cowichan Bay, and Nanaimo, and were accordingly eaten fresh when caught in those locations. Halibut hooks were the only type of hook used for halibut but could also be used to catch large ‘cod’ (likely rockfish) (Barnett 1955:84-85). Halibut hooks were described as bent Pacific yew, oceanspray (*Holodiscus discolor*), Pacific crabapple (*Malus fusca*), or other hardwoods. Floats were not used, and sinkers were either grooved or smooth not perforated. Kelp lines were only used around Victoria, elsewhere, twined inner cedar and willow bark were used (Barnett 1955:85). It should be noted that Barnett was conducting ethnographic fieldwork after the boom period of the industrial halibut fishery (1880’s-1920’s), when abundance, particularly in easily assessable areas close to major ports had sharply declined (Thompson and Freeman 1930).

In the 1970’s anthropologist Eugene Arima spent time in Port Renfrew on the southwest coast of Vancouver Island and interviewed Pacheedaht hereditary chief Charles Jones to learn more about Pacheedaht fishing practices (Arima 1975). Arima

writes that halibut were available just off shore year-round, and that they were the second most important resource after salmon (Arima 1975:66). “With knowledge of the banks, weather, currents and other pertinent conditions, seaworthy cedar canoes, and refined gear, the native halibut fisherman was able to take great quantities of the tasty and nutritious fish” (Arima 1975:66). Chief Jones recounted that halibut tasted better in the winter but Arima did not record why (Arima 1975:86). Halibut hooks were constructed from steam-bent hemlock or fir knots<sup>8</sup> (Arima 1975:68). Bone barbs were lashed on with split root. Hooks were fished in three different ways, as a handline, as a setline and as a driftline. With all three configurations, kelp line with a spreader bar was used (Arima 1975:80).

Anthropologist Phillip Drucker (1951:36) conducted ethnographic fieldwork primarily among the northern Nuu-chah-nulth on the west coast of Vancouver Island in 1935-36. For a contextualization of Drucker’s work see McMillan (2009). Drucker describes halibut as of varying importance to different Nuu-chah-nulth Nations, with the Kyuquot having a “famous” halibut fishery (1951:36). Drucker describes halibut being caught with U-shaped hooks made from steamed spruce roots, bent by hand (1951:22). Plaited nettle fibers attached hooks to kelp line and stone sinkers with wooden spreaders were used. Halibut were fished on offshore banks and had to be procured when the weather was calm (Drucker 1951:36). Typically, halibut are described being caught with species specialized equipment. However, occasionally halibut gear was used for “red snapper” (1951:58). Drucker (1951:44-45) describes halibut fishermen anchoring at their

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<sup>8</sup> Knots, the base of branches inside a tree trunk, are a type of reaction wood. Reaction wood has a different structure than normal wood due to its reaction to the forces of gravity (Scurfield 1973). Knots are harder and have greater tensile strength than normal wood to support the weight of branches.

preferred bank using a large rock and kelp rode. Octopus bait was tied on the back of the hook from the leader to the end of the barbed arm, or alternatively was attached to the inside of the hook covering the barb. A wooden fishing pole was used to take the weight of the rig while waiting for a bite and to add elasticity to the rig. Large halibut “[which] are not infrequent on Nootkan banks” were brought into canoes by clubbing the fish then tipping the canoe until the gunnel is just above the surface and sliding the fish in. Removing the specialized hook from the halibut’s mouth was a difficult task which required practice. Drucker (1951:65) describes many specific halibut fishing locations for individual groups.

*Native Accounts of Nootka Ethnography* (1955) produced by Anthropologist Edward Sapir and his student Morris Swadesh contains the first-hand accounts of several Nuu-chah-nulth community members including Tom Sayach’apis a Tseshaht elder whose words were translated by his grandson Alex Thomas and Sapir (McMillan 2009). Sayach’apis describes the Tseshaht giving halibut hooks, as a valuable wealth item, to the Ucluelet during potlatch ceremonies (Sapir and Swadesh 1955:39). Tseshaht communities in the Broken Group Islands on the West Coast of Vancouver Island started to fish halibut once summer was well in effect (Sapir and Swadesh 1955:41). All community members would participate in this fishery. Fishers would paddle whaling canoes four to a vessel as soon as night fell. They would paddle all night reaching their destination at an offshore bank by dawn. The distance from the outer Broken Group Islands to La Perouse Bank is approximately 25 km, and the approximate time from sunset to sunrise at this latitude in June is 8 hrs. This produces a paddling speed estimate of approximately 3 km per hour, remarkably similar to Ames’s (2002:30) estimate used

previously. Fishing lines would have a series of five hooks. Canoes would head home before noon navigating by distant mountain peaks. Plentiful halibut and skilled fishers made it easy to fill the boats with fish. Once returning Tseshah would feast on halibut heads. These were clearly trips intended to stockpile a large amount of halibut, “one could not see the houses for the halibut hanging in front to dry” (Sapir and Swadesh 1955:41).

John Jewitt, a British blacksmith who was held captive in Chief Maquinna’s territory on the West Coast of Vancouver Island from 1803-1805 wrote about Mowachaht use of halibut. He describes drying halibut flesh in the sun and “halibut heads and tails” steam cooked in a pit (Jewitt 1896:108,151). He also describes fashioning iron hooks to replace wooden halibut hooks (Jewitt 1896:86). This is a consideration when assessing the possible antiquity of museum specimens (see Chapter 3), although his situation is unique.

In the early 20<sup>th</sup> century Franz Boas wrote about the Kwakwaka'wakw largely based on information compiled and translated by his Tlingit/Kwakwaka'wakw collaborator George Hunt. Boas’s method, which would later influence the methodology of students such as Edward Sapir, was to present information as unaltered as possible, recording in Kwak'wala and translating to English. These manuscripts contain many details about halibut fishing. Halibut hooks were made from a fir knot (Boas 1909:334). Pieces of wood were cut square with one end thinner than the other. All pieces were made the same length then soaked in fresh water. Patterns were laid out and pegs fitted into a board to produce the desired shape. Use of patterns ensured replication of identical hooks (Boas 1909:412). Hooks were steamed using hot rocks and kelp, and after being

bent to shape they were heated to retain their shape (Boas 1909:334). Bone barbs were lashed on with spruce root and hooks were fished in pairs (Boas 1909:471). The Kwakwaka'wakw were said to be unique in attaching the sinker loosely with cedar bark so it is shaken off by the halibut when it bites (Boas 1909:480). Fishing line made from cedar bark lasted a long time for halibut fishing (Boas 1921:122). Gushgimukw people remembered using trolling hooks to catch halibut until the bentwood hook was introduced from other areas (Boas 1909:488).

Descriptions of the halibut fishing process recorded by Boas and Hunt are extremely detailed (see Boas, 1909:472-480; 1921:241-252). Halibut fishing requires many prerequisite steps. For example, soaking hooks with hot spruce root infused water, pounding octopus tentacles, washing hands with seaweed etc., all of which are vital to the success of the endeavor. Notable details from these descriptions include the amount of octopus tentacle per hook is one span<sup>9</sup> plus two finger widths (Boas 1909:476). Two sealskin floats are used, the smaller one called “sitting below” sitting seven meters under the larger “bladder on top” which presumably helps accommodate tide changes and keeps the line vertical (Boas 1909:477). Once clubbed and brought into the canoe halibut must be laid on their backs with the head facing towards the fisher (Boas 1909:478). Once brought back to the beach, halibut are cleaned by women using four different knives (Boas 1921:242). Eating the first halibut immediately is a crucial step in the fishing process and demonstrates the fisher’s respect for the halibut. For the first fish caught, filets are removed by cutting through the vertebral processes. These are cooked over the fire while preparations are made for steam cooking. Vertebrae fins and heads are steamed

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<sup>9</sup> A ‘span’ is measured with the open human hand, from the tip of the thumb to the tip of the little finger.

on the beach and eaten there (Boas 1921:245). Remnants from this meal are tossed onto a mat, then the halibut fisher's wife throws all the bones into the ocean (Boas 1921:246). When butchering the second and any other halibut following, the head, fins, vertebrae, and tail may be retained and dried (Boas 1921:249). The vertebral processes containing meat (ribs) may be cut off for consumption or storage (Boas 1921:248). For storing, the flesh of the halibut is cut thinly, dried, and kept 100 pieces to a bentwood box (Boas 1921:252).

Detailed recipes for every part of the halibut are found in Boas (1921:357-379). Recipes describing interactions with bones are summarized here. One method of preparation involves chopping heads and vertebrae into small pieces and boiling (Boas 1921:357), this soup is served to guests and receptacles are provided for bone chunks. After the soup is finished the bone chunks are chewed to extract the fat then spat out (1921:358). Dried halibut heads were rehydrated using the bilge water of the halibut fisherman's canoe, then thoroughly boiled (Boas 1921:372). Any remaining bones were tossed into the fire. Halibut heads were only consumed in the afternoon and evening because the high fat content is liable to make one sleepy (Boas 1921:358).

Geologist and ethnologist George Dawson visited Haida Gwaii in 1878. Alongside his geological observations, Dawson also wrote about the Haida community members he encountered. Dawson (1878:44) recounts that the inhabitants of Haida Gwaii relied almost entirely on fish, of which halibut were described as most important. Halibut were plentiful on many nearshore banks and could be caught in any season, although the halibut near Skidigate were most plentiful in spring and summer (Dawson 1878:109). Dawson describes the fishery as "systematically pursued" using wooden hooks with iron

barbs or curved iron hooks “of their own manufacture”. He describes Haida Fishers using wooden hooks made from a forked branch or from two pieces of wood lashed together, the latter were decoratively carved, and “owing to the want of the yew, it has not the same graceful shape with that of the Ahts<sup>10</sup> and Makah Indians” (Dawson 1878:114). Halibut were processed by women who removed the larger bones, cut the meat into “long flakes” and then dried them using smoke. Halibut heads were occasionally left on the beach below the high tide line to partially decompose before being consumed (Dawson 1878:111).

Anthropologist Frederica de Laguna conducted fieldwork among the Yakutat Tlingit from 1949-1954. De Laguna (1972) describes halibut as ‘ranking first’ among flatfish. Her informants described halibut being caught in the winter, spring, and summer, using octopus for bait (de Laguna 1972:52,55). Large V-shaped composite hooks are used with spruce root to bind the two arms together (de Laguna 1972:388). Upper arms were made from yellow cedar (*Cupressus nootkatensis*), and lower arms from alder (*Alnus sp.*). Yellow cedar is appealing to halibut because of its smell. Fishing line was made from braided spruce root or kelp. Hooks were fished singly or in pairs as a setline with a float. Halibut hooks were elaborately carved and each one carried a name (de Laguna 1972:389). These carvings had important functional implications, communicating certain meaning to halibut. Hooks would float with the carved yellow-cedar upper arm facing downwards towards the halibut. Fishermen could tend multiple setlines at once, hauling halibut up and clubbing them when a float begins to move (de Laguna 1972:391). Halibut skins were used to make large bags or glue (de Laguna 1972:416,425).

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<sup>10</sup> This term was previously used to refer to Nuu-Chah-Nulth peoples.

To document traditional Tlingit subsistence practices, Richard Newton, a Tlingit historian, and archaeologist Madonna Moss conducted interviews with Tlingit elders in the 1980's (Newton and Moss 2005). Newton conducted the majority of interviews in Tlingit and Moss conducted hers in English. Newton's grandfather John Jackson recalls catching halibut in the spring when other foods were running low (Newton and Moss 2005:13). Fishers tried to target large halibut and left small halibut to reproduce. Tlingit halibut hooks only hooked large halibut as small halibut's mouths were too small. Fishers would use larger bait which would keep the halibut's mouth open if they wanted it to drown. Large halibut were speared and towed to shore rather than risk taking them into the boat. Henry Katassee recalls March and April as the months Tlingit people fished halibut. Winter halibut were best for storing and dried a much lighter colour than summer halibut which dried dark. George Dalton told Newton that Tlingit people cooked and ate the fins tail and head of the halibut (Newton and Moss 2005:13).

This ethnographic and ethnohistoric work, written from 1868 to 2015, speaks to the importance of halibut both in pre-contact times and its enduring importance today. As Swan (1868) and Sapir and Swadesh (1955) recount, fishers were willing to paddle extremely long distances to load their canoes with halibut. Halibut are described being caught both in the winter and the summer. Fishing techniques were generally similar, involving specific wooden hooks, line made from kelp or other materials, weights, and other implements such as spreaders. Hooks are described catching certain size halibut, and this will be examined further with additional ethnographic information in Chapter 3. Fish were butchered with halibut specific knives, and different butchery practices were followed depending on the circumstance. As summarised in Table 2, most descriptions of

halibut consumption involve cooking of cranial and vertebral elements, often through boiling. Cooking particularly boiling, has been observed to change the chemical composition of bone, making it more susceptible to destructive processes (e.g., Nicholson 1996; Zohar et al. 2016). Taphonomy is discussed further in Appendix C.

**Table 2:** Ethnographic descriptions of destructive treatment of halibut skeletal elements.

| Region                         | Group         | Treatment  | Reference                 |
|--------------------------------|---------------|--|---------------------------|
| Cape Flattery                  | Makah         | -Flesh cut thinly and dried<br>-Vertebrae dried and stored<br>-Vertebrae and heads boiled  | Swan 1868:22              |
| Salish Sea                     | Coast Salish  | -Flesh cut thinly and dried<br>-Tails fins and other bones roasted over fire or boiled for soup  | Barnett 1955:62           |
| Haro and Rosario Straits       | Straits       | -Vertebrae cooked and eaten  | Suttles 1974:173          |
| Barkley Sound Vancouver Island | Tseshah       | -Halibut heads eaten after halibut fishing trip  | Sapir and Swadesh 1955:41 |
| Yuquot Vancouver Island        | Mowachaht     | -Halibut heads and tails steam cooked  | Jewitt 1986:108,151       |
| Northern Vancouver Island      | Kwakwaka'wakw | -Flesh cut thinly and dried<br>-Processes (spines) cut off vertebrae<br>-Heads tails and vertebrae dried<br>-Heads and vertebrae chopped up and boiled for soup then chewed<br>-Heads boiled | Boas 1921:249, 357-359    |
| Haida Gwaii                    | Haida         | -Halibut heads left in the intertidal to soften before consuming   | Dawson 1880:111           |
| Alaska                         | Tlingit       | -Halibut heads fins and tail cooked and eaten  | Newton and Moss 2005:13   |

## 2.5 Early Industrial Fisheries

Drastic changes occurred in the way people interacted with halibut in the North Pacific after European contact. Longstanding Indigenous management regimes were

subsumed by an unregulated industrial fishery and then later IPHC management. Halibut abundance declined drastically then fluctuated. In this section I outline a brief history of the industrial halibut fishery to connect the ethnographically documented accounts observed in the previous section to the present day.

Halibut has been an item of food and commerce on the Northwest Coast for millennia. For example, Makah community members traded halibut for all sorts of things including canoes, mats, and dried salmon (Reid 2015; Swan 1868). Makah community members are also said to have traded their high-quality halibut hooks to northern groups (Niblack 1890:291). Euro-industrial exploitation of Northeast Pacific halibut stocks began in the 1880's (Thistle 2004). Thompson and Freeman (1930:14–15) perform a rough comparison of Indigenous and non-Indigenous halibut fisheries in 1884, using values from early Canadian Government reports. In that year Indigenous halibut landings (~300,000 lbs<sup>11</sup>) were twice as large as non-Indigenous landings (~150,000 lbs).

Harvests quickly increased and by 1888, 200,000 lbs and 150,000 lbs were landed in Victoria and Vancouver respectively (Thompson and Freeman 1930:16). Many of these fish were sold by Indigenous fishers who have played a significant role in the industrial halibut fishery since its inception (Bell 1981; Knight 1996; Menzies and Butler 2008; Reid 2015). During this period two-person vessels which could hold approximately 3000 lbs of halibut, “Indian canoes” and a few larger vessels fulfilled the local needs of Victoria, Nanaimo, Vancouver, Seattle, Port Townsend, and other small ports (Bell 1981; Thompson and Freeman 1930). Three large East Coast schooners made a go at salting

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<sup>11</sup> Imperial pounds and centimeters are the common units of the international halibut fishery.

halibut for the east coast market in 1888, but this only lasted two seasons (Bell 1981:21–22).

In the late 19<sup>th</sup> century, the Cape Flattery Makah community sold large amounts of halibut to burgeoning Victoria and Seattle markets and beyond (Thompson and Freeman 1930:15). Estimates for the 1880's include yearly takes of 1.5 million pounds, with 600,000 pounds for non-commercial use (Reid 2015:217; Thompson and Freeman 1930:15). Continuing their long-maintained fishery management system, Makah community members initially fished and sold halibut to non-Makah buyers, rather than let outsiders directly fish on their owned banks (Reid 2015:211). In the winters of 1888 and 1889, three early settler industrialists manning the small sloop *Alice* were some of the first non-Makah to fish the nearshore banks off Neah Bay and Cape Flattery (Thompson and Freeman 1930:17). During this period, by following Indigenous fishers “or by hiring them directly, white men began to learn the locations of the more distant fishing banks, offering, it is said, 50 cents per fish but failing often to pay” (Thompson and Freeman 1930:17). Some early attempts were made to sell fish southward to distant ports such as San Francisco, but generally this was a nearshore fishery serving local ports.

Expansion of railways connecting Eastern North America, fossil fuel powered boats, and the decline of Atlantic halibut due to overfishing, quickly ramped up the industrial halibut fishery by the end of the 19<sup>th</sup> century (Bell 1981; Morris 1932; Thistle 2004; Thompson and Freeman 1930). Stymied at first by the cost and availability of ice, with some shrewd fishers prefacing their fishing with a trip to Alaskan glaciers, the industry quickly gained momentum (Thistle 2004:107–8). Development of the fishery

followed the framework of a gradual ‘discovery’ of productive banks, rapid expansion of a suitable fleet, eventual declines, then boats moving on elsewhere (Thompson and Freeman 1930:29). Previously productive nearshore banks quickly became barren (Thompson and Freeman 1930:17). From 1888 to 1915 combined Canadian and American halibut landings increased by 4,500 percent reaching 69 million lbs in 1915 (Thistle 2004:108). To put this in present-day perspective, the combined commercial catch limit for the entire geographic range of Pacific halibut in 2017 was 25.9 million lbs, which is less than half of the 1915 international catch (IPHC 2017). In 1914 the New England Fish Company had a dedicated fleet of 18 steamers each deploying 14 dories and 40 crew, fishing all along the coast of British Columbia and the eastern Gulf of Alaska, servicing large cold storage facilities. These steamers could transport as much as 300,000 lbs in a single trip (Thistle 2004:108). Declining productivity eventually produced a shift away from large company owned steamers, towards more efficient and smaller owner operated vessels (Bell 1981:39). After World War One the fishery shifted from using multiple small dory deployed setlines, to mothership deployed longlines (both of these methods involve an anchored series of hooks on the ocean floor). These allowed for an increase in fishing effort; they were more efficient with depleted stocks, safer for fishermen, and allowed boats to fish in worse weather and at night (Morris 1932:25). Increased industrialization during this period shifted ownership of capital intensive fishing equipment away from Indigenous fishers who did not have the same access to loans and capital as non-Indigenous fishers (Boxberger 1989; Harris 2009b; Knight 1996; Menzies 2016; Menzies and Butler 2008; Reid 2015). Government policy in both Canada

and the USA intentionally worked to exclude Indigenous fishers from ownership roles (Harris 2009a; Menzies and Butler 2008:142; Reid 2015:250).

Thompson and Freeman (1930:30) describe declining stocks beginning early in the 20<sup>th</sup> century as follows:

From 1904 to 1905 fishing seemed to be at its peak, several more boats having entered the field. Some of the best fishing grounds began to show a decline, both in quantity and size. Whenever a new spot was discovered, there would be a considerable number of gray (discolored)<sup>[12]</sup> and poor fish caught. In some places the percentage was as high as 10. After a short period of fishing on these grounds, there would be scarcely any gray left, and a much smaller average size would be obtained; until, at some places, the fish, while fairly plentiful, would be so small that they were not worth fishing for. At this particular time there was no market for these small fish. This went on for four or five years before the catches lessened very much, but the trips got longer, more gear, bait and ice were required, and the number of fishing days per trip increased.

In 1899 Richard Rathbun, ichthyologist with the United States Fish Commission (USFC) warned that nearshore banks were showing signs of depletion and that a limit should be placed on the number of fish caught (Thistle 2004). Despite this and other early warnings, management of halibut fishing did not take place until 1923—24 years later.

Thistle (2004:109) quotes the following passage from 1906 written in the *Pacific Fishermen* a regional trade journal:

A recent close inspection of the northern halibut banks has revealed the fact that many of the grounds have been depleted. Banks which half a dozen years ago were bountiful in their yield of halibut were found as free of fish as a billiard ball is of hair, while others known to have been fine fishing grounds in the past where large fish were numerous were found to carry nothing but the smallest of fish.

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<sup>12</sup> It appears Thompson and Freeman (1930) are making the point that even newly discovered banks had poor quality fish at this time because of the overall impacts of Industrial harvesting. It is unclear exactly why halibut would be grey; however, this is an interesting observation.

The Canadian Bureau of Fisheries reported that by 1910 British Columbian commercial fishermen were moving from nearshore mainland waters and were fishing near Haida Gwaii as well as along the West Coast of Vancouver Island (Thistle 2004). Thompson and Freeman (1930:30) summarize a 1915 report from the British Columbia Department of Fisheries, which examined the logs of five independent steamers operating out of Vancouver from 1902 to 1915. Results showed a shift towards deeper water, with formerly productive banks declining in productivity by 75% per decade as measured by decreased catch per unit effort. Between 1903 and 1915 the average fished depth of the commercial fishery moved from 30 fathoms (55 m) to over 110 (200 m). Halibut were getting smaller, fishing voyages were getting longer, and catches were diminishing (Thompson and Freeman 1930:30).

Declining stocks quickly brought international tensions between Canada and the USA. Thistle (2004) provides a cogent review of this period: fishers from both sides of the border blamed each other for declines. Independent fishers attributed declines to the steamer fleet and their practice of “highgrading,” or keeping only medium-sized fish which obtained the best price (Thistle 2004:110). Despite a growing awareness of declines within the industry, as well as Rathburn’s early warning, in 1912 A.B. Alexander (also with the USFC), argued that continuing high catches indicated a healthy population of halibut (Thistle 2004:110). Uncertainty emanating from official sources foreshadowed continuing uncertainty with Pacific Halibut management (Hilborn and Walters 1992:56; IPHC 2014; Thistle 2004).

In 1914 the British Columbia Department of Fisheries (BCDF) commissioned further study of the halibut fishery (Thistle 2004:110-117). Unlike Alexander, William

Thompson who was hired to perform the study, maintained that catch volume without considering efforts was a poor indicator of stock health. Thompson reviewed the biological composition of catches as well as fishing effort, concluding that halibut were vulnerable and that most fish being caught at the time were not mature. The fishery was undermining halibut's capacity to reproduce. However, he was cautious about declaring a crisis, wanting more evidence. Alvah Hagger, then president of the Canadian Fishing Company (CFC), advocated strongly for a winter closure to conserve the stocks.

Thompson believed that this would only be advantageous to large organizations such as the CFC with access to cold storage plants and would not result in significant conservation effects due to halibut's long life history with multiple spawning opportunities. Further complicating matters, the Biological Board of Canada published a study in 1916 advocating against conservation measures. The report's author Arthur Willey argued that thinning of the banks would be beneficial to stocks and that catches showed no signs of being diminished. That same year the BCDF published Thompson's next report. His analysis of the fishery based on catch data (number and size of fish caught, fishing effort etc.) showed evidence of serious depletion. Catch data from northern British Columbia showed a decline in halibut abundance (as estimated by comparing fishing effort and catches) of as much as 90 percent from 1906 to 1912. From 1902 to 1914 the average weight of halibut caught had declined by more than half. Banks which had been fished longer showed more declines than more recently discovered areas. In addition, Thompson maintained that closed seasons were incompatible with halibut biology, and he advocated for a closed area-based approach (Thistle 2004:110-117). Thompson concluded, "The intense fishery has, it is evident, made its influence felt

throughout the whole biological appearance of the species and in doing so has rendered precarious the future of the banks” (Thistle 2004:117).

It was not until 1923 that an international agreement between Canada and the US for halibut management was finally ratified (Bell 1981). The 1923 “Convention for the Preservation of the Halibut Fishery of the North Pacific Ocean including the Bering Sea”, had been a long time coming after many failed agreements over more than a decade, and was a significant milestone for international fisheries management (Bell 1981:149). After consideration of both Thompson’s area-based approach and winter closed seasons, a three-month winter closed season subject to review after three years, as well as a four-person International Fisheries commission (now the IPHC) was agreed upon (Thistle 2004:123, Bell 1981:149). Thistle (2004:124) argues that this agreement “favoured expansion and exploitation of the stock over restraint and restoration”. Despite sound scientific evidence, the strong voices of economic stakeholders such as Alvah Hagger prevailed.

Since the signing of the Pacific halibut treaty, the IPHC has been based in Seattle Washington and has been the nexus of international monitoring, survey, harvest strategy decision making, and halibut research. The IPHC conducts annual fisheries-independent setline surveys and gather fisheries-dependant data from commercial boats and use this and other information such as bycatch mortality from other fisheries, to estimate stock abundance and make harvest decisions. Harvest limits allowed halibut abundance to recover to reach highs in the 1990s, before falling substantially to current levels (Stewart and Hicks 2018a). This history of significant depletion in the first half of the 20<sup>th</sup> century is now largely overlooked, and due to limited early data, management efforts have

generally only focused on the more recent history of the fishery. Writing in 1932, historian Allan Morris grouped Pacific halibut, sockeye salmon, and fur seal (*Callorhinus ursinus*) as the three fisheries of the Pacific coast most seriously depleted due to ‘ruthless exploitation’ (1932:3). Currently, halibut is largely considered to be a model sustainable fishery and is Marine Stewardship Council certified until 2020.

## **2.6 Summary of Background and Literature Review**

In this chapter I have compiled a historical ecological review of a wide variety of information concerning past and present halibut fishing to provide context for the work presented in the following chapters. I reviewed the framework of historical ecology, and biological understanding of Pacific halibut life history and behavior, along with assessments of the health of the population. I have also reviewed past anthropological examinations of halibut fishing including zooarchaeological and approaches focused on fishing technology. I have summarized ethnographic and ethnohistoric accounts from throughout the Northwest Coast, as well as the history of the industrial halibut fishery.

## Chapter 3: A Morphometric and Biological Examination of Traditional Northwest Coast Halibut Fishing Technology

“No hook known is as certain as this. For the capture of the halibut this device is superior to any invention.”

Sailor William Beresford 1789  
(Emmons and de Laguna 1991:115)

### 3.1 Introduction

Indigenous methods used to fish halibut on the Northwest Coast are known to be technologically sophisticated and broadly consistent throughout this large region and emerge from a rich history stretching back into past millennia. Halibut hooks and their affiliated materials (lines, leaders, spreaders, weights etc.) are characteristic elements of Northwest Coast fishing equipment and are part of a specialized system that connects people and specific fish species over the extraordinarily long time periods represented in archaeological records (Figure 3). Traditional halibut technology has been shown to be species selective, hooking significantly more halibut than other fish (Scordino et al. 2017), and is frequently considered to be selective for certain size range of halibut.

Informed by the framework of historical ecology, this thesis explores the long-term relationship between people and Pacific halibut using a variety of methods. In this chapter, I investigate Indigenous halibut fishing technology to better understand past fishing practices. Several researchers have previously examined the functional attributes of Northwest Coast fishing equipment, exploring its physical strength as well as its fish catching characteristics (e.g., Croes 1997; LaBarbera 1985; Scordino et al. 2017; Stewart 1977). Here, I build on this research and conduct quantitative and qualitative morphological analysis of ethnographic fishing equipment housed in museum and archival collections. I specifically consider halibut mouth structure as a relevant aspect of

hook design and selectivity by comparing measured and observed hook attributes with mouth morphology. I relate mouth structure, halibut size, and hook dimensions to address the question of whether traditional halibut hooks are indeed size-selective—that is, if the characteristics of the hooks select for a certain size range of fish. This has long been suggested (see Table 3), but most previous considerations of NWC halibut fishing equipment have not directly investigated these properties:

**Table 3:** Previous explanations of halibut hook size-selectivity

| Source                   | Size Range                                    | Explanation   | Source                               | Location                                       |
|--------------------------|---|---|--------------------------------------|--|
| Malindine 2017:4         | 20 - 100 lbs<br>~(90 to 148 cm) <sup>13</sup> | Barb gap determines size  | Ethnographic                         | Southeast Alaska                               |
| Scordino et al. 2017:22  | Wide  | Not more selective than circle hooks                                  | Experimental replication and testing | Makah, NW Washington                           |
| IPHC 2014:34             | Large fish                                    | None given  | None given                           | Northeast Pacific                              |
| Newton and Moss 2005:13  | Large fish                                    | Size of hook limits small fish  | Ethnographic                         | Tlingit, Southeast Alaska                      |
| Stewart 1977:48          | None Given                                    | Size of hook and barb   | Experimental replication and testing | Northwest Coast                                |
| Waterman n.d.:11         | <25 lbs<br>~(<97 cm)                          | Barb gap  | Ethnographic                         | Makah, NW Washington                           |
| Arima 1975:86            | None given                                    | Hook size inversely related to captured halibut size. No explanation. | Ethnographic                         | Pacheedaht, SW Vancouver Island                |
| Thompson and Weld 1961:4 | All sizes                                     | Hook dimensions select for the average size you wish to catch         | Ethnographic                         | Tulalip/Neah Bay NW Washington and Puget Sound |
| Niblack 1890:290         | 50-120 lbs<br>~(120-157 cm)                   | None given  | Ethnographic                         | Southeast Alaska to Northern BC                |

<sup>13</sup>Weight converted to fork length using the standard 1926 Pacific halibut length/round weight relationship:  $W_R = (9.205 \times 10^{-6})L^{3.25}$  (Clark 1991; Courcelles 2011). It should be noted that this conversion is thought to have a 10 to 20% error range which has been shown to change over time.

As seen in these culturally diverse examples, descriptions of the specific size-selective properties of traditional halibut hooks are variable. The question of size-selectivity has implications for understanding traditional fishing technology, harvest and management strategies, and for the quality of zooarchaeological samples used for reconstructing past size frequency distributions (see Chapter 4). Furthermore, as fisheries scientists seek novel approaches to tackle declining marine ecosystem health (e.g., Golden et al. 2016; Halpern et al. 2012; Jennings et al. 2016; Pauly et al. 2002), implementing improved fishing technology is emerging as an important tool for fisheries management (Valdemarsen and Suuronen 2003; Worm et al. 2009). Indigenous technology represents an important source for such methods (e.g., Dale and Natcher 2015).

In this chapter I analyze halibut hooks and halibut mouth structure and propose two key size-selective hook attributes. I relate measurements of these attributes to halibut morphology to estimate the minimum and maximum length halibut each ethnographic hook will theoretically select for. I then discuss the implications of these properties for past and future halibut management.



**Figure 3:** Example of ethnographic museum collection of halibut fishing technology from Haida Gwaii n.d., one-piece V-shaped halibut hook with metal barb and spruce root line with gut core. RBCM#699<sup>14</sup>.

### Theoretical Approach

In this chapter, drawing on the ‘ontological turn’ in anthropology (Paleček and Risjord 2013) which seeks to take “ontological alterity seriously” (Alberti and Marshall 2009:345) recognizing the potential of multiple life worlds where humans are not necessarily the only agents (Nadasdy 2007; Poirier 2013), I employ anthropological theory as a useful heuristic to better conceptualize the relational nature of halibut fishing (e.g., Jonaitis 1981; Losey 2010). My approach considers technology as fundamentally social in that it reflects relationships between objects, makers, users, and the worlds they interact with (Dobres and Hoffman 1994). Such social relationships can be manifested in materials through embodied “knowledge in the hands” that is circulated between individuals over the course of generations (Johnson 1989; Merleau-Ponty 1996:144). I

<sup>14</sup>Unless otherwise stated all photos were taken by the author.

find it fruitful to extend John Robb's (2015:168–69) framework of “material logic” which anticipates how “encoded knowledge, cues, and prompts are built into object design to channel the user's responses," to the interactions of non-humans with objects, to better conceptualize the anticipated responses built into the morphology of traditional hooks.

On the Northwest Coast, Indigenous peoples have a long history of thoroughly familiar embodied understanding of the practice of fishing (e.g., Brown and Brown 2009; Claxton 2015; Claxton and Elliott 1994; Menzies 2013; Umeek [Atleo] 2007; White 2011). A component of such familiarity could be considered an ‘interspecies material logic’, wherein fishers draw on their longstanding relationships with particular fish species to craft technology which anticipates the fishes’ reactions to the “built in logic” of the design (Robb 2015:169). Traditional halibut fishing technology and present-day sport fishing lures both draw on an understanding of halibut biology and behavior; however, by mobilizing knowledge gained through respecting halibut and the hooks as fully animate and even ‘thinking’ beings (e.g., Arima 1975; de Laguna 1972; Losey 2010), traditional equipment extends beyond the behavioural understanding represented in present-day sport fishing equipment. This allows traditional hooks to anticipate the halibut’s personality and values as well as behavior. For example, by crafting wooden hooks which through their animate properties “go for the halibut’s wife” Tlingit fishers drew on their understanding of the species’ personality (jealous monogamy) to trigger an emotional response (de Laguna 1972:390). I provide further examples to illustrate this point in the discussion section of this chapter. Anthropological considerations of Northwest Coast peoples have long recognized the importance of relational worldviews. For instance, ethnographic accounts discuss the interacting agency of hooks, halibut, and

fishers (e.g., Arima 1975; Boas 1909; Emmons and de Laguna 1991; de Laguna 1972). As Thom (2017:143) states, “these Indigenous, ‘relational ontologies’ are not just a ‘view’ or a ‘perspective’ but a total entailment in the world” For example, Umeek (2007) has expressed a Nuu-chah-nulth relational worldview as “heshook-ish tsawalk” or everything is one. This framework is “inclusive of all reality, both physical and metaphysical” (Umeek [Atleo] 2007:xi). Cullon (2017:2) describes a Laich-Kwil-Tach worldview as, “an enlivened world, filled with sentient beings who have agency in the human world who willingly come to humans to support wellness among them; beings who are often kin and who have influence and effect among humans.”

Losey (2010:20) argues that NWC fishing technology, specifically fish weirs and hooks, are best understood as animate components of the social world inhabited by fish and fishers. To illustrate this point Losey (2010:20) quotes Emmons and de Laguna (1991:117): “When he [a Tlingit fisherman] begins to lower hook [sic], he begins to talk to fishhooks, telling them to be watchful and catch his game, and when once caught, not to let it go”. De Laguna (1972:390) describes Tlingit fishers as instructing their halibut hooks to “go down to halibut land and fight!” Boas (1921:1322) describes Kwakwaka'wakw fishers referring to halibut hooks as “younger brother” and halibut as “smelling woman” or “old woman.” Finally, Suttles (1974:118) describes Straits Salish fishers referring to halibut as “sister” while fishing, and ritually beating and consuming a small halibut to attract mature halibut “crying for their child.”

Taking these enlivened qualities into account, I employ a relational and phenomenological approach, situated with ethnographic and first-hand accounts (e.g., Claxton and Elliott 1994; Umeek [Atleo] 2007). Considering an individual halibut’s

perspective and preferences, imagining looking up at a hook from the ocean floor, touching and smelling the bait and the wood, observing form and carvings and considering their intended effects, enriches other forms of analysis, and leads to greater understanding of how people craft animate hooks with specific material configurations to communicate with fish and provoke responses.

As an additional form of experimental archaeological and phenomenological analysis which built on previous experimentation (e.g., Croes 1995; 1997; 2005; LaBarbera 1985; Scordino et al. 2017; Stewart 1977), I constructed traditional halibut fishing equipment (see Appendix B). This effort sought to pin down the specific details of the process from an experimental perspective, providing greater understanding of the materials, manufacturing process, and technology. This included learning from skilled practitioners through hands on practical experience.

### **3.2 Materials and Methods**

#### **Morphometric Hook Analysis**

To obtain measurements of traditional hooks and observe their material qualities, I visited a variety of museum and archival collections in British Columbia and Washington State, including the Museum of Anthropology (MOA), the Campbell River Museum (CRM), the Royal BC Museum (RBCM), as well as the Makah Cultural and Research Center (MCRC). In addition, I located images of ethnographically collected hooks from various museums worldwide (e.g., the Pitt Rivers Museum at Oxford) on the MOA hosted Reciprocal Research Network (RRN) (Table 4). With the exception of the Burke Museum whose collection was being moved to a new building during this thesis

research, these specimens represent the totality of publicly curated and accessible hooks from Southeast Alaska to Washington State.<sup>15</sup>

**Table 4:** Traditional halibut hook sample composition.

| Institution | Mode of Engagement                                      | Number Measured |
|-------------|---|-----------------|
| MOA         | Quantitative/Qualitative <sup>16</sup>                  | 26              |
| RBCM        | Quantitative/Qualitative                                | 80              |
| CRM         | Qualitative <sup>17</sup>                               | N/A             |
| MCRC        | Qualitative <sup>18</sup>                               | N/A             |
| RRN         | Quantitative/Qualitative (Photogrammetry) <sup>19</sup> | 14              |

In total, I examined over 200 hooks and obtained morphometric measurements of 120. My criteria for identifying ‘halibut hooks’ was informed by ethnographically documented examples from a variety of locations (e.g., Arima 1975; Boas 1909, 1921; Drucker 1951; Emmons and de Laguna 1991; Niblack 1890; Swan 1868; Swanton 1905; Waterman 1920), as well as archaeological bentwood U-shaped hooks from the Ozette site I observed at the MCRC archives. Chronological information for hooks was limited; however, most hooks were collected in the late 19<sup>th</sup> and early 20<sup>th</sup> century. My sample included composite, solid, and bent hooks with composite barbs (Figure 4). I also included traditionally shaped hooks made from metal. I rejected a small number of hooks

<sup>15</sup> The Museum of Northern BC does not have any halibut hooks in their collections besides those on display.

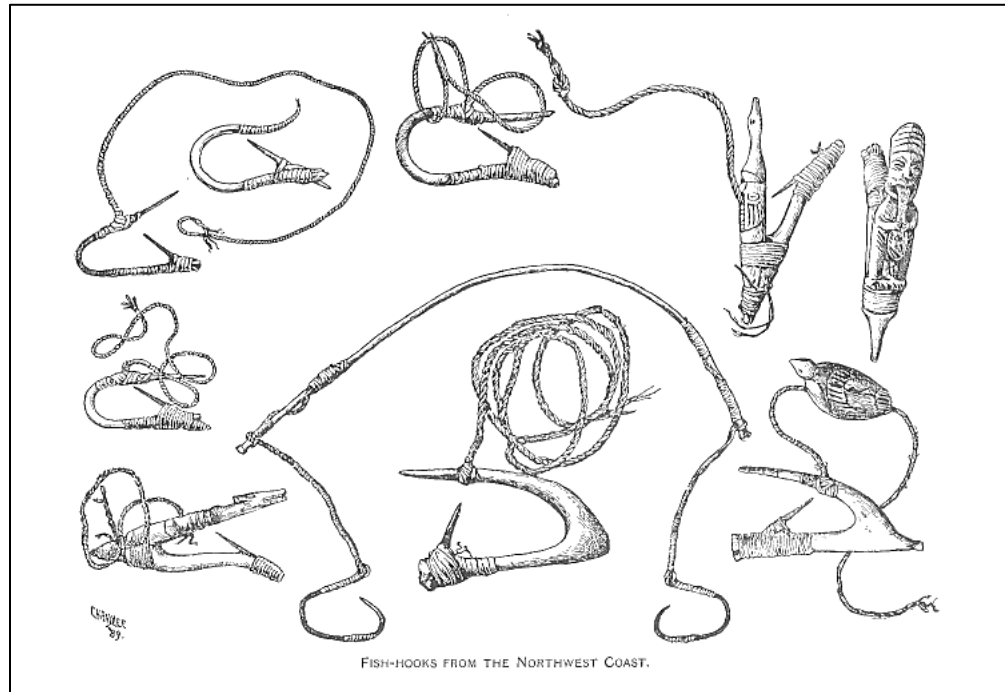
<sup>16</sup> Quantitative refers to measuring hooks, while qualitative refers to closely observing hooks.

<sup>17</sup> All available (not in the display case) hooks at the CRM were not measurable or appeared to be non-functional recent replicas.

<sup>18</sup> At the MCRC museum and archives I was fortunate to be allowed to examine archaeologically recovered hooks from the Ozette and Hoko River excavations as well as ethnographic examples. I did not take measurements as these bentwood archaeological specimens had unbent and did not retain their original morphology.

<sup>19</sup> Although the RRN indexes 408 halibut hooks (including MOA and RBCM), most RRN hooks were unmeasurable through photogrammetry due to the oblique angle of the photograph. However, I was able to capture dimensions of 16, from the Pit Rivers Museum in Oxford, and the National Museum in Washington D.C. using “Image J” software.

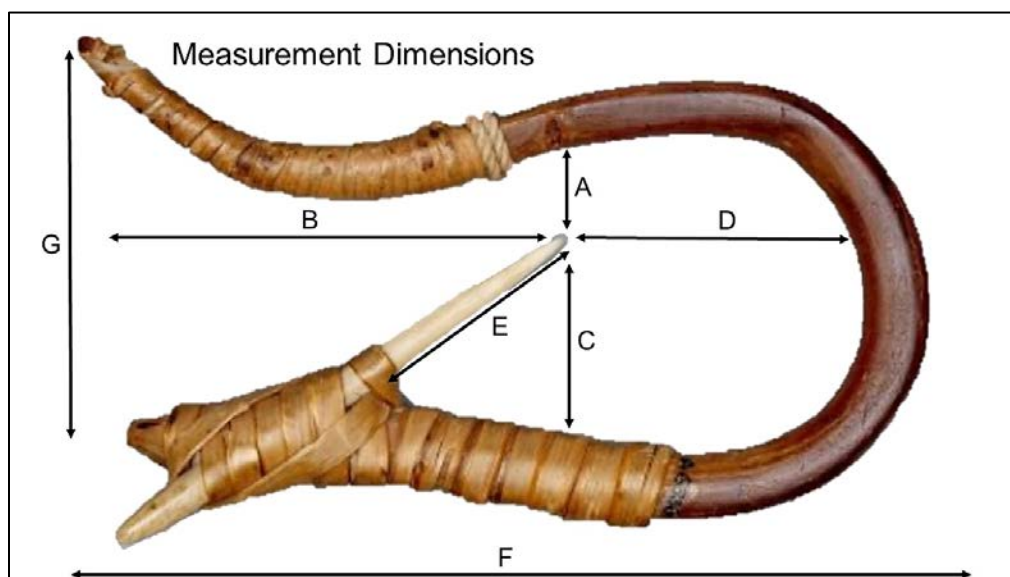
obviously created recently as non-functional display objects (e.g., with fake plastic bait). Self-barbed wooden hooks normally identified as ‘cod’ hooks were also excluded (Croes 1997; Waterman 1920).



**Figure 4:** Examples of NWC halibut hooks from a variety of locations (Niblack 1890:195). All are identified as halibut hooks except the central metal hooks which are identified as ‘red fish’ hooks.

Measurements of hook attributes were intended to capture key elements of shape, design, and functionality. My supposition was that important hook morphology would vary less across hooks than parts which do not directly relate to the qualities of the target species. Measurements were taken using the conventions outlined by (Scordino et al. 2017) with the two additions of ‘length’ (F) and ‘spread width’ (G) (Figure 5). In-field measurements were taken with digital calipers, and when calipers could not be used due to specimen fragility, I used a 1 mm cloth measuring tape. During examination and measurement, the wooden shanks and other surfaces were carefully inspected for evidence of bite marks to establish the hook’s ‘fished’ status. On many hooks, linear striations and gouges presumably reflect the sharp teeth of struggling fish (Figure 6). I

considered hooks to have been ‘fished’ when striations were clearly visible. They were classified as having possible bite marks when striations were faint. Rudimentary macroscopic wood identification was carried out without a reference collection and relied on my personal woodworking experience. Identifications were only made when species was obvious, such as with yew or yellow cedar. Due to their visual similarity I could not readily differentiate hemlock, fir, and spruce. Measurements were entered into a spreadsheet along with descriptions of bite mark identification, provenience, hook style, wood type (if obvious), condition, and general comments.



**Figure 5:** Hook measurement dimensions adapted from Scordino et al. (2017) with the addition of ‘F’ and ‘G’. I also refer to Dimension A as ‘lip gap’ and Dimension C as ‘barb height’.



**Figure 6:** V-shaped hook (MOA 1225) with visible gouges and striations from halibut teeth on the inside of the barbed shank. Photo from MOA.

### Halibut Mouth Morphology

Direct examination of halibut mouth morphology has not been a focus of previous investigations of halibut hook functionality. However, to better conceptualize how hooks interact with halibut, it is first necessary to review the underwater dynamics of traditional hooks<sup>20</sup>. Since hooks are always secured from the non-barbed shank (attachment at the barbed shank would impede the hook entering the halibut's mouth), depending on their material, they either float barb up or hang barb down, staying vertically aligned unless near neutrally buoyant (Figure 7). This vertical alignment corresponds with the vertical orientation (see Figure 11) of the halibut's mouth (Arima 1975). Floating hooks must be secured to the seafloor with a weight, while sinking hooks must be suspended.

U-shaped hooks are typically described as being fished in pairs with hooks floating either up or down from the spreader which is anchored to the sea-floor (e.g.,

<sup>20</sup> Since no underwater footage of halibut interacting with traditional hooks yet exists, the following explanations represent a hypothetical representation of a dynamic scenario.

Arima 1975; Boas 1909; Drucker 1951; Stewart 1977). Hilary Stewart (1977:33), with the underwater assistance of Don Abbott, found U-shaped hooks made from different woods to float differently: yew hooks sank barb-down, while hemlock knot wood hooks floated barb-up.

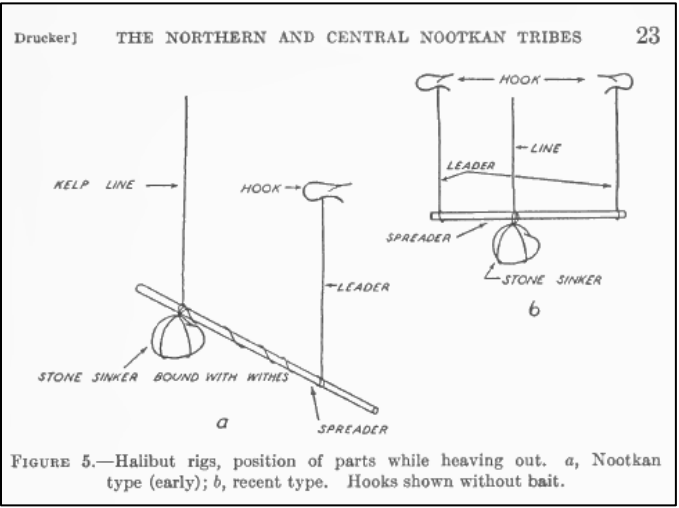
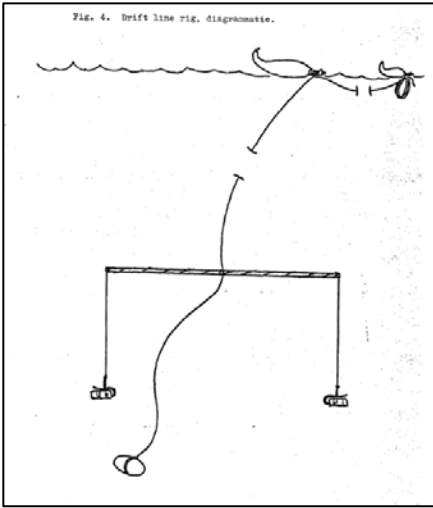
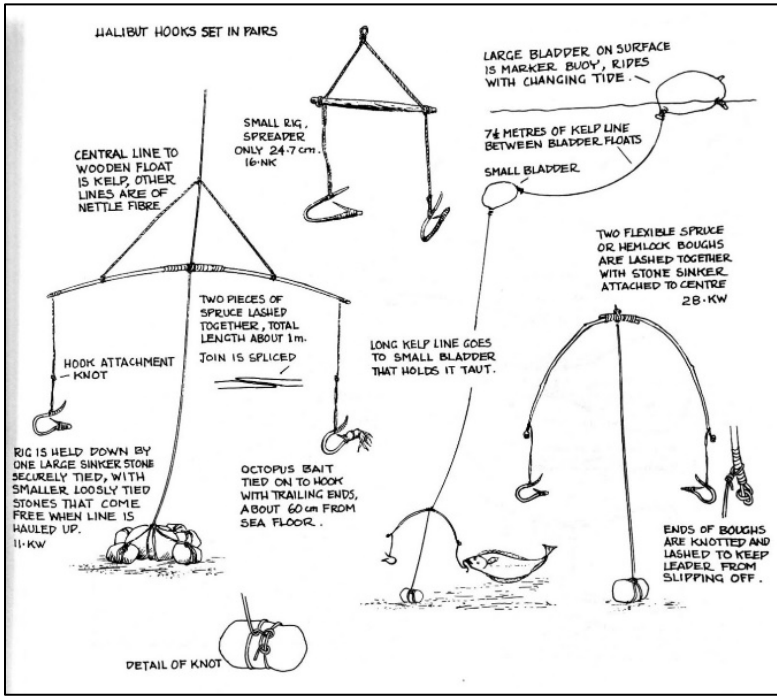
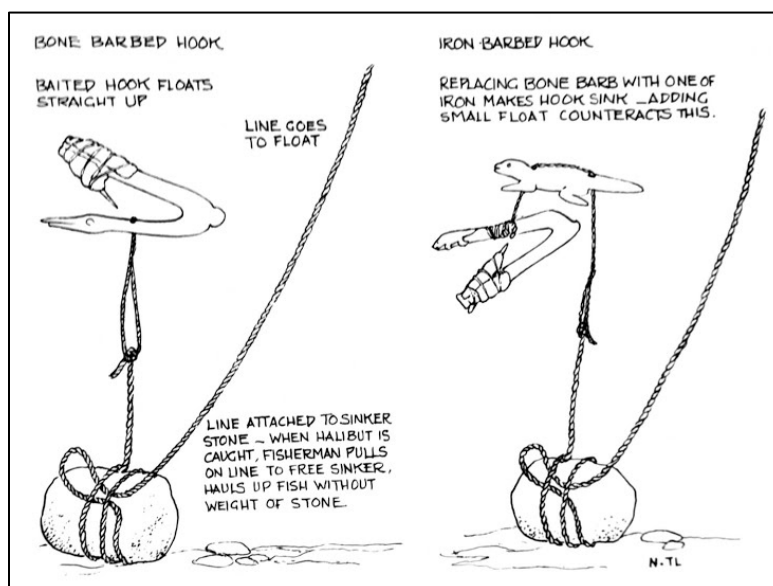


Figure 7: Illustrations of U-shaped halibut hook floating behavior. Images from Stewart 1977 (top), Arima 1975 (bottom left), and Drucker 1951 (bottom right).

V-shaped hooks are usually described floating barb up (e.g., Emmons and de Laguna 1991; Malindine 2017; Stewart 1977) (Figure 8). With the arrival of plentiful

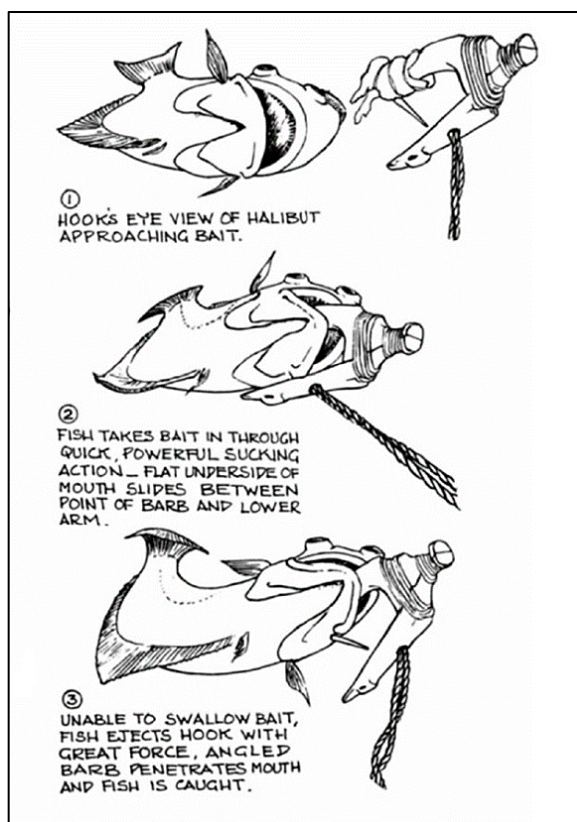
metals in the post-contact period, some bone barbs were replaced with metal. Fishers used to bind small wooden floats onto the barbed arm to maintain proper floating characteristics (Malindine 2017), or alternatively use an additional wooden float. Vertical underwater orientation will not only interface with the halibut's mouth more easily (Figure 9), but in the case of carved hooks, it will allow the carving to be oriented towards the halibut's gaze.



**Figure 8:** V-shaped hook floating behavior. Note carvings oriented towards an approaching halibut. Image from Stewart 1977.

Halibut and bottom-dwelling ambush predators and feed using suction, creating a low-pressure zone through expansion of their mouth structure which draws in prey (Willson 2018). Arima (1975:67-68) recorded: “as the halibut's mouth is vertical instead of horizontal like that of most other fish, it readily takes the hook, the upper portion of which passes outside and over the corner of the mouth” (Figure 9). These corner joints (Figure 11), the ventral (lower) and dorsal (upper) commissure, represent the thinnest part of the mouth margin. Reviewing ethnographic and experimental accounts (e.g., Malindine 2017:56; Newton and Moss 2005:13; Scordino et al. 2017:22; Stewart

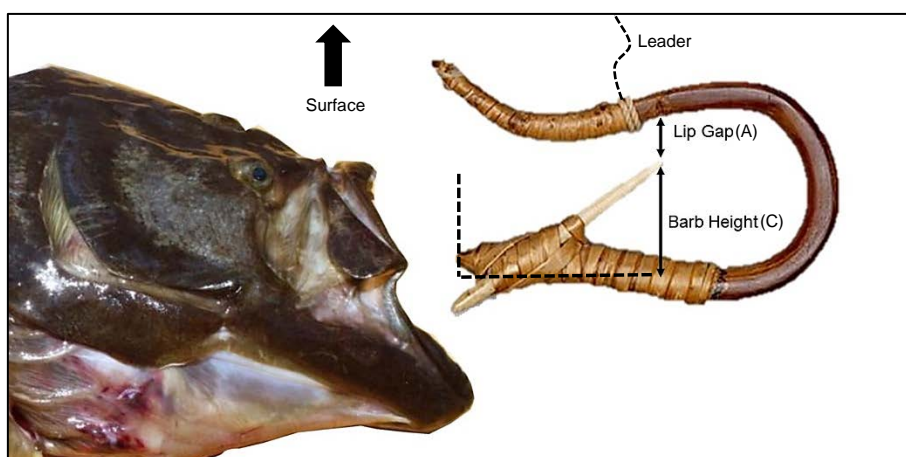
1977:38; Waterman 1920:11) and examining hooks and halibut, I surmised that the minimum width of the commissure will constrain hooking as moderated by the hook's Dimension A, or 'lip gap' (see Figure 5). In other words, Dimension A represents the maximum commissure thickness which the hook can readily pass through, setting a maximum halibut size threshold (Figure 10). I further surmised that minimum hooking size (below which halibut are too small to be hooked) is moderated by the size of the hook barb area, hereafter called 'barb height' (Dimension C is a proxy for this, see Figure 10) and halibut gape (how wide a fish can open its mouth) (e.g., Newton and Moss 2005:13; Stewart 1977:48).



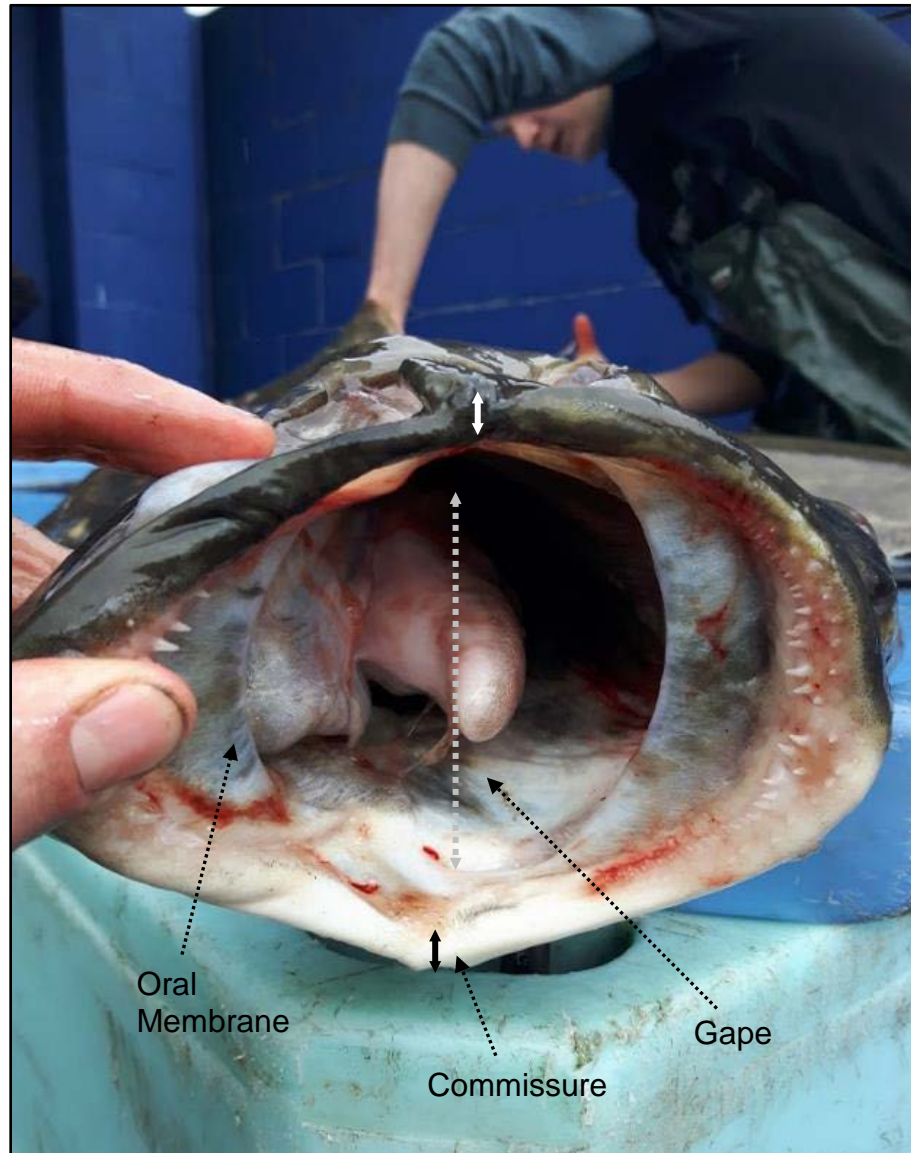
**Figure 9:** Halibut/halibut hook interaction; the barb passes over the ventral commissure and the fish is hooked when the hook moves back out of the mouth. If the commissure is too thick the barb will not be able to pass over. Note the halibut's vertically oriented mouth. Also note the typical floating direction (barb up) of the V-shaped hook. Image from Stewart (1977).

To investigate the size selective properties of my sample of hooks by relating hook morphology to halibut length, I obtained morphometric measurements of post-mortem halibut from a fishing derby. I attended the 2017 halibut derby hosted by Island Outfitters in Victoria BC, and measured the ventral and dorsal commissures (Figure 11) as well as the fork length of 58 halibut as they were brought to the weigh in station. These halibut were caught within approximately a 100 km radius of Victoria over two days. I also measured seven halibut caught on Swiftsure Bank during Makah traditional hook (*čibu-d*) testing in Washington state. Commissures were measured using digital calipers. These fish ranged in length from 65 to 135 cm.

Using these specimens, I examined the relationship between commissure thickness and halibut length with least squares linear regression (Kutner et al. 2004). Regressions were performed using the “lm” function in R version 3.2.4 (R Core Team 2018). This allows calculation of an estimate of maximum halibut length for each measured hook. I did not measure gape as a robust regression formula relating gape to halibut length has previously been established (see Webster 2017).



**Figure 10:** Representation of minimum and maximum hooking size constraints. Lip gap sets maximum size threshold and barb height sets minimum size threshold. Note that in reality halibut swim horizontally. Morphology of the hook such as the flared shank on U-shaped hooks, and the shape of V-shaped hooks helps guide the commissure past the barb.



**Figure 11:** Photo from halibut derby showing the ventral and dorsal maxillary/dentary commissure (black and white arrows respectively). This halibut is in a natural swimming orientation. Note the membrane behind the tooth rows guiding prey into the throat and potentially deflecting non-vertically oriented hooks.

### 3.3 Results

#### Qualitative Observations

The halibut hooks I observed in museum collections were made in a variety of shapes (Figure 5). While many fell into the previously used typologies of ‘composite V’ and ‘bent U’ shaped hooks (Croes 1997; Stewart 1977), a range of styles blended

between these two categories (Figure 12). Non-conforming examples included: U-shaped hooks made from single pieces of carved wood (not steam bent) with a barb attached, or V-shaped hooks made from single pieces of wood with a barb attached. I describe these hooks as ‘hybrids.’ The largest proportion of measured hooks were U-shaped (48%) followed by V-shaped (34%), and hybrids (18%). Metal hooks made up 18% of the measured sample, see Table 5. Slightly more than half of the wooden hooks had metal barbs (52%).



**Figure 12:** A range of hook styles showing non-binary design characteristics and morphology (RBCM: 709,719,9943,3229,16203,15842). Dashed line indicates missing barb location on 3229.

**Table 5:** Qualitative attributes of measured ethnographic hooks.

| Type                  | All  | U-shaped   | V-shaped   | Hybrid  | Metal |
|-----------------------|--|--|--|---|-------|
| <b>Total Measured</b> | 120  | 35   | 41   | 22  | 22    |
| <b>Bite Marks</b>     | 50 certain<br>9 possible<br>38 no visible use wear | 11 certain<br>4 possible<br>20 no visible use wear | 26 certain<br>5 possible<br>10 no visible use wear | 13 certain<br>0 possible<br>9 no visible use wear | N/A   |
| <b>Material</b>       | 22 Metal<br>98 Wood                                | Wood   | Wood   | Wood  | Metal |

In this analysis, I observed a variety of material types. Metal hooks were usually steel with a few possible wrought iron examples. I observed a single hook made from copper, and a single brass hook. U-shaped hooks often appeared to be made from yew which has a distinctive colour and appearance. Hybrid hooks were observed to be made from a range of materials including yew and possibly alder or hemlock/fir/spruce. V-shaped hooks were frequently made from two different materials, with the upper arm made from a high buoyancy wood such as yellow-cedar and the lower arm made from

harder less buoyant woods such as alder or hemlock/fir/spruce. Only one hook had an arm carved from redcedar (*Thuja plicata*). This is likely due to its reduced strength (redcedar has a Janka hardness score of 1,560 N versus 2,580 N for yellowcedar)<sup>21</sup> and greater propensity to split. Indeed, Waterman (1920:10) describes redcedar as too brittle to be used for halibut hooks. Distinctive tooth marks were visible on 49% of all wooden hooks, with another 8.7% having possible marks (Table 5).

### **Quantitative Observations**

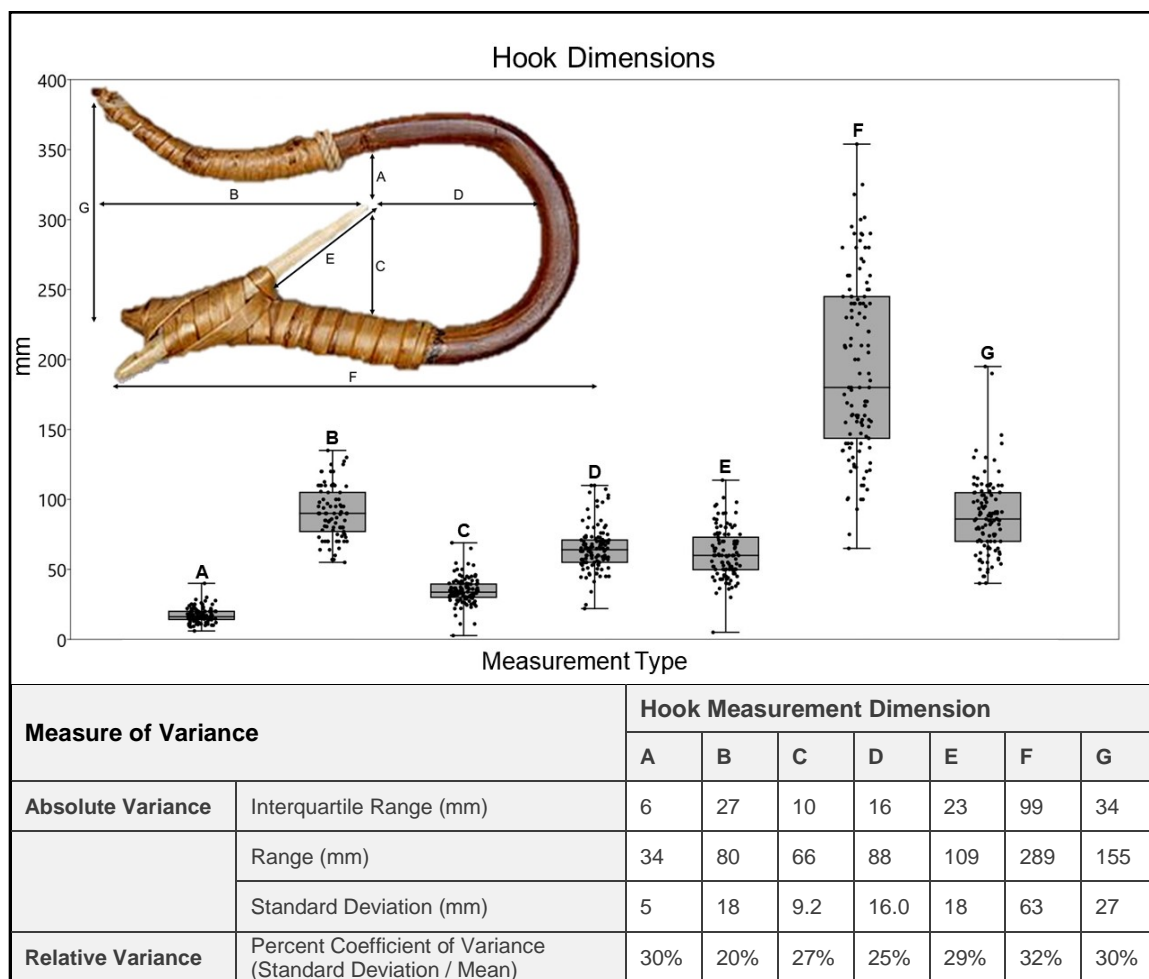
Of the ~200 hooks examined, 120 yielded measurements (Table 5). Non-measurable hooks usually had loose barbs, were missing barbs, or were visibly distorted. The majority of ethnographic hooks seemed to have retained their original morphology and did not appear warped. Dimension A showed significantly less variance than all of the other measured dimensions across all hooks measured as measured with a standard two sample F test<sup>22</sup> ( $p < 0.00$ ) (Figure 13). Dimension A also displayed the least variance as measured by interquartile range<sup>23</sup>. Dimension C displayed the second least variance as measured by interquartile range.

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<sup>21</sup> The Janka hardness scale reflects a wood's ability to resist denting and wear, expressed in Newtons (Doyle and Walker 2007).

<sup>22</sup> An F test is a statistical test of equality of population variance.

<sup>23</sup> Interquartile range (IQR) measures the spread of the central portion (quartiles) of the data to exclude outliers which would be included in an observation of range.



**Figure 13:** Boxplots and variance comparison of measured dimensions across the entire measured hook sample (N=120).

If variance is standardized by dividing by the mean of each measured variable to calculate coefficient of variance; relative to the mean of each measurement dimension there is minimal difference in variance (Figure 13). However, rather than observing percent variation relative each measured dimension, I seek to compare absolute variation in millimetres to observe consistency or differences in hook shape. I had proposed that those dimensions which vary considerably are less related to halibut morphology than those which vary only a little. As seen in Figure 13 Dimensions A and C displayed the least absolute variance.

Excluding metal hooks, different independent subdivisions of Dimension A (i.e. with/without bite marks, or V, U, H-style) had significantly similar variance (F test  $p > 0.5$ ), and mean Dimension A was significantly similar across the same subdivisions (Welch's t-test<sup>24</sup>  $p > 0.1$ ). That is to say, lip gap was very similar across all hooks and hook types, excluding metal hooks. Dimension A was significantly larger on metal hooks than on wooden hooks (Welch's t test  $p < 0.00$ ).

Excluding metal hooks, the same independent subdivisions of Dimension C (i.e. with/without bite marks, or V, U, H-style) had significantly similar variance (F test  $p > 0.7$ ) but mean dimension C was only significantly similar between hooks with and without bite marks (Welch's t-test  $p = 0.5$ ) (Table 6). Dimension A was slightly larger on wooden hooks than on metal hooks (Welch's t-test  $p = 0.02$ ).

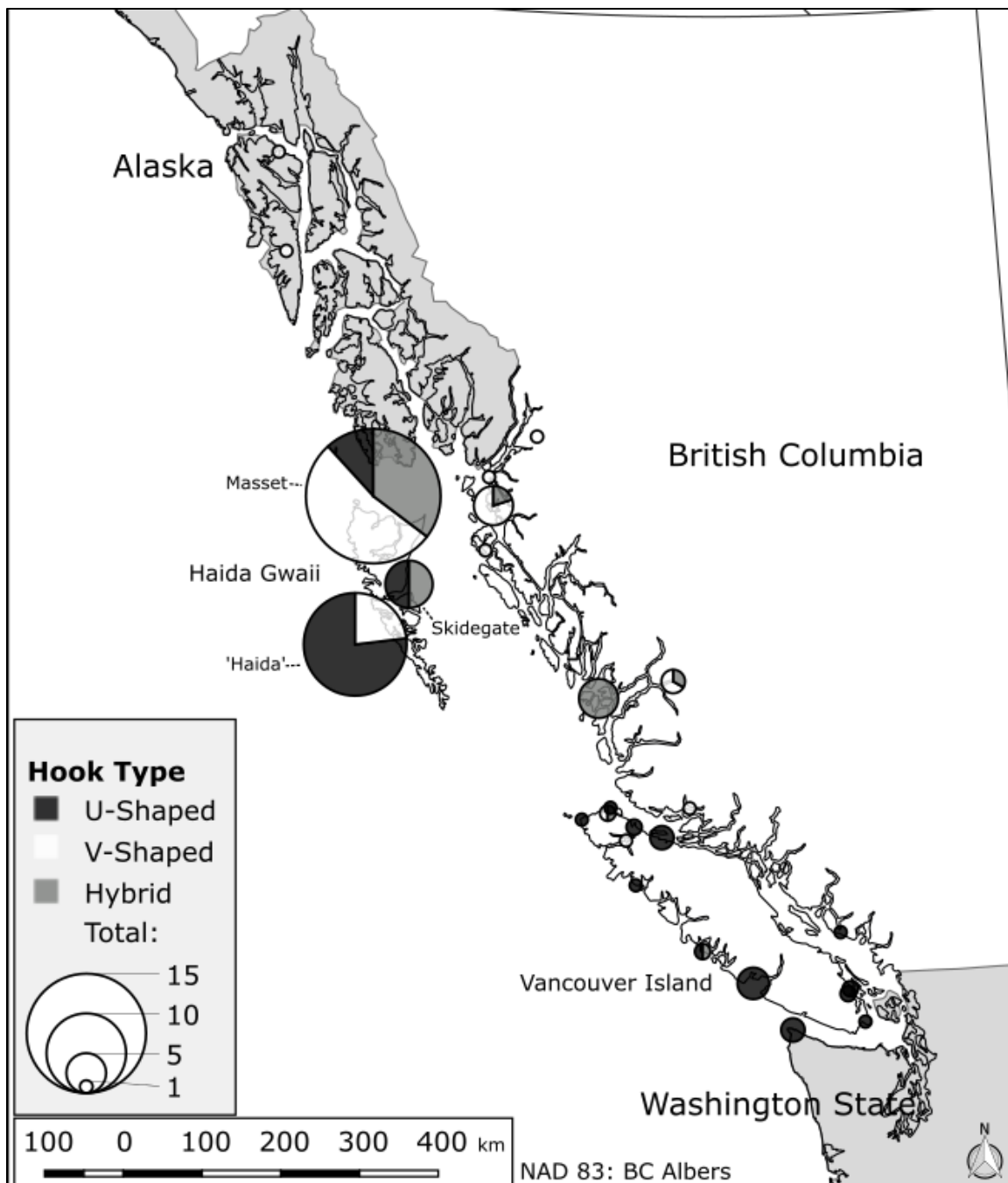
**Table 6:** Lip gap (A) and barb height (C) measurement by hook attribute.

| Hook Style Subdivision    | Average Lip Gap (A) (mm) | With tooth marks (mm) | No tooth marks (mm) | Average barb height (C) mm | With tooth marks (mm) | No tooth marks (mm) |
|---------------------------|--------------------------|-----------------------|---------------------|----------------------------|-----------------------|---------------------|
| Entire sample             | 17.05<br>(n=120)         | N/A                   | N/A                 | 34.57                      | N/A                   | N/A                 |
| Entire sample (wood only) | 16.02<br>(n=98)          | 15.51<br>(n=50)       | 16.98<br>(n=38)     | 35.25                      | 34.52                 | 36.21               |
| Metal hooks               | 21.30<br>(n=22)          | N/A                   | N/A                 | 31.82                      | N/A                   | N/A                 |
| V-shaped hooks            | 16.79<br>(n=41)          | 16.34<br>(n=26)       | 19.24<br>(n=10)     | 31.25                      | 30.30                 | 31.54               |
| U-shaped hooks            | 14.59<br>(n=35)          | 12.89<br>(n=11)       | 15.57<br>(n=20)     | 37.87                      | 38.23                 | 39.00               |
| Hybrid hooks              | 16.68<br>(n=22)          | 16.07<br>(n=13)       | 17.55<br>(n=9)      | 38.70                      | 39.82                 | 37.11               |

<sup>24</sup> Welch's t-test is a statistical test of the equality of population means which is not sensitive to differences in variance (Ruxton 2006).

**Geographic Patterning and Variability**

Eighty-four of the sample of 120 hooks (70%) had geographic provenience information. This information varied from very general “Haida Gwaii”, to specific “Ohiat [sic] Dodgers Cove” (Huu-ay-aht First Nation, Diana Island). Provenience information was interpreted into geographic coordinates and plotted (Figure 14). Because of the rudimentary nature of much of the provenience information, for example “Haida Masset”, many of the hooks overlap on the same point. This provenience data allows for a basic geographic comparison of attributes.



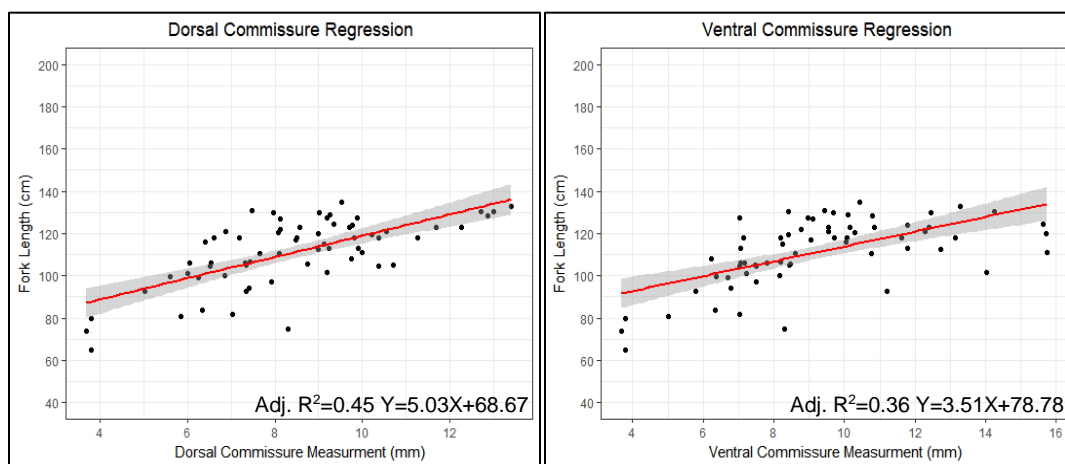
**Figure 14:** Hook provenience (n=84); note that hooks attributed only to 'Haida' could have originated from Kaigani Haida on Prince of Wales Island directly north of Haida Gwaii.

My analysis of hook provenience suggests regional trends of hooks styles with a degree of morphological fluidity across regions. Haida Gwaii appears to represent a unique node of hybridity. Thirty-nine of the hooks I measured were from Haida Gwaii (46%): 9 were hybrids, 16 were U-shaped, and 11 were V-shaped (Figure 14).

### Halibut Mouth Morphology and Size Estimation

Halibut commissure were difficult to measure due to the inherently flexible and dynamic nature of the halibut's mouth (Figure 11). Within my sample of measurements, I noted a very slight difference between upper (dorsal) commissure which were smaller than lower (ventral) commissure. Dorsal commissure ranged from 3.70-13.41 mm with a mean of 8.45 mm (SD = 1.94). Ventral commissure ranged from 3.79 to 15.75 mm with a mean of 9.23 mm (SD = 2.50).

There is a moderate (Adj.  $R^2 < 0.45$ ) linear relationship present between each commissure measurement and halibut fork length, see Figure 15. The imperfect nature of this relationship is likely caused by the difficulty of measuring this flexible joint, as well as by the relatively narrow size range of fish used (65-133 cm).



**Figure 15:** Dorsal and ventral commissure/fork length regression relationships (n=65). Grey area is 95% confidence interval.

To estimate the maximum size-selective threshold of traditional hooks the regression formulae relating dorsal commissure to fork length ( $length (cm) = 5.03 * commissure thickness (mm) + 68.67$ .) was applied to all ethnographic hook lip gap measurements. Dorsal commissure was used because it was slightly smaller on average,

therefore it represents the thinnest part of the halibut's mouth<sup>25</sup>. This relationship is also stronger as observed by comparing adjusted  $R^2$  values. The average maximum size estimate is 154 cm. Maximum halibut size estimates for each sample hook are seen in Figure 17 and

Table 7.

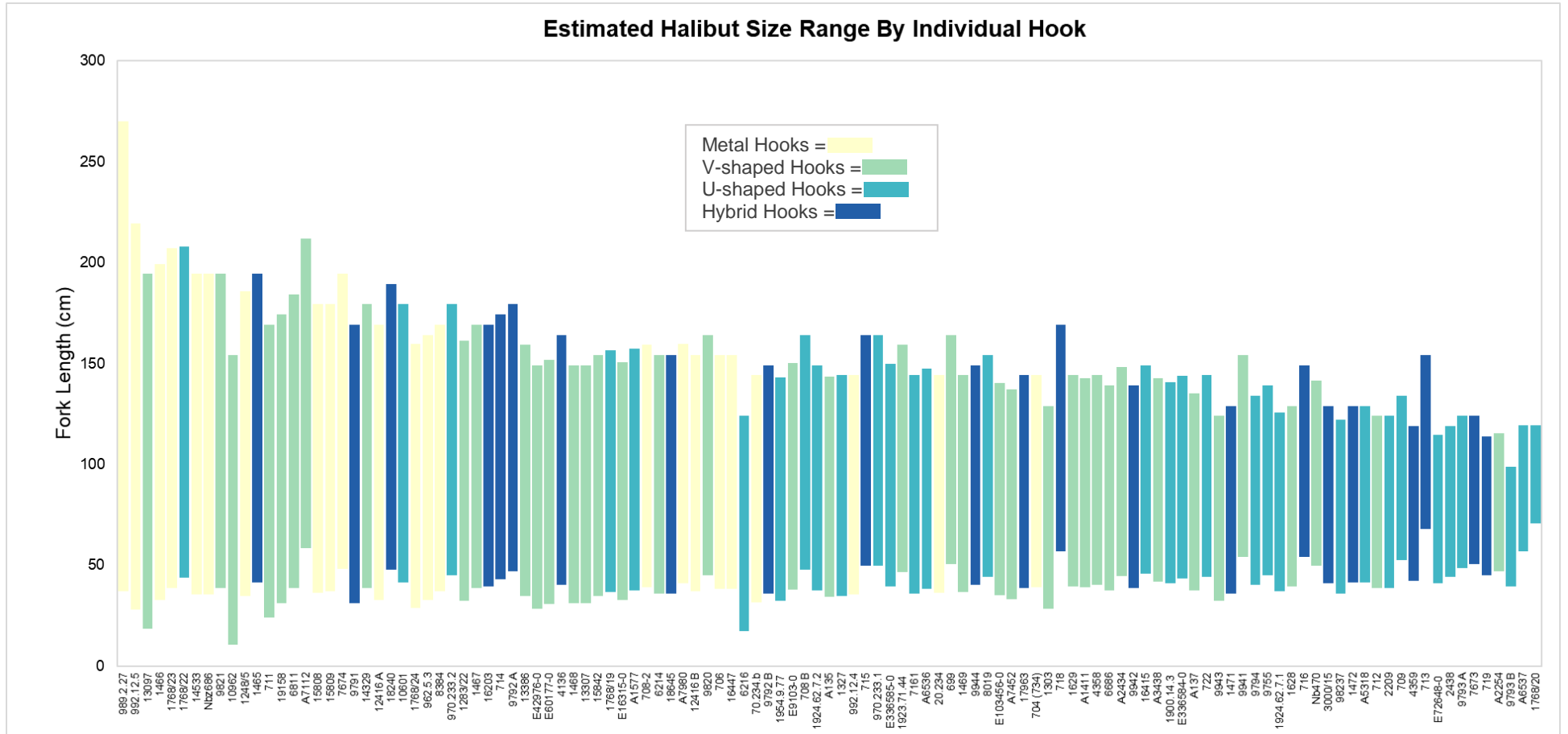
To estimate the minimum size selective threshold of traditional hooks, Webster's (2017) regression formula relating halibut gape to fork length (Adj.  $R^2 = 0.86$ ):  $length (cm) = 9.2 * gape (cm) + 6.2$ , was applied to all ethnographic hook barb height measurements. For the purposes of this estimation, I adjusted dimension C to include the width of the hook shank by adding 1.25 cm to all U-shaped hooks, 2.25 cm to all hybrid and V-shaped hooks, and 0.75 cm to all metal hooks to represent best approximations based on observations of shank thickness across these different styles. The average minimum halibut size estimate is 39.55 cm. Minimum size estimates for all hook samples are presented in Table 7 and Figure 16.

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<sup>25</sup> The commissure that the hook interfaces with will ultimately be determined by the hook floating direction.

**Table 7:** Estimated halibut size from hook morphology.

| <b>Method of calculation</b>   | <b>Catalogue Number</b> | <b>Minimum Size Estimate (cm)</b> | <b>Maximum Size Estimate (cm)</b> | <b>Range (cm)</b> |
|--------------------------------|-------------------------|-----------------------------------|-----------------------------------|-------------------|
| Average of all hooks (n=120)   | N/A                     | 40<br>(1.5 lbs)                   | 154<br>(112 lbs)                  | 114               |
| Hook selecting for max         | RBCM<br>989.2.27        | 37                                | 270                               | 233               |
| Hook selecting for min         | RBCM<br>10962           | 11                                | 154                               | 143               |
| Hook with most range           | RBCM<br>989.2.27        | 37                                | 270                               | 233               |
| Hook with least range          | MOA 1768/20             | 71                                | 120                               | 49                |
| Average wood (n=98)            | N/A                     | 40                                | 149                               | 109               |
| Average with bite marks (n=50) | N/A                     | 40                                | 147                               | 107               |
| Average metal (n=22)           | N/A                     | 36                                | 175                               | 139               |
| Average hybrid (n=22)          | N/A                     | 44                                | 153                               | 109               |
| Average U (n=35)               | N/A                     | 42                                | 142                               | 100               |
| Average V (n=41)               | N/A                     | 37                                | 153                               | 116               |



**Figure 16:** Estimated targeted halibut size range using hook morphology and the relationship between mouth morphology and fork length, sorted left to right by descending range. Each hook (n=120) is represented by one bar.

### 3.4 Discussion

#### Hooks

Here, I consider the representative quality of the halibut hooks used for this analysis (cf. Huster 2013). I recognize that the category of ‘halibut hooks’, is a fluid expression of human variation and innovation, anchored around a stable template of tradition and style as well as halibut behavior and morphology. The sample population I examined offers examples of how the concept of halibut hook has previously been constructed into material reality by past makers (cf. Abbott 2017; Hogseth 2012; Ingold 2013; Keller 2001), and from this one can assume some of the tendencies and commonalities of its broader existence.

As is common for ethnographic collections in museums, geographic provenience information for hooks was of varying quality. Many hooks were donated or sold to museums in the 19<sup>th</sup> and 20<sup>th</sup> century by collectors (Brian Seymour, research visit to RBCM, Pers. Comm. 2017.), as well as directly obtained from communities by museums and other cultural institutions (see Cole 1982). Geographic provenience information accompanied 70% of hooks, however, the quality of this information was variable. I note that U shaped hooks were more commonly observed in the south (Figure 14) and that these hooks tended to select for slightly smaller fish than Hybrid or V-shaped hooks (Table 7). It is uncertain how meaningful this small geographic difference (~10 cm) would be in practice, however it could relate to the thinner shanks of bentwood hooks. Notably a large number of my sample of hooks were from Haida Gwaii (46%) which likely speaks to the geographic distribution of collection effort in the 19<sup>th</sup> and 20<sup>th</sup> centuries. The age of hooks is also uncertain. Only 13 hooks had specific date of

collection information, ranging from 1853 to 1925. It is worth considering that for objects with potentially very long use lives, provenience information may not be representative of the place of manufacture and entire object life history (cf. Mackie 1995). Two metal U-shaped hooks from Haida Gwaii were collected in 1884, suggesting that this form was adopted relatively quickly, but also that the wooden style persisted after the invention of metal U-hooks.

The high percentage of hooks with bite marks (52% certain and 9% possible), indicates that many of the specimens were made and used for fishing. The stability of the lip gap measurement (IQR = 5.78 mm) and the barb height measurement (IQR = 9.5 mm) across wide geographic, cultural, and stylistic variation of hooks (with and without bite marks) used to catch the same fish (Table 6), provides support for the representativeness of this assemblage of halibut hooks, and supports the other lines of inference (ethnographic and observation of mouth mechanics) suggesting these hook dimensions are important components of hook design and size selectivity. Practitioners in both the north and south emphasized the use of a finger width to set the correct lip gap (Malindine 2017:56; Waterman 1920:11). This provides a mechanism of cross cultural standardization for this measurement type. The use of steam bending molds could also promote standardization (e.g., Boas 1909:412; Drucker 1951:21).

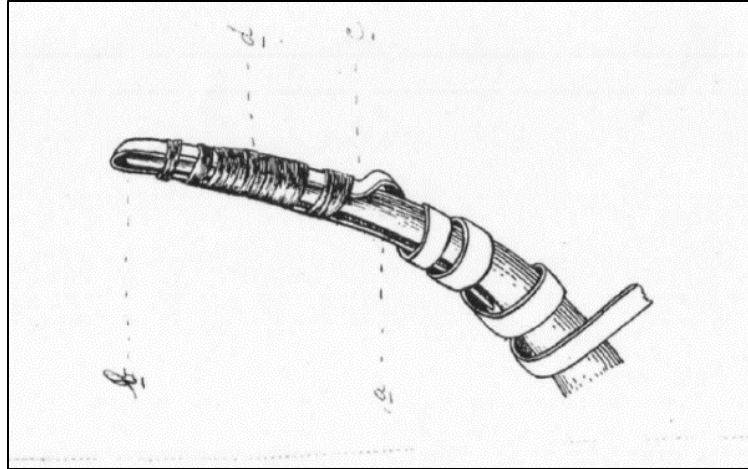
A notable qualitative observation was the presence of many hybrid hooks, particularly from Haida Gwaii (Figure 14). In previous regional considerations of Northwest Coast halibut hooks, binary U/V North/South classification schemes were used (Croes 1997; Stewart 1977). Stewart (1977:49) includes illustrations of “one-piece northern halibut hooks” but no further information. Based on my findings, expanding this

single attribute (i.e., V or U-shaped) classification scheme to include a third hybrid category, allows for consideration of multiple attributes across what appears to be regional trends of hooks styles with a degree of morphological fluidity across regions. (Figure 14). This is supported by ethnographic accounts (e.g., Boas 1909, 1921; Drucker 1951; de Laguna 1972; Suttles 1990; Swan 1868; Waterman 1920). For example, (Waterman 1920:6) reports use of bentwood U-shaped hooks among the “the Kwakiutl [sic], the Tsimshian and the Haida”, however generally, and as seen in Figure 14, V-shaped wooden hooks are more prevalent in the north while U-shaped bent hooks are more common in the south. Haida Gwaii appears to represent a unique node of hybridity. Indeed, Waterman (1920) and (Niblack 1890) describe the Haida using three different types of hooks which fit into my V, U, and hybrid categories; however, it should be noted that my sample was heavily weighted towards Haida Gwaii which itself is a large and geographically diverse archipelago.

Hybrid and V-shaped hooks displayed evidence of halibut bite marks more frequently (59% and 63%) than U-shaped hooks (32%) (Table 5). It is possible that fewer U-shaped hooks showed bite marks because less of these were used for fishing. However, it is also possible that other factors caused this discrepancy. Many U-shaped hooks were made of Pacific yew. As I noted during my experimental construction of yew hooks (Appendix B), this wood is very hard in comparison to other species observed in the ethnographic sample (Janka = 7,120 N). Specifically, Pacific yew is 2.7 times harder than the yellow cedar (Janka = 2,580 N) or Alder (Janka = 2,620 N) often used for the construction of V-shaped halibut hooks.

### **Interspecies Material Logic**

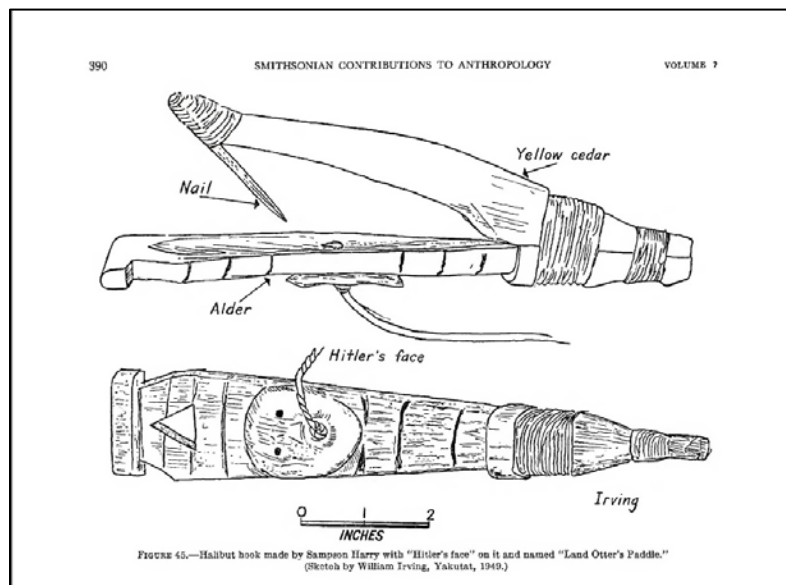
Many other considerations play a role in the functionality of traditional hooks besides the physical dimensions I measured. Considering the Indigenous cultural framing of a halibut's ontology is crucial to understanding the role and function of animate halibut hooks. As communicated by Pacheedaht Chief Charles Jones to anthropologist Eugene Arima (1975:71), halibut can "smell as well as a dog". Yellow-cedar was considered by Tlingit fishers to 'smell' more attractive than other wood types (de Laguna 1972). Among Kwakwaka'wakw fishers, management of scent plays an important role in preparation for fishing (Boas 1909, 1921). Bentwood hooks constructed by the Makah and Pacheedaht had the tip of the non-barbed shank covered with material (Figure 17) (Arima 1975; Waterman 1920). "This hood is to prevent the fish from hurting himself on the point" (Waterman 1920:13). The pattern of wood grain showing in the center bend of the hook is appealing to some halibut and explains why some hooks are more successful than others (Arima 1975). Bait selection, preparation, and placement is an important part of fishing (Boas 1909; Thompson and Weld 1961). The top shank of U-shaped hooks must be curved away from the cheek of the fish to minimize irritation once fish are hooked or they will struggle (Stewart 1977; Waterman 1920). Chief Jones used metal hooks after 1907 and would fish with a variety of different metals (brass, galvanized iron, etc.) "since the preference of the halibut varied from time to time" (Arima 1975:76). Anticipating the halibut's potentially variable preferences involves respecting its agency to have preferences beyond simple biological behavioral triggers.



**Figure 17:** Illustration showing Makah style of covering the non-barbed shank of a U-shaped hook. Image from Waterman (1920).

Many V-shaped hooks and some hybrids are elaborately carved with zoomorphic and anthropomorphic figures. These carvings are a central component of the hook's functionality and agency which actively seeks to entice and or provoke an emotive response from fish (cf. Jonaitis 1981; de Laguna 1972; Losey 2010). For example, de Laguna (1972:390) describes a Tlingit halibut hook carved early in World War Two with Hitler's face (Figure 18) called "catches big halibut". This was intended to provoke and anger a halibut into biting the hook. As mentioned, other hooks were instructed to "go for the halibut's wife, so that the halibut will become angry and attack the hook" (de Laguna 1972:390). Building an anticipated and intended emotional response into the design of an individual hook involves an awareness of the halibut's value system as an animate being interacting with an animate hook. Underwater hook orientation is also an important consideration. Carvings are intended to face downwards towards the gaze of a halibut, as they are meant for the fish not the fisher. Finally, Thompson and Freeman (1930) report that by impeding the halibut's ability to close its mouth and move water over its gills, the morphology of Indigenous halibut hooks caused halibut to be subdued or drown, making

large fish more manageable when taken aboard a canoe. Newton and Moss describe fishers using particularly large bait when they wanted to subdue halibut in the same way (2005:12).



**Figure 18:** Tlingit halibut hook carved to represent Hitler's face to provoke an emotional response in the fish (de Laguna 1972:390).

### Size-Selectivity

To determine if traditional halibut hooks are indeed size selective, the meaning of 'size-selective' warrants consideration. While it appears that this technology selects for a certain range of fish sizes, this is true of many if not all types of fishing gear (e.g., Colley 1987; Leaman et al. 2012; Løkkeborg and Bjordal 1992; MacLennan 1992). In contrast to some previous accounts, the ethnographic wooden hooks examined in this chapter suggest that size selective morphological attributes were tuned to select for a wide average size range of halibut (40-149 cm [1.5-101 lbs]). This fits most closely with Thompson and Weld (1961), who report that traditional hooks select for all fish sizes, and that when making hooks fishers constructed them for the average size they wished to catch. This would account for some of the divergent explanations seen previously and

corroborates Scordino et al.'s (2017) results which suggest that traditional Makah halibut hooks (*čibu-d*) did not catch a significantly different size range than modern 8/0 circle hooks.

As seen in Figure 16 and Table 7 the results of this chapter suggest that Indigenous fishers across the Northwest Coast targeted an approximately similar size range of halibut, with metal hooks selecting for a wider range and larger fish than V-shaped and hybrid hooks, which in turn select for a wider range and larger fish than U-shaped hooks. It is uncertain how significant these differences would be in practice, considering factors such as slight hook and barb flexibility and the use life of barbs (cf. Mackie 1995). Indeed, Drucker (1951:44) and Waterman 1920:6 describe U-shaped hooks as slightly flexible which would expand the lip gap.

Another important consideration is the fact that halibut grow to be over 2 meters long and over 300 pounds. Having an upper selective size threshold while still relatively large (e.g., 149 cm) could prevent unexpected catch of huge 'barndoor halibut' which could damage boats and gear and compromise the safety of a fishing expedition. That said, ethnohistoric, and archaeological sources suggest that Indigenous fishers had the ability and skill to catch very large halibut when desired (see Crockford et al. 2004:63; Keast 1866; Turner 1886; Waterman 1920). Towards this point, Waterman (1920) and Densmore (1939) describe a hook of a totally different design employed when fishers wanted to catch an extremely large halibut. This large hook most closely resembles a modern J-hook and could be used to catch a variety of large-mouthed fish.

Assessments which conclude that Indigenous fish hooks only caught a narrow range of halibut sizes (e.g., Malindine 2017) ignore a more nuanced relationship with the

species and promotes a deterministic conceptualization of human agency. Furthermore, employing highly selective technology which turns away large numbers of potential catches would not be efficient. Despite having the knowledge that hook dimensions can be manipulated to influence fish size, fishers may not have been overly concerned with the minutia of size-selective properties much as fishers today select a large circle hook to catch generally large halibut and a small hook for smaller fish, as a small component of the many important concerns which are part of a halibut fishing trip.

### **Resource Management**

A small number of hooks showed relatively narrow estimated selective size ranges (see Figure 16). 1768/20 from the MOA (Figure 19) had the narrowest estimated range of 49 cm (71 to 120 cm), see

Table 7. If the dimensions of this hook do select for such a range in practice, the technology could be useful for reaching minimum regulatory size limits, while also protecting large fecund fish. The commercial halibut fishery currently uses an 81.3 cm minimum size limit where any smaller fish are discarded, and discard mortality has been estimated at around 30% (Myhre 1974). The Canadian recreational halibut fishery currently utilizes a maximum size limit (115 cm)<sup>26</sup> and discard mortality for sport caught halibut is unknown<sup>27</sup>. Traditional halibut hooks modified to select for a narrow range could be used for ‘slot limit fishing’, a conservation-oriented approach (Gwinn et al. 2015) where only fish larger than a minimum size yet smaller than a maximum size are retained. Although slot limit fishing is currently carried out by tossing back fish too small

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<sup>26</sup> This has recently decreased from 133 cm in 2017.

<sup>27</sup> American recreational halibut fisheries have no size limits, but they have strict limited openings and a one fish daily limit.

or too large, some released fish do not survive and the most effective way to reduce discard mortality is to not hook these fish at all.



**Figure 19:** 1768/20 from the MOA, this hook had the narrowest estimated size selection range. Note the narrow lip gap and large barb area. The cordage is likely used to help the hook keep its shape and could also be used to tie on the bait. Photo from MOA.

Size limits are an important component of present-day fisheries management (King 2013). As mentioned, size limits are used to target certain components of the population, usually to protect young fish until they reproduce or more rarely, old mature fecund fish. However, size limits are only one component of management and exist alongside other important measures such as harvest and stock monitoring, biomass modelling, spatial restrictions, and catch quotas (King 2013). Furthermore, incorrect placement of size limits or other factors causing intensive size-selective harvesting can cause dire outcomes for entire ecosystems (e.g., Barneche et al. 2018; Costa-Pereira et al. 2018; Zhou et al. 2010). Indeed, intensive size-selective fishing has been directly associated with reduced halibut size-at-age (Sullivan 2016).

Northwest Coast Indigenous fishers had strong sociocultural mechanisms in place to buffer resource depletion prior to European contact (Berkes et al. 2000; Brown and

Brown 2009; Lane 1973; Lepofsky and Caldwell 2013; Pinkerton 1989; Thornton et al. 2015; Troster 2003; Turner and Berkes 2006). Taxon specific technology, crafted through thousands of iterations, and millennia long relations with species in specific locations is crucially important, but represents only one component of this framework. For example, Reid (2015:220) describes Makah community members selecting certain banks at specific times for different sized halibut needed for particular uses, such as preservation, trade or immediate consumption. While it has been previously suggested (e.g., Malindine 2017) that these hooks allowed for sustainable harvests by only selecting for a very narrow range of halibut, my analysis indicates that using hooks selecting for a wide range coupled with strong social control, extensive local understanding, monitoring, and management of specific halibut banks, is a more effective, efficient, and sustainable scenario.

### **3.5 Conclusion**

Analysis of traditional halibut fishing equipment and halibut morphology provides insight into past human/halibut interactions. My observations of a large number of ethnographically collected hooks and halibut mouth structure suggests that the morphology of traditional Northwest Coast halibut fishing equipment can constrain the size of fish being caught, but that most of the hooks observed were constructed to select for a wider than anticipated estimated size range. Estimating the size-selective capacity of the sample of wooden hooks suggests an average range of fish from 40 to 149 cm (1.5-101 lbs) can be caught with this group of hooks. These size-selective morphological properties have potential to be mobilized for slot limit fishing.

The hooks analyzed can be classified into three different styles (V, U, and H), and all styles had variable morphology, but were less variable in the key size selective dimensions identified (Dimension A and Dimension C) which were consistent across styles. This suggests that there was a similar framework at play across a wide range of hook-making circumstances. Singular target species and the use of bodily dimensions as measuring devices promotes standardization. Besides the shape of the hook, many other subtle anticipations of the halibut's reaction and the hook's agency play an important role in hook construction and fishing.

Despite the remarkable properties observed in this chapter, traditional fishing technology represents only one component of complex past human relations with halibut. Traditional fishing technologies are embedded components of enlivened human animal sociocultural systems which have allowed for millennia of rich sustained relationships with an enormous number of different species in the North Pacific.

## Chapter 4: Archaeological Data Contextualize Historical Change in Pacific Halibut Fisheries

### 4.1 Introduction

Understanding the effects of harvesting on a population is an essential component of fisheries management. Intensive fishing often changes fish population size structure, which has implications for both species and ecosystem fitness (Barneche et al. 2018; Barnett et al. 2017; Berkeley, Chapman, et al. 2004; Birkeland and Dayton 2005; Costa-Pereira et al. 2018; Hsieh et al. 2006). Fish body size is a simple yet fundamental metric of fisheries biology (Hilborn and Walters 1992; Jakobsen et al. 2016); however, uncertainty about fish population size structure in the past makes it difficult to contextualize size changes and variability over time (Jackson 2001; Jackson et al. 2001; Lotze and Worm 2009; Pauly 1995; Soga and Gaston 2018).

Pacific halibut (*Hippoglossus stenolepis*) is a high trophic level demersal fish that has been the focus of continuous human use in the North Pacific for at least 10,700 years (Fedje et al. 2005; McKechnie and Moss 2016; Orchard and Wigen 2016). Halibut are the largest flatfish and one of the largest teleost fish worldwide (Eschmeyer and Herald 1999). They can grow to be over 250 cm, weigh in excess of 230 kg, and have a maximum documented age of 55 years (Love 2011; Munk 2001). Halibut migrate widely at all life stages, moving to deep water in the winter to reproduce, and shallow water in the summer to feed (Skud 1977; Valero and Webster 2012; Webster et al. 2013).

Halibut are culturally, ecologically, and economically important to communities throughout the Pacific Rim. Indigenous fishers have regularly caught halibut for millennia, traditionally using specialized species-specific fishing equipment (Croes 1997; McKechnie and Moss 2016; Orchard and Wigen 2016; Scordino et al. 2017; Stewart

1977). Currently, halibut is one of the most economically valuable fish in the North Pacific, and in British Columbia the annual wholesale value of commercial halibut harvests can be over 100 million dollars and is surpassed only by the combined species of wild salmon (British Columbia 2016).

The International Pacific Halibut Commission (IPHC) has been responsible for managing the Pacific halibut fishery since a Canadian/American international treaty in 1923 (Bell 1981). This transnational management agency was created after several decades of unregulated industrial<sup>28</sup> halibut fishing, which led to drastic localized declines of as much as 75% per decade in the early 20<sup>th</sup> century, as estimated by decreased catch per unit effort (Thompson and Freeman 1930:30). Since its establishment, the IPHC has instituted rigorous data collection and exerted management controls that are designed to maintain a viable commercial, subsistence, and recreational Pacific halibut fishery.

Following recovery from early historical depletion, halibut abundance has fluctuated over the last century, and biomass is estimated to have declined continuously following highs in the 1990's until the early 2010's (IPHC 2014:8; Stewart and Hicks 2018a). From 2002 to 2013, exploitable biomass declined by 60% (Stewart and Martell 2014b). Size-at-age, which has important consequences for the structure and fitness of the population (Clark et al. 1999; Clark and Hare 2002; Stewart and Martell 2014a) has decreased by more than 60% since the late 1980's and is now comparable with values seen only in the 1920's, following the highest documented exploitation rates (Sullivan

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<sup>28</sup> We use the word 'industrial' to refer to the halibut fishery which began in the late 19<sup>th</sup> century, recognizing previous millennia of Indigenous economic engagement with halibut, and Indigenous participation in all aspects of the industrial fishery (Knight 1996; Reid 2015).

2016:1). Intensive size selective fishing is thought to be a significant contributing factor for these declines in growth rates (Sullivan 2016:72). Various minimum commercial size limits have been in place since the 1940's ranging from 66 cm to the current 81.3 cm (32") limit (Stewart and Hicks 2018b). While biomass and size-at-age were thought to be holding steady or slowly increasing as a response to reduced harvests (Stewart and Hicks 2016), the most recent stock assessment (Stewart and Hicks 2018a) noted a 25% coastwide reduction in numbers-per-unit-effort (NPUE) from 2016 to 2017 with continuing low size at age. As a result of a pronounced lack of recent recruitment, the IPHC is forecasting a high likelihood of decline in population and fishery yield moving forwards (Stewart and Hicks 2018a:1).

The detailed and long-term biological data collected annually by the IPHC has been described as "arguably the best fisheries dataset in the world" (Walters and Hilborn 1992:56). Despite this exceptional timeseries which helps situate changes over the history of the industrial fishery, considerable uncertainty about the drivers of these changes and their temporal dynamics persists. Archaeological data have the potential to provide a much longer record of Pacific halibut fisheries prior to the 20<sup>th</sup> century. While marine scientists have long called for improved and extended baseline data to frame current rates of change in long-term perspective (e.g., Jackson et al. 2001; Pauly 1995) relatively few research efforts in the northeast Pacific have focused on archaeological fisheries data to provide comparable proxies specifically body size distributions in the past versus present (e.g., Betts et al. 2011; Braje et al. 2017; McKechnie 2007; Nims and Butler 2018). The potential of using archaeological data to broaden perspectives on marine conservation and fisheries management is well established (e.g., Braje and Rick 2011; Hambrecht et al.

2018; Kittinger et al. 2015; Leach and Davidson 2000; Maschner et al. 2008; Morales et al. 2017; Plank et al. 2018; Pitcher 2001, 2005). However, archaeological halibut elements have never been investigated for this purpose, and it is currently unknown what length frequencies a non-industrially exploited population of Pacific halibut would exhibit.

Archaeological sites throughout the North Pacific contain a record of human halibut utilization stretching back at least 10,700 years (Fedje et al. 2005; McKechnie and Moss 2016). Here, we use archaeological halibut samples present in late-Holocene Indigenous occupation sites to derive body size estimates from pre-industrial fisheries. This fisheries-dependent dataset provides additional baseline information about past population characteristics that contrasts with and extends current observations.

To derive size estimates, we present a method for estimating halibut fork length from archaeological skeletal elements using linear regression. Regression formulae relate measurements of vertebral or cranial elements and halibut fork length from modern reference specimens of known size. This type of size estimation methodology has been broadly applied in archaeological and ecological research (e.g., Braje et al. 2017; Casteel 1974; Granadeiro and Silva 2000; McKechnie 2007; Orchard 2003; Plank et al. 2018; Rojo 1986); nevertheless, size estimation for archaeological halibut specimens has not been developed. Indeed, previous methods have consisted of approximate size category assignment based on visual inspection and rarely have size or weight estimates been offered (e.g., Crockford et al. 2004).

In this paper we present a regression-based size estimation method and apply the resulting formulae to nine archaeological assemblages in two areas of the Pacific

Northwest Coast representing 3000 years of Indigenous halibut harvests. We intentionally incorporate a wide range of sites representing different time periods, cultural variability, and environmental conditions, to derive a time and space averaged baseline for Indigenously harvested Pacific halibut. We then compare these size distributions with IPHC fisheries independent setline survey data from the historic (1914-1940) and recent past (2014-2017). Results suggest significant differences in population size structure between pre and post-industrially harvested halibut populations.

## **4.2 Materials and Methods**

### **Size Estimation Method**

We calculated 43 regression formulae to estimate halibut fork length from select skeletal measurements using modern specimens of known length. We obtained approximately 165 different measurements from each of 38 skeletonized reference halibut. Specimens were caught in coastal waters off Washington, British Columbia, and Alaska, over the last two decades. Our reference sample included 31 Pacific halibut from the University of Victoria zooarchaeology comparative reference collection (See Appendix D for skeletal preparation methods), and seven specimens from the NOAA National Marine Mammal Lab comparative osteological collection in Seattle WA. We selected halibut from 16.6 to 163.0 cm attempting to include a uniform distribution of sizes (Figure 22). Measurements were obtained using Bluetooth calipers to increase efficiency and reduce transcription error.

Element measurement followed the conventions and terminology developed for other fish taxa by Orchard (2003). We selected five skeletal elements (Articular,

Quadrates, Premaxilla, Maxilla and Ultimate Vertebrae<sup>29</sup>), and from these five elements we obtained 8 different measurements, targeting structures that commonly occur in archaeological contexts (Table 8/Figure 20).

**Table 8:** Element measurements for regression method.

| <b>Element</b>     | <b>Measurement Type</b> |
|--------------------|-------------------------|
| Articular          | Articular 4             |
| Quadrat            | Quadrat 3 and 4         |
| Premaxilla         | Premaxilla 1 and 3      |
| Maxilla            | Maxilla 2 and 3         |
| Ultimate Vertebrae | Hypural 2               |

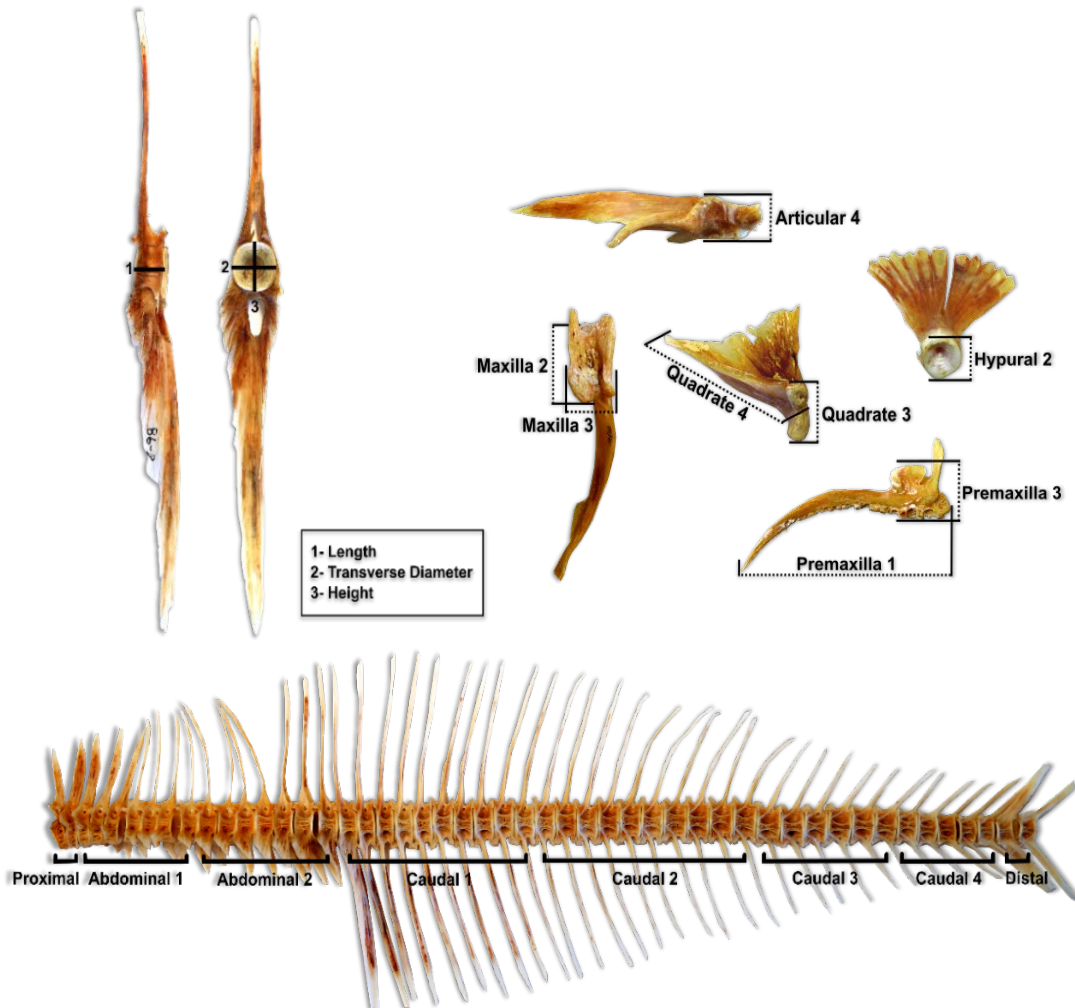
Following the vertebral naming conventions for salmon used by Moss et al. (2014), we recorded the height and transverse diameter of the anterior side of each halibut vertebra, as well as the vertebral length (Figure 20/Table 9). Halibut specimens had 48 to 51 vertebrae per individual. We split the vertebral column into eight different sub-sections (Table 9), based on observed variability in measurements taken across the spectra of reference specimens. We focused on groupings that had similar morphology and minimal variance, as well as a group for all vertebrae. Each of the three measurements per vertebrae (i.e., height, transverse diameter, and length) were averaged by section. This allows for archaeological specimens to be assigned to a vertebral category by the angle of the vertebral processes and other distinctive morphological attributes and provides a variety of measurement options to allow for selection of an intact dimension.

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<sup>29</sup> Although not a cranial element, the ‘Hypural 2’ measurement of the ultimate vertebrae was included in this group as they are easily differentiated from the rest of the vertebral column in archaeological contexts.

**Table 9:** Vertebral divisions for regression method.

| Group Name  | Vertebral Range | Number in Group |
|-------------|-----------------|-----------------|
| Proximal    | 1-2             | 2               |
| Abdominal 1 | 3-9             | 7               |
| Abdominal 2 | 10-16           | 7               |
| Caudal 1    | 17-26           | 10              |
| Caudal 2    | 27-36           | 10              |
| Caudal 3    | 37-42           | 6               |
| Caudal 4    | 43-48           | 6±2             |
| Distal      | 49-50           | 2               |
| All         | 1-49±2          | 49±2            |



**Figure 20:** Element measurements and vertebral groups. The fork length of the specimen shown (UVic 04/57) was 90 cm.

Each of the 43 measured dimensions were plotted against corresponding fork length (Figure 22) and least squares linear regression was used to fit models (Table 11). Calculated relationships predict size (Y) from element measurements (X), following the formula  $Y = \beta X + \alpha$ , where  $\alpha$  and  $\beta$  are model constants (y intercept and slope) (Kutner et al. 2004). This equation allows for computation of fitted values of Y (fork length) based on values of X (archaeological bone measurement). Linear regressions were generated using the “lm()” function in R version 3.2.4 (R Core Team 2018).

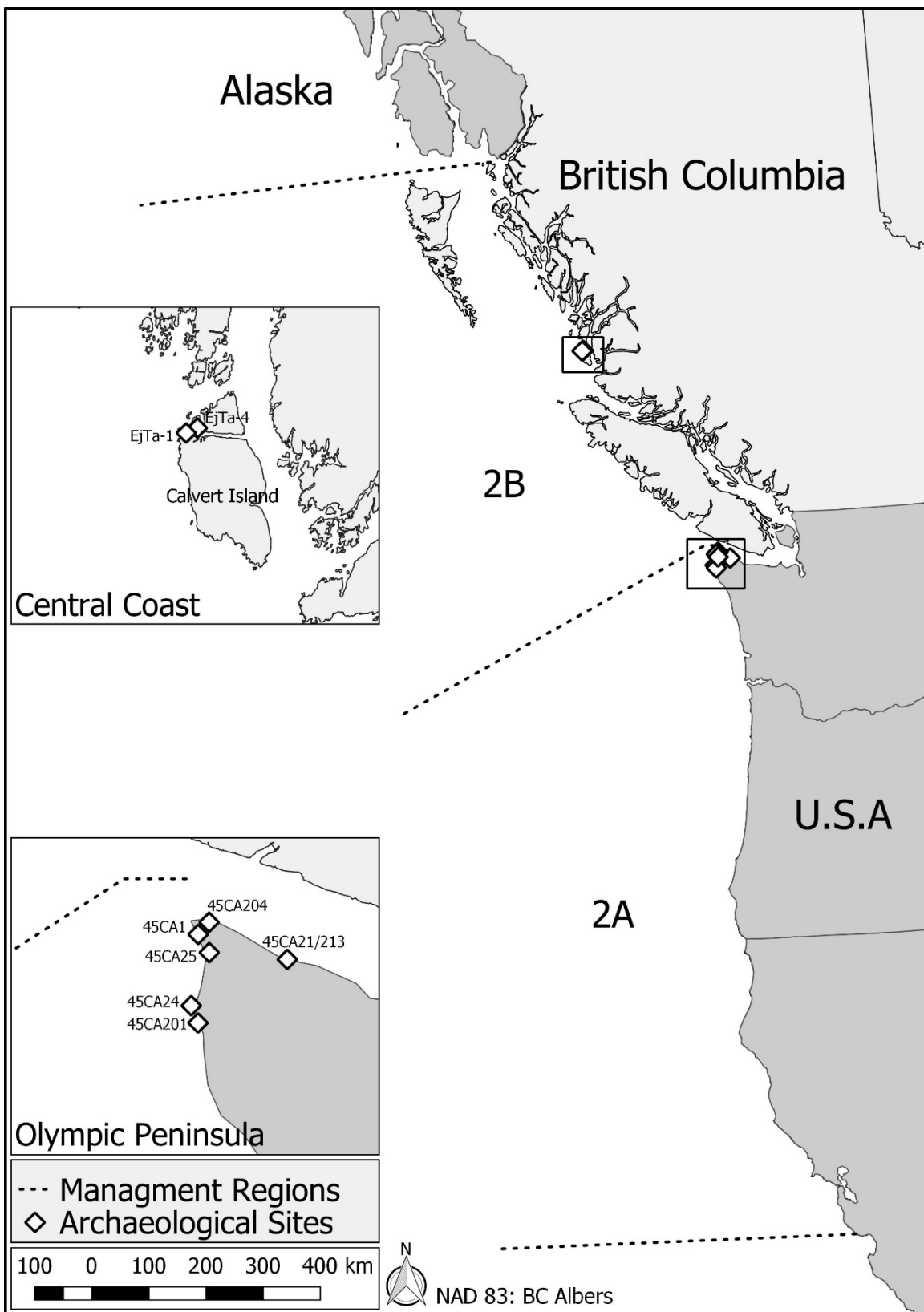
To assess inter-analyst measurement error (e.g., Lyman and VanPool 2009), two different analysts with similar experience measured each dimension (length, transverse diameter, and height) of each vertebrae for three reference halibut vertebral columns from fish of various lengths (19.5, 62.0, and 103.5 cm). Average measurement difference between analysts across these 441 different measurements is 0.25 mm or  $\pm 2.5\%$ .

To examine prediction error, we observed standard error of the estimate (average distance between residuals and the prediction line) for each regression relationship (Table 11). This value offers an error estimate (in cm) for each model. Average error across all regression equations is  $\pm 6.42$  cm (Table 11). When multiple vertebral measurement types are possible with archaeological samples, the relationship with the least amount of associated error is used (Table 11).

### **Archaeological Application**

To examine archaeological harvest profiles, we estimated the size of halibut represented by 1100 skeletal elements from two geographic regions representing 3000 years of fishing effort. Halibut elements were obtained from previously excavated faunal assemblages from seven archaeological sites in the territory of the Makah Tribe in

northwest Washington State, and two archaeological sites in the territory of the Heiltsuk and Wuikinuxv Nations in the Calvert Island region of the Central Coast of British Columbia (Figure 21/Table 10). These assemblages were chosen for their representation of halibut, which does not always preserve well in archaeological contexts (Orchard and Wigen 2016). Halibut skeletal elements are morphologically distinctive from other flatfish and were confidently identified to element and species using modern reference specimens. We measured archaeological halibut elements and applied regression formulae to estimate length.



**Figure 21:** Map of study area showing archaeological sites in relation to Pacific Halibut management regions 2A and 2B.

**Table 10:** Archaeological halibut samples sorted from north to south top to bottom.

| Region            | Site                      | Elements Measured | Associated Dates (cal yr BP) | Screen Size (mm) | Halibut %NISP (Fish)    | Reference                              |
|-------------------|---------------------------|-------------------|------------------------------|------------------|-------------------------|--|
| Central BC Coast  | EjTa-4                    | 13                | 1500-1000                    | 3 and 6          | /                       | (McLaren et al. 2015; Rahemtulla 2014) |
| Central BC Coast  | EjTa-1                    | 53                | 1000-700                     | 3 and 6          | 22.0                    | (Stafford and Christensen 2010)        |
| Olympic Peninsula | Warmhouse 45CA204         | 49                | 200                          | 6                | 5.27                    | (Friedman 1976)                        |
| Olympic Peninsula | Waatch 45CA1              | 11                | 200                          | 6                | /                       | (McMillan 1999:101)                    |
| Olympic Peninsula | Sooes 45CA25              | 320               | 1000-800                     | 6                | /                       | (Friedman 1976)                        |
| Olympic Peninsula | Hoko Rockshelter 45CA21   | 24                | 1000-100                     | 6                | 1.6                     | (Croes 2005)                           |
| Olympic Peninsula | Hoko Wet/Dry Site 45CA213 | 79                | 3000-2000                    | 6                | 5.5                     | (Croes 1995)                           |
| Olympic Peninsula | Ozette House 1/2/5 45CA24 | 388               | 450                          | 6                | 3.7 (houses 1 & 2 only) | (Huelsbeck 1981; 1994:72-73)           |
| Olympic Peninsula | Sand Point 45CA201        | 163               | 2400-1300                    | 3 and 6          | 25.5                    | (Wessen and Huelsbeck 2015)            |

#### Northwestern Olympic Peninsula:

Makah archaeological sites reveal at least a 5000-year relationship with local marine resources (Wessen and Huelsbeck 2015), which continues into the present (Sepez 2008). Halibut have always been an important resource for Makah community members, both for food and exchange (Reid 2015), and regularly occur in Makah archaeological sites (Friedman 1976). Generally, zooarchaeological data from Makah sites suggests a heavy emphasis on offshore marine resources, with varying levels of nearshore, intertidal, and terrestrial species use (Croes 2005; Friedman 1976; Gustafson 1968; Huelsbeck 1981, 1988b; McKechnie and Wigen 2011; Wessen and Huelsbeck 2015). For this study region, we obtained measurements of 1034 skeletal halibut elements from seven sites

dating from approximately 100-3,000 calibrated years before present (cal BP) (Table 10/Figure 21).

#### Central Coast of British Columbia

Sixty-six halibut elements from two sites in the Calvert Island area (EjTa-1 and EjTa-4) were used to estimate the size of fish harvested from approximately 1500 to 700 cal BP (Table 10). These two sites along with others in the region have a very long history of continuous occupation facilitated by relatively stable Holocene sea levels (McLaren et al. 2014, 2015). Archaeological research in Heiltsuk and Wuikinuxv territories indicates a primary focus on marine resources throughout the Holocene, with use of a diverse range of marine species, including large deep-water fish such as Pacific halibut (Cannon 1991, 1998; Cannon et al. 2008; Duffield 2017).

#### Setline Survey Data

Pooled archaeological length frequencies are compared with size data from IPHC fisheries-independent setline surveys. These systematic surveys are currently conducted annually on a fixed grid of survey stations, using 549 m longline skates (weighted ground lines holding a series of baited hooks on short leaders) with 100 #3 (16/0) circle hooks baited with chum salmon. Survey fork length data is recorded to the nearest cm. For a review of IPHC setline survey methods see Soderlund et al. (2012). To ensure geographic comparability, we obtained data from management regions 2A and 2B, which includes the waters off British Columbia and Washington state (Figure 21/Table 15). To compare archaeological data with different industrial management regimes we obtained the earliest IPHC length records 1914-1940 (n=11,636) as well as the last three years (2014-2017) of records (n= 37,914).

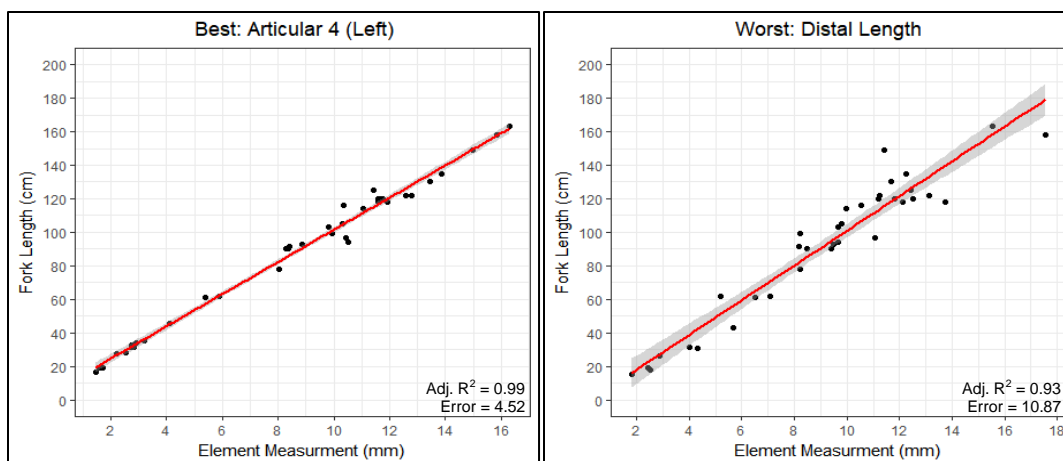
## Comparative Data Analysis

The following statistical procedures were applied to compare archaeological and IPHC data, with an alpha value of 0.05 used to assess significance. A standard two sample F-test was used to compare population variances, and Welch's unequal variance t-test is used to compare population means (Ruxton 2006). With these two tests, when sample size was disproportionate, a bootstrapped Monte Carlo method was employed (Manly 2007). A random sample of data points from the larger sample, equalling the number of data points in the smaller sample, was used to perform the t or F-test. These values were then replaced back into the larger sample and this process was repeated 100,000 times. The resulting distribution of p-values was observed, and the median p-value was used to assess the outcome of the test. Frequency distributions were compared using a two sample Kolmogorov–Smirnov test, and a chi-squared test was used to examine equality of proportions.

## 4.3 Results

### Size Estimation Method

A very strong correlation between element measurement and halibut fork length was observed in all relationships, with an average adjusted coefficient of determination of 0.97 (Table 11). Best and worst model fits (0.99 and 0.93 respectively) are shown in Figure 22. Observation of the symmetrical distribution of residuals, and generally low standard error (average  $\pm 6.42$  cm) support the strength of model fits.



**Figure 22:** Best and worst model fits. Grey area is 95% confidence interval.

**Table 11:** Regression relationships, see Figure 20 for measurement dimensions.

| Body Region | Measurement                       | Slope | Intercept | Adjusted R <sup>2</sup> | Standard Error (cm) |
|-------------|-----------------------------------|-------|-----------|-------------------------|---------------------|
| Vertebrae   | Proximal Height (H)               | 6.71  | -0.20     | 0.98                    | 5.11                |
| Vertebrae   | Proximal Transverse Diameter (TD) | 6.69  | 3.88      | 0.97                    | 6.91                |
| Vertebrae   | Proximal Length (L)               | 13.03 | 0.34      | 0.96                    | 7.90                |
| Vertebrae   | Abdominal 1 H                     | 6.69  | 1.39      | 0.98                    | 5.51                |
| Vertebrae   | Abdominal 1 TD                    | 6.28  | 3.33      | 0.98                    | 5.86                |
| Vertebrae   | Abdominal 1 L                     | 10.16 | 1.85      | 0.98                    | 6.29                |
| Vertebrae   | Abdominal 2 H                     | 6.03  | 2.45      | 0.98                    | 5.11                |
| Vertebrae   | Abdominal 2 TD                    | 5.95  | 4.34      | 0.98                    | 5.56                |
| Vertebrae   | Abdominal 2 L                     | 7.99  | 1.37      | 0.98                    | 5.53                |
| Vertebrae   | Caudal 1 H                        | 5.78  | 1.51      | 0.98                    | 5.50                |
| Vertebrae   | Caudal 1 TD                       | 5.72  | 2.35      | 0.99                    | 4.95                |
| Vertebrae   | Caudal 1 L                        | 8.43  | -0.83     | 0.99                    | 4.93                |
| Vertebrae   | Caudal 2 H                        | 5.72  | 2.12      | 0.98                    | 5.70                |
| Vertebrae   | Caudal 2 TD                       | 5.64  | 2.93      | 0.98                    | 5.79                |
| Vertebrae   | Caudal 2 L                        | 7.50  | -1.79     | 0.98                    | 5.12                |
| Vertebrae   | Caudal 3 H                        | 5.89  | 3.78      | 0.98                    | 5.77                |
| Vertebrae   | Caudal 3 TD                       | 5.99  | 2.84      | 0.98                    | 5.56                |
| Vertebrae   | Caudal 3 L                        | 7.13  | -2.44     | 0.98                    | 5.31                |
| Vertebrae   | Caudal 4 H                        | 7.27  | 0.68      | 0.98                    | 5.17                |
| Vertebrae   | Caudal 4 TD                       | 6.82  | 3.30      | 0.98                    | 6.19                |
| Vertebrae   | Caudal 4 L                        | 9.34  | -6.79     | 0.98                    | 5.23                |
| Vertebrae   | Distal H                          | 8.88  | -0.78     | 0.98                    | 5.29                |

| Body Region | Measurement        | Slope | Intercept | Adjusted R <sup>2</sup> | Standard Error (cm) |
|-------------|--------------------|-------|-----------|-------------------------|---------------------|
| Vertebrae   | Distal TD          | 7.59  | 5.81      | 0.96                    | 7.63                |
| Vertebrae   | Distal L           | 10.32 | -1.84     | 0.93                    | 10.87               |
| Vertebrae   | All Vertebrae H    | 6.22  | 1.57      | 0.99                    | 4.96                |
| Vertebrae   | All Vertebrae TD   | 6.07  | 2.93      | 0.98                    | 5.19                |
| Vertebrae   | All Vertebrae L    | 8.44  | -1.44     | 0.99                    | 4.86                |
| Cranium     | Articular 4 Left   | 9.59  | 5.67      | 0.99                    | 4.52                |
| Cranium     | Articular 4 Right  | 10.06 | 4.41      | 0.99                    | 5.31                |
| Cranium     | Maxilla 2 Left     | 6.15  | 1.34      | 0.96                    | 8.63                |
| Cranium     | Maxilla 2 Right    | 6.39  | -1.68     | 0.98                    | 6.69                |
| Cranium     | Maxilla 3 Left     | 7.52  | -0.43     | 0.98                    | 6.35                |
| Cranium     | Maxilla 3 Right    | 7.30  | -3.93     | 0.97                    | 6.89                |
| Cranium     | Premaxilla 1 Left  | 1.81  | 0.98      | 0.98                    | 6.57                |
| Cranium     | Premaxilla 1 Right | 1.88  | 4.04      | 0.97                    | 8.05                |
| Cranium     | Premaxilla 3 Left  | 6.66  | -5.09     | 0.97                    | 7.95                |
| Cranium     | Premaxilla 3 Right | 6.85  | -2.24     | 0.94                    | 10.24               |
| Cranium     | Quadrate 3 Left    | 8.56  | 3.47      | 0.98                    | 5.87                |
| Cranium     | Quadrate 3 Right   | 2.18  | -4.79     | 0.98                    | 6.42                |
| Cranium     | Quadrate 4 Left    | 2.34  | -3.71     | 0.98                    | 6.77                |
| Cranium     | Quadrate 4 Right   | 2.18  | -4.79     | 0.98                    | 6.42                |
| Tail        | Hypural 2          | 10.28 | 1.52      | 0.97                    | 7.70                |

### Archaeological Estimations

As expected for a wide variety of environmental conditions and cultural contexts, halibut size profiles differed among archaeological sites (Table 12). Mean length varied from 54 cm at the Hoko Wet/Dry site to 102 cm at EjTa-4, with an average of 87 cm. Coefficient of variance<sup>30</sup> (CV) ranged from 16% at EjTa-1 to 34% at EjTa-4. Range varied from 51 cm (50-101 cm) at Waatch to 145 cm (64-209 cm) at Sand Point. Distributions ranged from unimodal at Sand Point to tri-modal at Ozette.

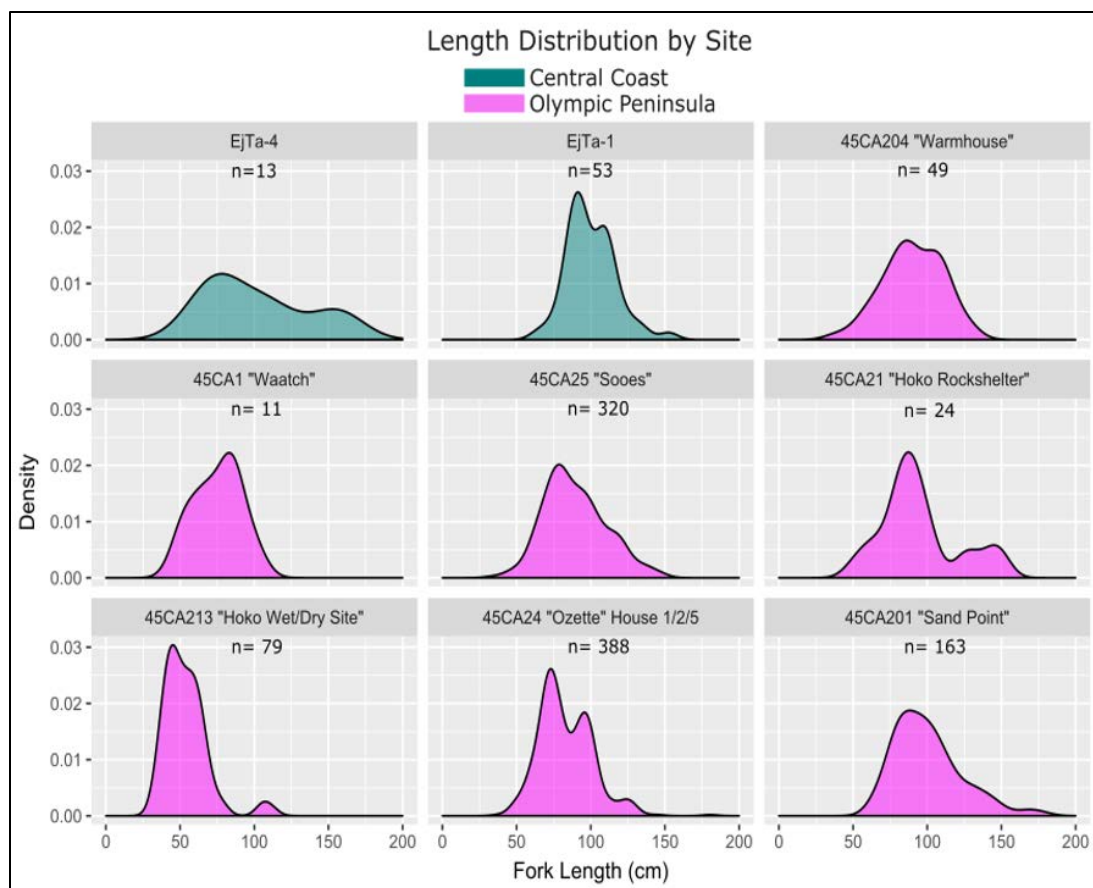
<sup>30</sup>Coefficient of Variance or (CV) is calculated by dividing the standard deviation by the mean.

**Table 12:** Estimated halibut lengths from archaeological assemblages sorted north to south top to bottom (see Figure 21).

| <b>Region</b>     | <b>Site</b>               | <b>~Cal BP<sup>a</sup></b> | <b>Count</b> | <b>Mean Length (cm)</b> | <b>CV<sup>b</sup></b> | <b>Range (cm)</b> | <b>Min (cm)</b> | <b>Max (cm)</b> |
|-------------------|---------------------------|----------------------------|--------------|-------------------------|-----------------------|-------------------|-----------------|-----------------|
| Central Coast     | EjTa-4                    | 1500-1000                  | 13           | 102                     | 34%                   | 101               | 58              | 159             |
| Central Coast     | EjTa-1                    | 1000-700                   | 53           | 100                     | 16%                   | 88                | 64              | 152             |
| Olympic Peninsula | Warmhouse 45CA204         | 200                        | 49           | 90                      | 22%                   | 91                | 39              | 131             |
| Olympic Peninsula | Waatch 45CA1              | 200                        | 11           | 75                      | 21%                   | 51                | 50              | 101             |
| Olympic Peninsula | Sooes 45CA25              | 1000-800                   | 320          | 89                      | 23%                   | 144               | 34              | 148             |
| Olympic Peninsula | Hoko Rockshelter 45CA21   | 1000-100                   | 24           | 95                      | 28%                   | 97                | 51              | 149             |
| Olympic Peninsula | Hoko Wet/Dry Site 45CA213 | 3000-2000                  | 79           | 54                      | 21%                   | 78                | 33              | 112             |
| Olympic Peninsula | Ozette House 1/2/5 45CA24 | 450                        | 388          | 83                      | 22%                   | 143               | 38              | 181             |
| Olympic Peninsula | Sand Point 45CA201        | 2400-1300                  | 163          | 101                     | 24%                   | 145               | 64              | 209             |

<sup>a</sup>See Table 10 for date range citations.

<sup>c</sup>Coefficient of variance or (CV) is calculated by dividing the standard deviation by the mean.

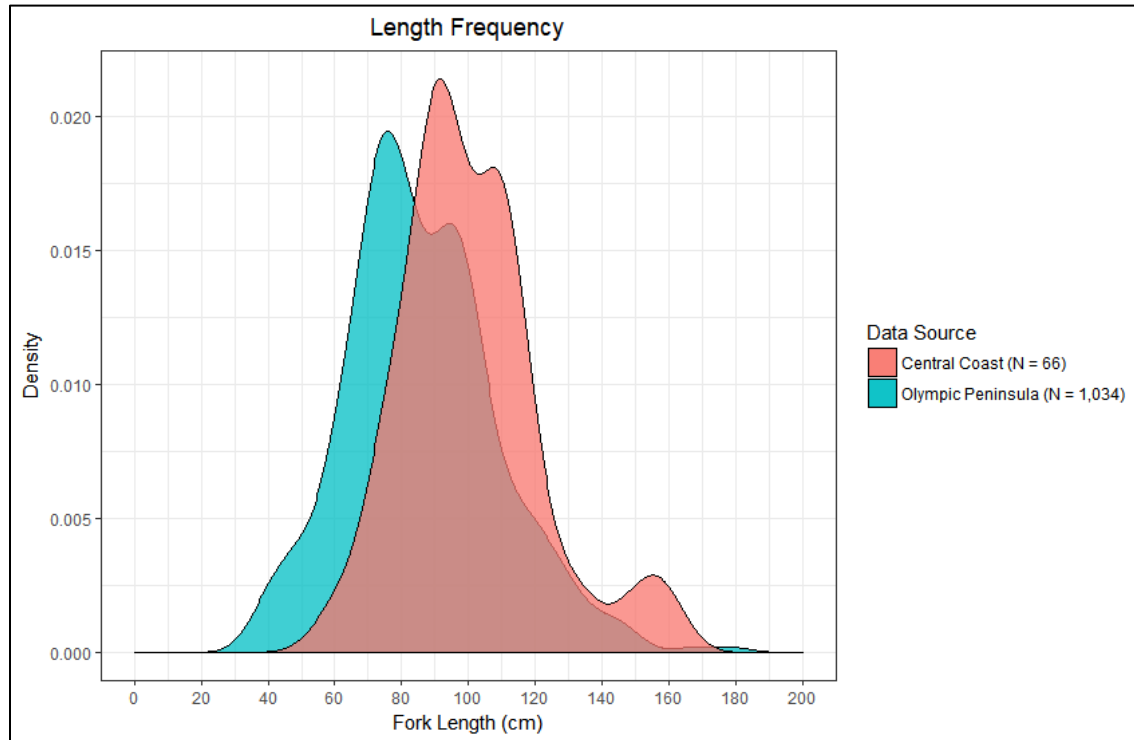


**Figure 23:** Estimated length frequency distributions by archaeological context. Assemblages are sorted north to south from left to right top to bottom (see Figure 21). Area under each density plot is scaled to equal one.

Grouped by geographic region, Central Coast halibut (n=66) had significantly similar variance (F-test  $p = 0.44$ ) as Olympic Peninsula halibut (n=1034), and distributions were visually similar (Table 13/Figure 24). However, the shape of their distributions and mean length were significantly different (Welch's t-test and K-S test  $p < 0.00$ ).

**Table 13:** Comparison of Central Coast and Olympic Peninsula archaeological halibut lengths.

| Area              | ~Cal BP     | Count | Mean Length (cm) | CV  | Range (cm) | Min (cm) | Max (cm) |
|-------------------|-------------|-------|------------------|-----|------------|----------|----------|
| Central Coast     | 1500-700 BP | 66    | 101              | 21% | 101        | 58       | 159      |
| Olympic Peninsula | 3000-200 BP | 1034  | 86               | 26% | 176        | 33       | 209      |



**Figure 24:** Length frequency comparison between archaeological size profiles from two geographic regions (see Figure 21). Area under each density plot is scaled to equal one.

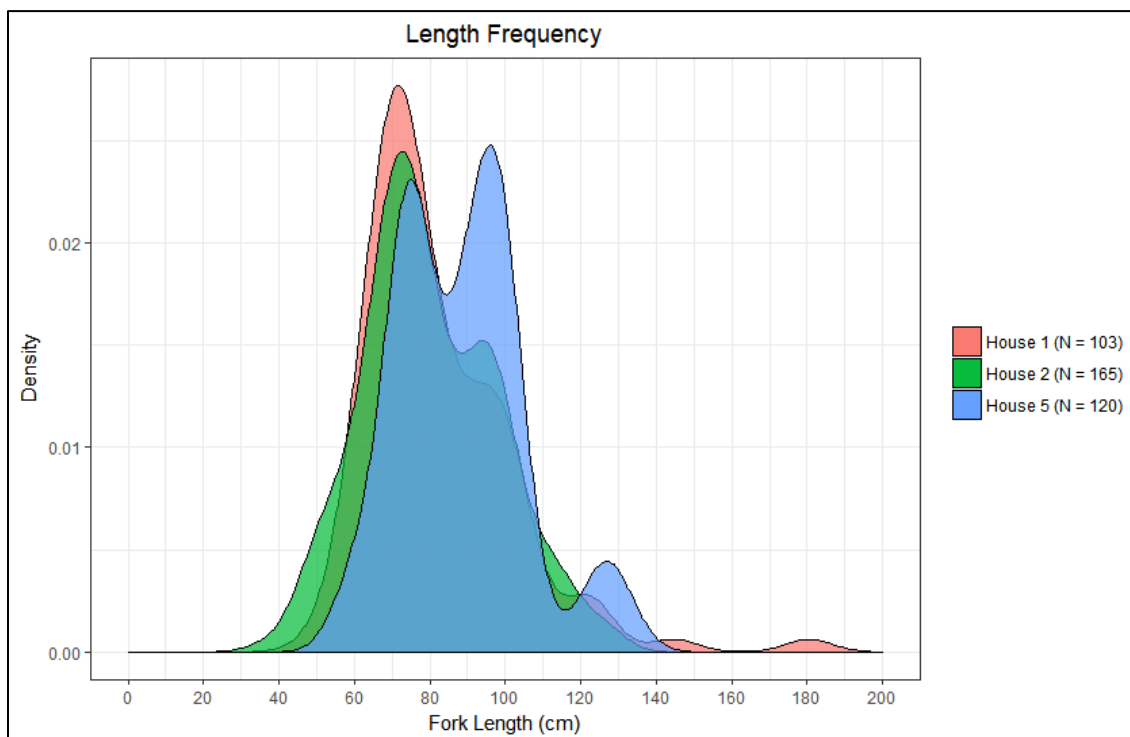
To observe harvest profiles from an environmentally and temporally constrained sample, we compared size distributions between three different houses from the extensively researched Ozette Village Site (45CA24) in Northwest Washington State (see Kirk 2015). Houses 1, 2, and 5 at Ozette, were all occupied during an approximate 100-year period<sup>31</sup> (Huelsbeck 1988a; Samuels 2006) around 450 BP (Samuels et al. 1991:181). Although length variance is similar between all houses (F-test  $p > 0.07$ ), only Houses 1 and 2 have significantly similar mean length and distribution shape (Welch's  $t$  and K-S test  $p > 0.4$ ). Additionally, we observe that despite being located only a few hundred meters apart (see Figure 21), Hoko Rockshelter halibut (1000-100 calBP) and

<sup>31</sup> Although these houses were all occupied during a 100-year period, House 2 and House 5 were not contemporary with each other. Indeed, House 5 is located just underneath House 2. However, a  $\pm 100$ -year timeframe represents a very narrow analytical period for archaeological purposes.

Hoko Wet/Dry site halibut (3000-2000 calBP) differ significantly in mean length and distribution shape (Welch's t-test and K-S test  $p < 0.00$ ) (Table 11/Figure 23).

**Table 14:** Comparison of archaeological halibut lengths between houses at Ozette.

| Assemblage | Count | Mean Length (cm) | CV  | Range (cm) | Min (cm) | Max (cm) |
|------------|-------|------------------|-----|------------|----------|----------|
| House 1    | 103   | 82               | 24% | 131        | 50       | 180      |
| House 2    | 165   | 80               | 22% | 89         | 38       | 127      |
| House 5    | 120   | 88               | 19% | 77         | 57       | 134      |



**Figure 25:** Length frequency comparison between three approximately contemporary Ozette houses circa 450 BP. Area under each density plot is scaled to equal one.

#### Pooled Archaeological Data

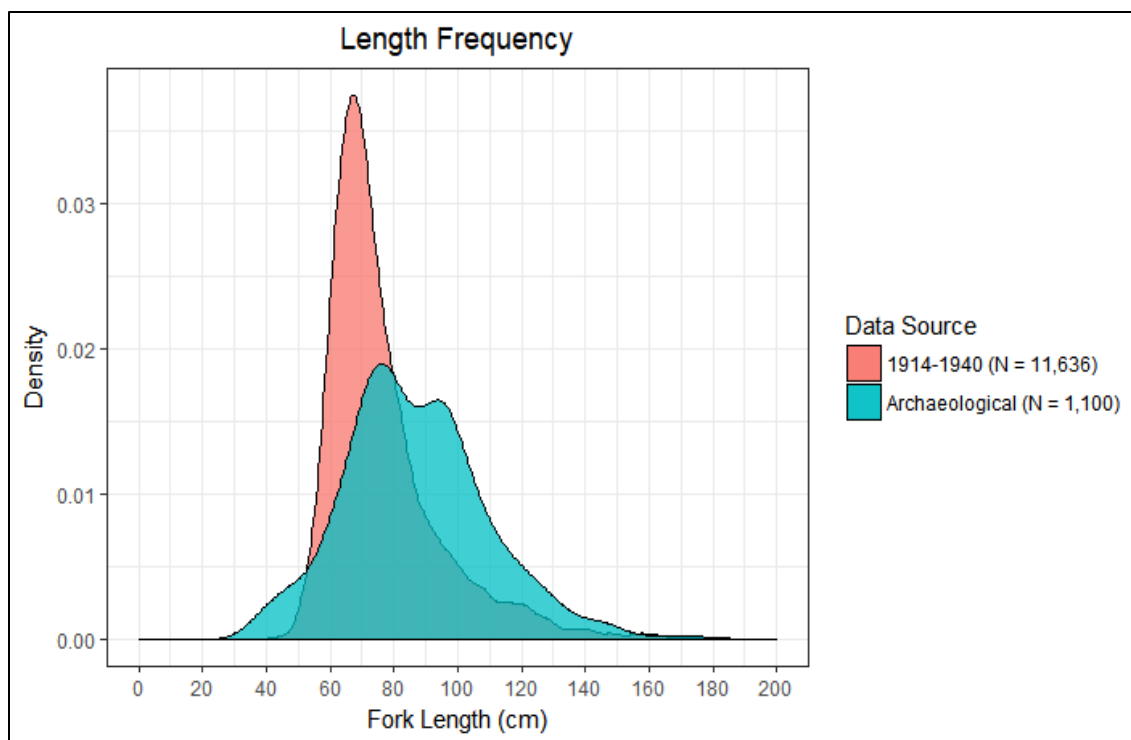
To estimate a pre-industrial baseline size range, we pooled all archaeological samples (3000-200 calBP) and compared these with historical (1914-1940) and present day (2014-2017) size data from IPHC setline surveys. Combined archaeological data from both regions ( $n=1,100$ ) exhibit significantly greater variance (F-test  $p < 0.00$ ) than

all IPHC setline survey fish caught in management region 2A/2B (Figure 21) from 1914-1940 (n=11,636), see Table 15/Figure 26. Moreover, archaeological data include a significantly greater percentage of fish under 50 cm (Chi-Square  $p < 0.00$ ), a significantly different frequency distribution (K-S  $p < 0.00$ ), as well as significantly more fish larger than the 81.3 cm (32 inch) commercial size limit (Chi-Square  $p < 0.00$ ), a larger coefficient of variance (CV), and significantly greater mean length (Welch's t-test  $p < 0.00$ ).

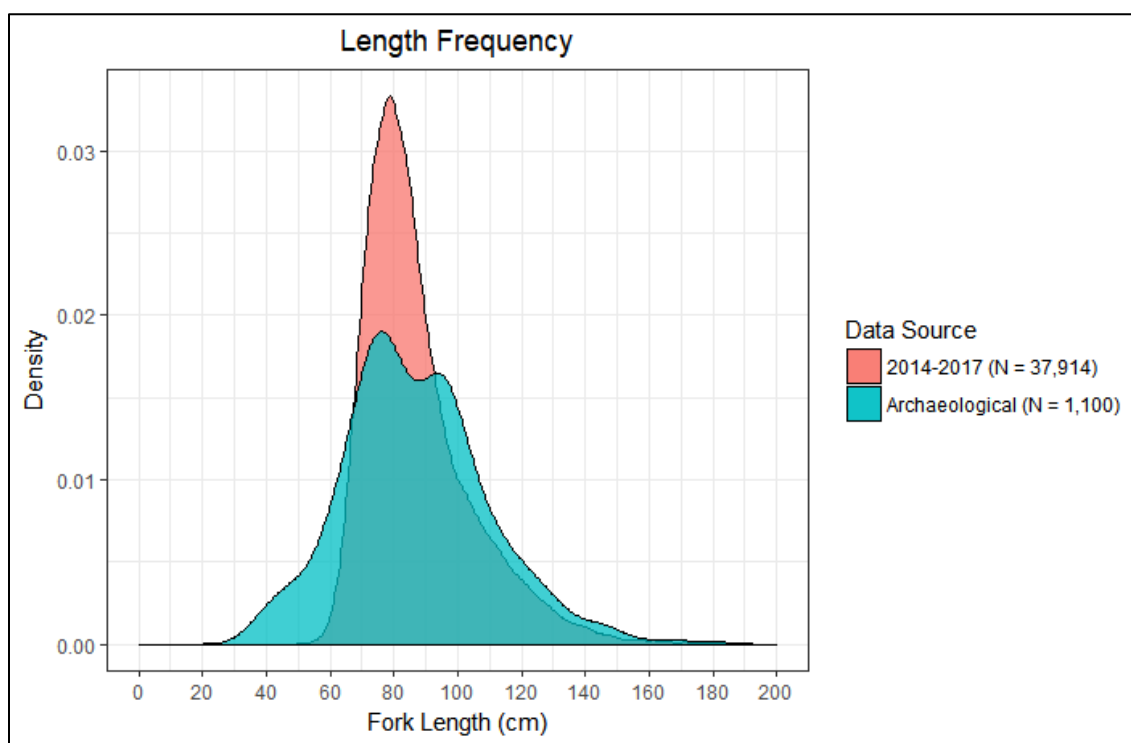
Pooled archaeological samples similarly exhibited significantly greater variance (F-test  $p < 0.00$ ) than all setline survey fish caught in 2A/2B (Figure 21) from 2014-2017 (n=37,914), see Table 15/Figure 27. Archaeological samples had significantly more fish under 50 cm (Chi-Square  $p < 0.00$ ), a larger coefficient of variance (CV), and a significantly different frequency distribution (K-S  $p < 0.00$ ). However, when compared with present-day survey data, there was no significant difference in average length (Welch's t-test  $p = 0.6$ ) or in the proportion of fish above the commercial limit (Chi-Square  $p = 0.5$ ).

**Table 15:** Size comparison between archaeological and industrially fished halibut.

| Sample    | Count  | Gear Type            | Mean Length | CV  | % $\geq$ 81.3 cm | %< 50 cm | Range  | Min   | Max    |
|-----------|--------|----------------------|-------------|-----|------------------|----------|--------|-------|--------|
| All Arch. | 1,100  | Wooden Shanked Hooks | 87.08       | 27% | 56.55            | 4.36     | 176.05 | 33.22 | 209.27 |
| 1914-1940 | 11,636 | Metal J Hooks        | 76.76       | 24% | 27.13            | 0.28     | 214    | 35    | 249    |
| 2014-2017 | 37,914 | 16/0 Circle Hooks    | 87.30       | 19% | 55.53            | 0        | 157    | 51    | 208    |



**Figure 26:** Length frequency comparison between archaeological and historical (1914-1940) catch data. Area under each density plot is scaled to equal one.



**Figure 27:** Length frequency comparison between archaeological and present-day (2014-2017) catch data. Area under each density plot is scaled to equal one.

## **4.4 Discussion**

### **Size Estimation Method**

We have developed a pragmatic and simple methodology for estimating halibut body size from zooarchaeological specimens with a reasonable level of predictive error, insomuch as error can be estimated across such a wide geographic and chronological range (Singh et al. 2015). Notably, our linear regression formulae do not attempt to articulate an allometric model of ancient halibut growth or link size and age (cf. Clark 1992). The strong correlation observed between bone size and body size for a variety of skeletal elements including multiple vertebral categories represents a significant improvement from previous archaeological halibut size estimation methodology (Crockford et al. 2004).

### **Length Frequency Comparison**

Recent population conditions and corresponding coastwide harvest reductions (Stewart and Hicks 2018a), as well as increased awareness of the impacts of intensive size selective fishing on halibut growth (Sullivan 2016:72), highlight the need for new insight into the broader historical trajectory of this species. Following the expectations for assessing population fitness based on size distributions (e.g., Anderson et al. 2008; De Roos and Persson 2002; Hsieh et al. 2006), our pooled results indicate that Indigenous fishers selectively accessed a halibut population that had significantly more robust characteristics than observed both in the early 20<sup>th</sup> century and within the past 4 years. These characteristics include a significantly wider size distribution with more small fish and larger or equal average size (Figure 26/Figure 27). Archaeological length frequencies exhibit greater normality despite a smaller sample size than industrially harvested halibut

populations, which display positively skewed and narrowed size distributions indicative of low recruitment and a lack of large fecund fish (cf. Barneche et al. 2018).

IPHC samples displayed only 0.28% and 0% fish below 50 cm, compared with 4.36% of archaeological fish. Additionally, 27.13% and 55.3% of IPHC setline fish were above the 81.3 cm commercial limit compared to 56.55% of archaeological fish.

Furthermore, we note that the large average size observed in the 2014-2017 2A/2B setline survey data are somewhat anomalous to conditions coastwide, which display smaller average fish size (Goen et al. 2018).

Despite known low size-at-age (slow growth) during the period of early survey records, as well as in the last 3 years (Stewart and Hicks 2018a), conditions which should shift population distribution towards smaller fish, IPHC data suggests significantly fewer small fish (less recruitment) than archaeological data. This difference may indicate fishing induced changes in spawning locations and recruitment, with more young fish available in areas 2A and 2B before industrial harvests. Additionally, we note that as a long-term fisheries independent dataset the IPHC setline data would be expected to display more size variance than our fisheries dependant sample.

It is well established that changing fish population size structure through fishing can produce negative outcomes, such as increased variability in abundance (Anderson et al. 2008; Hsieh et al. 2006), reduced reproductive potential (Berkeley, Hixon, et al. 2004; Birkeland and Dayton 2005; Hutchings and Baum 2005; Stige et al. 2017), increased vulnerability (Ohlberger et al. 2014; Pauly and Cheung 2018), size related deepening (Frank et al. 2018), cascading ecosystem outcomes (Costa-Pereira et al. 2018), and in the

case of Pacific halibut, female-biased commercial catches when large minimum size limits are used (Loher et al. 2016).

Although the earliest survey records are understood to represent degraded conditions following initial decades of unregulated fishing and subsequent declines (Thompson and Freeman 1930), they continue to effectively define the earliest available baseline for fishery conditions (cf. McKechnie et al. 2014). Notably, these early survey records are fairly concentrated geographically. For instance, the only body size measurements from region 2A (which bore the brunt of much of the initial unregulated industrial harvesting) before 1941, is from a single survey trip in 1926, and represents only 303 length records. Archaeological data significantly extend these baselines by contextualizing industrially harvested population dynamics with millennial scale catch records.

Here we have generated a temporally and spatially averaged example of pre-industrially harvested conditions, as sampled by different actors across multiple conditions and climatic regimes. Thus, instead of offering an example of halibut size distribution as a product of specific past environmental states or particular human conditions that may not be well resolved, this record represents a “noise filtered” sample of average conditions across multiple sites and time frames thereby increasing inferential power (Lyman 2003; Olszewski 1999). This allows present day conditions from shorter timespans to be contextualized through comparison to the pre-industrial average, and it is notable that length frequencies resulting from relatively short periods of industrial extraction display significantly narrower distributions than the average result of 3000 years of continuous harvesting.

## **Indigenous Halibut Fishing and Resource Management**

Here we review Indigenous harvesting and management practices on the Pacific Northwest Coast, in the context of our size estimations, to further investigate our archaeological data, and to examine the characteristics of baseline halibut size data derived from archaeological samples. The archaeological data we have presented demonstrate a 3000-year record of sustained harvests, with broadly similar mean size (Table 12/Figure 23). The Hoko Wet/Dry Site (45CA213) stands out with the smallest average size (54 cm). Previous archaeological analysis of this assemblage has suggested that these fish were obtained near to the site along with other medium-sized flatfish (Croes 1995). This is notable due to a pronounced lack of small halibut in management region 2A, in both historical and recent survey data (which includes a sample station near 45CA213 [Figure 21]) (IPHC 2018) and suggests changes in local breeding and migration patterns. Archaeological data grouped by region (Central Coast vs. Olympic Peninsula) had significantly similar variance, but Central Coast samples were significantly larger on average (Table 13/Figure 24). Due to the different samples and contexts, it is unclear how meaningful this difference (101 vs 86 cm) is but it may relate to local oceanographic conditions and a limited sample size in comparison to the Olympic Peninsula data.

Indigenous fishers throughout the region have caught halibut for at least ten millennia (Fedje et al. 2005; McKechnie et al. 2014), including through dramatic and geographically variable relative sea levels (Mackie et al. 2011; Shugar et al. 2014), and various climatic and tectonic fluctuations (Atwater 1987; Hutchinson et al. 2018; Kim et al. 2004; Losey 2005; Mayewski et al. 2004). Despite the population and technological capacity to overharvest resources (Rettig et al. 1989:280; Trospen 2009), past Northwest

Coast fishers mitigated depletion through strong sociocultural mechanisms including regulated access, enhancement strategies, and acute local understanding (Berkes et al. 2000; Lane 1977; Lepofsky and Caldwell 2013; Huelsbeck 1981; McKechnie 2007; Pinkerton 1989; Thornton et al. 2015; Trospen 2002, 2003, 2009). Long-term relationships with species couple natural and human worlds, allowing for fine-grained understanding and resilient systems (Berkes 2010; Brown and Brown 2009; Claxton and Elliott 1994; McKechnie 2007; Menzies and Butler 2007; Morales et al. 2017; Turner et al. 2000; Turner and Berkes 2006; Umeek [Atleo] 2007).

As an example of these mechanisms, Indigenous communities have been described as having sharply delineated fishing tenure areas including the asserted ownership and management of halibut fishing banks. Specific banks, triangulated from mountain tops or other coastline features were regularly accessed at different times for the size and number of halibut required for different needs (e.g., preservation, trade, immediate consumption) particularly in Makah and Nuu-chah-nulth territories on southwestern Vancouver Island and NW Washington State (Croes 2005; Drucker 1951; Huelsbeck 1981; Lane 1973; Reid 2015:220). This spatially distributed harvest and regulatory framework likely prevented intensive size selective overharvesting as is reflected in the current commercial fishery. Along with presumably lower catch rates, such conditions facilitated persistent sustainable harvests and long-term resource availability.

An archaeological indication of this sociocultural spatial management mechanism is suggested when comparing halibut length frequencies between houses at the Ozette Village Site (see Table 14/Figure 25). Although length variance is similar between all

three houses (F-test  $p > 0.07$ ), only Houses 1 and 2 had significantly similar mean length and distribution shape (Welch's  $t$  and K-S test  $p > 0.4$ ). It has been previously suggested, based on analysis of other archaeological material, that these two houses belonged to the same social group (Huelsbeck 1988a). In contrast, House 5 which displayed a significantly different mean size and distribution shape ( $p < 0.01$ ), is thought to represent a different extended family group with spatially separate fishing and harvesting territories. Spatial analysis of Makah and Nuu-chah-nulth archaeological data has previously supported the hypothesis of socially arbitrated fishing area access (Huelsbeck 1981, 1988a, 1989; McKechnie 2007; Samuels 2006; Wessen 1988). The large differences in size between Hoko Rockshelter and Wet/Dry Site halibut (Table 12/Figure 23) likely also relate to accessing different fishing areas despite their chronological differences (1000-100 BP versus 3000-2000 BP respectively). We note that the multimodal distributions seen in many of the archaeological assemblages may result from fishers accessing different areas of certain sized halibut (Figure 23). Indeed, Olympic Peninsula and Central Coast halibut showed very similarly shaped bi-modal distributions (Figure 24) which could result from this same mechanism.

For many groups including the Makah, halibut has long been both a food item and an article of trade, motivating large harvests continued over the long-term (Huelsbeck 1988b; Lane 1973; Reid 2015; Sepez 2008). For instance, historical records indicate that in 1880, the Neah Bay community of 728 individuals landed 1.5 million pounds (this is 5% of the coastwide 2017 harvest quota) of fresh halibut using traditional harvesting methods (Reid 2015:217). While the limited temporal resolution of archaeological data preclude an analysis of decadal or centennial scale halibut population dynamics (c.f.

Etnier 2007; McKechnie 2007); the long history of Makah halibut fishing traditions, the demonstrated ability to catch significant numbers of halibut, the abundance of fish available at the beginning of the commercial halibut fishery, and the length frequencies seen in this study, suggest effective mechanisms to manage halibut harvests long before the first international regulations in 1923 (Bell 1981; Huelsbeck 1981; Lane 1973; Reid 2015; Swan 1868; Thompson and Freeman 1930; Thompson and Weld 1961; Waterman n.d.; Wessen and Huelsbeck 2015). The disruption of these longstanding management systems contributed to the serious depletion observed in the early years of the halibut fishery (Bolster 2014; Menzies and Butler 2008; Thistle 2004; Thornton and Hebert 2015).

#### **4.5 Conclusion**

As fisheries worldwide face declining conditions, novel approaches that extend and enrich perspectives using a wider range of available data are becoming increasingly important (e.g., Berkes 2012; Eckert et al. 2017; Jackson et al. 2001; McClenachan 2009; Pitcher 2005; Rodrigues et al. 2018). This halibut size estimation methodology and application represents one more tool to engage with change over time. Our data provide a long-term baseline of a halibut population size distribution under a different management and harvest regime, contextualizing industrially harvested conditions. As seen when comparing halibut length frequencies, archaeological data imply that industrial exploitation practices have had a greater impact than millennia of Indigenous harvesting, resulting in narrowed size distributions indicating lower levels of recruitment and fewer large fecund fish. This comparison suggests that reducing the intensive size selectivity of industrial fishing by lowering the commercial size limit, as observed in pre-industrial

halibut management practices, could improve current population conditions. There are undoubtedly millions of halibut specimens present in the tens of thousands of coastal archaeological sites across the North Pacific. Further application of this method has the possibility to improve precision allowing for fine-grained analysis of population responses to specific conditions and dynamics over time. Our findings demonstrate the potential of historical approaches for broader perspectives on the sustainable management of fisheries.

## Chapter 5: Conclusions

In this final chapter each of my three central research questions is reviewed and answers to these questions as suggested by different components of this thesis are considered. Following this, I evaluate how this thesis meets the objectives outlined in Chapter 1. This leads into a discussion of future research directions and final concluding remarks.

### 5.1 Review of Research Questions

#### **Question 1: *What can an archaeological analysis of Indigenous halibut fishing equipment reveal about past fishing practices and present-day implications?***

In Chapter 3, I examined ethnographic and ethnohistoric fishing equipment housed in museums, and linked this information with halibut mouth structure, to identify some attributes of how humans interact with halibut using traditional hooks. This analysis was informed by interviews with knowledgeable fishers (Appendix A), experimental construction of halibut hooks (Appendix B), and by the historical and ethnographic accounts reviewed in Chapter 2. Drawing on anthropological materiality theory, I argued that these crafted material objects reflect a process by which fishers drew on multigenerational relationships with halibut to create and reproduce fishing technology ideally suited to halibut biology and personality. By conceptualizing halibut and hooks as animate and intended to engage individual fish, fishers were able to go beyond a simple behavioral understanding and build anticipated cognitive and emotional responses into the design of the hook.

I observed that hook makers in different parts of the Northwest Coast constructed hooks with different designs which I categorized as V-shaped, U-shaped, and Hybrid.

These styles show regional trends but overlap geographically despite being spread across culturally and linguistically distinct regions. Among all the hooks I examined, two morphological attributes were very consistent: lip gap and barb height (see Figure 10 in Chapter 3). Based on my review of previously published accounts and the results of my own analysis of hooks and halibut, I argued that these consistent attributes, moderate the size of fish able to be caught with these hooks. I related measurements of these attributes to halibut length estimates to evaluate the size-selective properties of each hook. Size-selective properties were broader than expected with the average wooden hook lip gap and barb height selecting for a range of halibut from 40-149 cm.

I argued that by modifying lip gap and the barb height, hooks could be constructed to select for a desired slot limit of halibut. Further testing of such hooks following a similar procedure as Scordino et al. (2017) could confirm this hypothesis. Slot limits (upper and lower size limits) are considered effective management measures as they protect the age and size structure of a fish population by protecting both young immature and old fecund fish. Currently fishing size limits are observed through catch and release measures which have associated discard mortality; however, the most effective way to protect undersize and oversize fish is to not hook these sizes at all. Scordino et al.'s (2017) promising observation of significantly reduced bycatch using traditional methods confirms the cutting-edge relevance of this traditional technology in the present day.

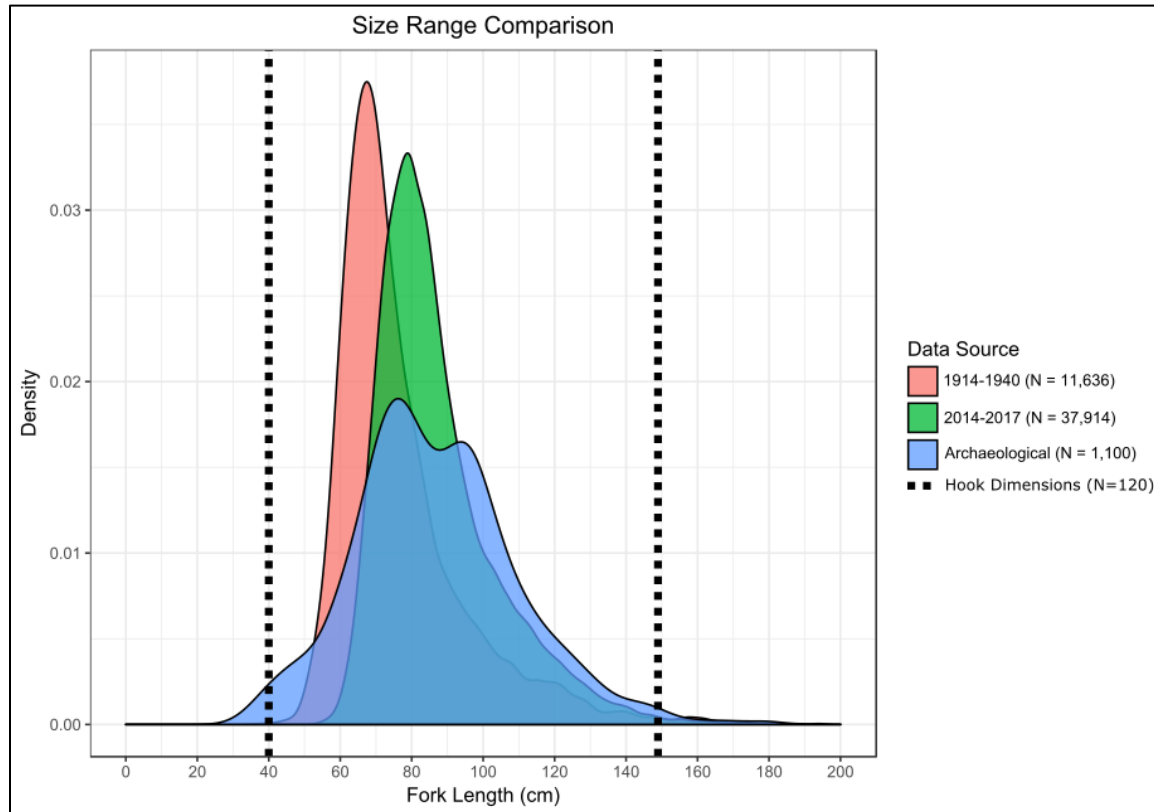
**Question 2: *What was the size range of halibut caught in the past?***

I proposed answers to this question using different methods in Chapters 3 and 4. Interviews with knowledgeable fishers (Appendix A) as well as historical information

reviewed in Chapter 2 also addressed size-at-harvest. In Chapter 3 I investigated halibut size by relating measured hook dimensions to halibut mouth morphology. In Chapter 4 I developed regression formulae to estimate fork length from a variety of different skeletal element measurements. I applied this methodology to 1100 late Holocene halibut elements to estimate a pre-industrial baseline of halibut size at harvest. IPHC setline survey data also indicate the size range of fish caught on the coast from 1914-1940 and from 2014-2017. See Table 16 and Figure 28 for historical size-at-harvest.

**Table 16:** What size halibut were caught in the past?

| <b>Source of Information</b>                  | <b>Data Type</b>                | <b>Size</b>                   |
|---|---------------------------------|-------------------------------|
| Archaeological Estimated Range<br>(Chapter 4) | Archaeological                  | 33-209 cm<br>(~1-303 lbs)     |
| 1914-1940 Survey Range<br>(Chapter 4)         | Setline Survey                  | 35-249 cm<br>(~1-534 lbs)     |
| 2014-2017 Survey Range<br>(Chapter 4)         | Setline Survey                  | 51-208 cm<br>(~3-298 lbs)     |
| Wooden Hook Estimated Range<br>(Chapter 3)    | Wooden<br>Ethnographic<br>Hooks | 40-149 cm<br>(~1.5-101 lbs)   |
| Ted Walkus Interview<br>(Appendix A)          | Lived<br>Experience             | Larger in the<br>recent past  |
| Malindine (2017:4)<br>(Chapter 2)             | Ethnographic                    | 20-100 lbs<br>~(90 to 148 cm) |
| Niblack 1890:290<br>(Chapter 2)               | Ethnographic                    | 50-120 lbs<br>~(120-157 cm)   |
| Waterman 1920:11<br>(Chapter 2)               | Ethnographic                    | <25 lbs<br>~(<97 cm)          |



**Figure 28:** Size comparison between different halibut length profiles with average estimated range from 120 ethnographic halibut hooks.

These size distributions expand understanding of the historical dynamics of the halibut population and have archaeological implications for interpreting the sociocultural context of past halibut use. Halibut grow exponentially in weight throughout their lifespan (Courcelles 2011) which has consequences for their dietary and economic utility. Catching mature halibut requires skill, knowledge, and appropriate technology. Due to the limited preservation of wooden artifacts, it remains unknown when the ethnographic style of fishing equipment I observed in Chapter 3 came into widespread use on the coast. However, the large halibut seen in the 3000-year archaeological sample (max = 209 cm) would have required robust and likely specialized technology to catch. Furthermore, large halibut are more likely to be butchered in different ways than other smaller bodied fish,

which would lead to different archaeological representation between sites and coastal regions, as was observed to a degree in Appendix C (halibut taphonomy).

Historically, the differences between the 1914-1940 samples and the 2014-2017 samples result from the fluctuating population dynamics of the modern era, controlled by harvest pressure and environmental effects. The earlier samples represent a heavily fished and mostly unregulated population, while the recent samples represent modern management practices.

I note that although the archaeological estimated size range is slightly larger than the estimated wooden hook selected range (Table 16/Figure 28), the archaeological fish below 40 cm and above 149 cm only account for 2.4 % of the sample. This strong level of coherence suggests two explanations: either the size range of fish available during the period the ethnographic hooks were being constructed is similar to the size range available over the period the archaeological sample was obtained from, and thus hook estimates correspond to an average natural halibut range, or similarly size-selective hooks were used to produce the archaeological sample. The first explanation suggests that the signature of a wider size range of fish available pre-industrially as seen in Chapter 4 is present both in archaeological materials and technological examples (see Figure 28), while the second suggests that even though a selective range of the population was being fished, archaeological samples still display a broader size range than industrial samples. Employing multiple methods of size estimation offers a broader view into past fish and fishing practices than a single method alone.

**Question 3: *Can archaeological halibut elements provide size data relevant for present-day management?***

In Chapter 4 I provided an estimate of late Holocene halibut length frequencies from archaeological data which is directly comparable with present day survey data using the simple but fundamental metric of fork length (aka. body size). This baseline allows industrial size changes to be put into long-term perspective. Although Pacific halibut have much more historical biological data available than most fish species (Hilborn and Walters 1992:56), this data only represents industrially harvested conditions and is geographically limited (my archaeological sample is also geographically limited; however, the method I demonstrated can be applied more widely). Before this research, the size distribution of a non-industrially harvested halibut population was largely unknown.




Comparing historical and present-day conditions with this archaeological baseline revealed significant differences in body size distribution that reflect broader population differences. A wider size range was observed in the archaeological data with a greater proportion of small halibut as well as larger fish. This suggests that historical and present-day conditions reflect less robust populations which likely result from intense size-selective industrial harvesting. Extending perspectives on current conditions is an important step to improve management targets moving forwards. Indeed, these observations of a wide size range being caught in the past, along with accounts of size-distributed Indigenous harvesting practices, support recent re-evaluations of the 81.3 cm minimum commercial size limit (e.g., Stewart and Hicks 2018b). Adopting an open slot limit approach (Barnett et al. 2017; Gwinn et al. 2015) which would shift fishing pressure away from large female fish may be an effective scenario moving forwards. Slot limits

are already often used for recreational halibut management in Canada. Furthermore, since archaeological baseline data were generated from an entirely different management framework, this framework can also be investigated as a time-tested source for alternatives to the status quo.

## 5.2 Review of Objectives

In Chapter 1, I outlined three objectives which motivated the production of this thesis. In this section I will discuss how my work has addressed these objectives.

### Thesis Objectives:

-  To emphasize the long history of human-halibut relationships in the North Pacific.
-  To examine the success of past management practices.
-  To contextualize the drastic changes in the halibut population brought about in the last 150 years.

My first research question (*What can an archaeological analysis of Indigenous halibut fishing equipment reveal about past fishing practices and present-day implications?*) relates to these objectives by providing specific detail about past halibut fishing practices through an examination of traditional fishing equipment. I observed that traditional hooks have design attributes which could be adapted for sustainable fishing efforts.

My second research question (*What was the size range of halibut caught in the past?*) addresses these objectives by providing detail about the size range of halibut caught over three millennia. Contrasting pre-industrial size ranges as archaeologically estimated and as inferred from traditional fishing technology with an industrially

harvested population suggests the success of past management practices and contextualizes industrial conditions.

Finally, my third research question (*Can archaeological halibut elements provide size data relevant for present-day management?*) utilizes longterm human use of halibut in the northeast Pacific as a source of data. The success of past management practices is supported by the robust archaeological distributions observed in comparison with industrially harvested samples, which contextualizes changes brought about in the industrial era.

Scholarship supporting the time depth of Indigenous engagement with marine resources has implications for the recognition and maintenance of legal rights (Harris 2001; Martindale 2014). Archaeological data indicate that human and halibut have been interacting for more than 10,000 years; meaning that at least 1,000 generations of halibut have been caught by 500 human generations<sup>32</sup>. Through this thesis I have endeavoured to add detail to this pre-industrial history of halibut fishing. My investigations of ethnographic sources, my interviews with knowledgeable fishers, my analysis of hooks, and my archaeological size estimations suggest that as an important fish to past Northwest Coast residents, harvest of halibut was carefully regulated to mitigate depletion. Indeed, Indigenous fishers on the Northwest Coast had the technology, capacity, population, and short-term incentive to overharvest marine resources, yet generally they did not (Butler and Campbell 2004; Trosper 2009). Specifically, this involved territorial use rights which extended to fishing areas, enhancement practices, harvesting technology, deep local understanding, and sociocultural mechanisms to

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<sup>32</sup> Assuming 10-year halibut generations and 20-year human generations.

prevent overharvesting (Lane 1973; Lepofsky and Caldwell 2013; Thornton et al. 2015). This did not come from an innate ecological nature of Indigenous peoples, (see King 2012), but rather specific sociocultural mechanisms that influenced the behavior of individuals who themselves were neither innately conservationists nor inherently destructive.

As noted previously, in 1880, James Swan estimated that the Makah, a community of 728 individuals (many of whom would not have been active fishers), annually took more than 1.5 million pounds of fresh halibut (Reid 2015:217). This is an enormous amount even by present-day industrial standards and represents dedicated Makah participation in the emerging industrial fishery. Considering that currently halibut prices in Canada can reach as high as 27\$ per pound for consumers, a catch of this magnitude would be valued at over 20 million dollars today. Stretched across the dozens of skilled halibut fishing communities throughout the Northwest Coast, the potential collective value of this kind of fishery effort would no doubt represent hundreds of millions of dollars. Given such potential capacity and economic value, it is a notable feat of resource management that coastwide halibut harvests were sustained for more than three millennia. The former existence of a well managed high potential capacity pre-industrial fishery underlies the efforts of Coastal Indigenous peoples to manage and carry out commercial fisheries today (Lutz 2008). Furthermore, in Chapter 4 I conclude that distributing size selective impacts such as seen in past bank specific management practices (e.g., Drucker 1951; Lane 1973) could be an effective tactic for the present-day commercial halibut fishery to mitigate intensive size selective harvesting.

In this thesis I have identified that an archaeological sample of three thousand years of Indigenous halibut harvesting reveals a wider sized range suggesting a healthy halibut population prior to current conditions as well as the conditions documented a century ago. The industrial fishing industry, built largely from the traditional harvesting practices and shared knowledge by Indigenous peoples, has marginalized Indigenous fishers, and continues to imperil their relationship with this species and the many other fish whose populations are now diminished relative to the past.

### **5.3 Future Directions**

Further study of traditional fishing equipment holds promise for improving present day halibut fishing methods. As mentioned, traditional halibut hooks have potential for targeting a slot limit of halibut sizes and thereby promoting sustainable harvests. By building and testing halibut hooks with a large barb height and a small lip gap these properties could be examined further. Jon Scordino and Makah fisheries colleagues are currently wrapping up the main portion of their four-year study, having compared different materials and configurations of traditional hooks with modern circle hooks (e.g., Scordino et al. 2017). Further directions building on their work and mine could focus on testing hooks shaped to fish a specific slot limit.

The size estimation methodology I have demonstrated here can be applied to additional archaeological assemblages to increase geographic and temporal detail and expand understanding of size dynamics and their responses to specific natural and cultural stimuli. This can help answer specific archaeological questions about past resource use, add further detail to the story of pre-industrial human-halibut relationships, and provide additional comparative material for situating present day size changes.

To investigate the currently poorly understood long-term effects of the early days of the unregulated industrial fishery, future work could explore changes in halibut habitat and life history traits. I would like to explore the premise that in the pre-industrial past halibut were more commonly found in shallow water, and more localized spawning occurred near what are now major urban centers, as is emphasized ethnographically (e.g., Suttles 1974). For example, between 1903 and 1915 the average fished depth of the commercial fishery moved from 30 fathoms (55 m) to over 110 fathoms (200 m) (Thompson and Freeman 1930:30). This is a demonstrated effect of size selective fishing whereby population biomass becomes concentrated at increasing depths as harvest pressure increases (Frank et al. 2018). Additionally, as reviewed in Chapter 2, halibut spawning behavior south of Haida Gwaii is not well understood, but this area is currently thought to receive a large amount of migration from more northern regions (Valero and Webster 2012). As both of my interview participants emphasized (Appendix A), nearshore halibut habitat is considerably less productive than it was in the past. This is not surprising given that areas closer to major ports such as the waters near Vancouver, Victoria, and Puget Sound have been subject to intensive industrial and recreational fishing for the greatest length of time, and in the pre-industrial past, population and harvest pressure were much more evenly distributed throughout the coast.

Area 2A south of the International border (Figure 21) currently only produces vary large fish in the setline survey (IPHC 2018), and observation of Pacific halibut migration suggests these fish move south from more northern spawning areas (Valero and Webster 2012). The presence of much smaller fish in this area in the past, as seen in the archaeological data, suggests the possibility of local spawning which has since been

disrupted. In addition, ethnographic material emphasizes the past existence of productive nearshore halibut banks in the Olympic Peninsula region (Friedman 1976; Reid 2015) which may not contain halibut anymore. Stable isotopic comparison of dietary signatures between archaeological halibut and a fish from a range of modern habitats, may shed further light on this question (Gao and Beamish 2003).

## **5.4 Closing Thoughts**

This thesis explores the historical ecology of halibut fishing on the Northwest Coast of North America. Combining study of archaeological materials, historical accounts, fisheries survey data, ethnographically collected fishing equipment, and halibut; as well as through experimentation with fishing technology, and by interviewing knowledgeable fishers, I have further documented the long relationship between humans and halibut at a variety of temporal and geographic scales.

I have touched on only a fraction of the history of Indigenous relations with one species in the North Pacific. Hundreds of other marine and terrestrial taxa from whales to chitons have sustained rich human life and culture on the Northwest Coast for millennia. This technologically-sophisticated and relational web of connection with the biosphere, developed through iterative refinement over generations, provided the foundation appropriated by the present-day resource extraction system; which in less than three centuries of non-Indigenous presence on the coast, already shows signs of irreversible damage.

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## **Appendix A: Conversations with Knowledgeable People**

Growing up on Vancouver Island I was fortunate to spend lots of time fishing, mostly in the territories of Hul'qumi'num', Shishalh, Huu-ay-aht, and Pacheedaht peoples. Despite this relatively limited experience, I had never caught a halibut before participating in Makah fisheries traditional hook testing trials in 2018. In attempting to remedy what I perceive to be an embarrassing lack of practical experience relevant to my research, I reached out to knowledgeable individuals with experience halibut fishing to help provide key pragmatic insights. Furthermore, writing this thesis about Indigenous fishing practices as a non-Indigenous person, I felt that it was important to make space for the voices of Indigenous halibut fishing practitioners. This appendix outlines the formal and informal contributions of people who shared their understanding of halibut and halibut fishing technology.

### **Formal Interviews**

After receiving ethics approval from the University of Victoria Human Research Ethics Board (HREB) in June of 2017, I interviewed individuals with knowledge of both past and present halibut fishing practices. Unfortunately, as a small component of my broader research agenda, I was not able to devote the time and energy needed for an in-depth methodology. Formal anthropological interview-based fieldwork is a time consuming process which cannot be rushed; building rapport and trusting relationships cannot always happen in the same timeframe as a Master's degree (Bernard 2017). I reached out to a number of personal connections inquiring about individuals who might be willing to talk to me about halibut fishing. While many responded with interest, of the fifteen individuals I contacted, only two formal interviews occurred. With permission,

interviews were audio recorded, later I reviewed interview recordings and took detailed notes. Interviews are presented here in note form with my questions in bold. For clarity, responses are paraphrased. Horizontal rules indicate shifts in interview topic. Participants were asked if they wished to remain anonymous, and both were presented with the paraphrased transcript below for their review, revision, or omission.

### **Ted Walkus**

Ted Walkus is a Wuikinuxv hereditary chief, lifelong fisherman, fishing guide, and fish scientist who lives on the central Coast of British Columbia. Notes from my interview with Ted are presented below.

#### **How long have you been fishing for halibut?**

-He (Ted) has fished for halibut all his life. Mostly for personal use or as a guide

#### **Do you think current commercial practices are sustainable in the long run?**

-Yes, if they follow total allowable catch (TAC)

-Fish are supposed to be a resource for all Canadians

-Currently there are many bad things about the commercial fishery. They get the majority of the TAC, and only 17% goes to the sport fishermen

-It is hard to understand the rationale behind this

-This year's early sport closure was strictly an allocation closure

#### **Did the early sport closure this year affect your business at all?**

-Not personally because the lodge he works for closes on labour day

-He had a trip planned after that and was not able to go halibut fishing

-This closure affects the day charter boats more severely

-Small operations which need the economic opportunity are affected.

**Do people in Rivers Inlet catch halibut for a food fishery**

-Yes

-It has been a staple in their diet since time immemorial

-The circle hooks used for commercial fishing are derived from traditional halibut hooks

**Are the fish getting smaller in your lifetime?**

-He would like to say yes

-He doesn't fish in the same spots as the big commercial guys

-He goes to local spots and the fish are now much smaller. They are 14-16 lbs (~84 cm), when they should be in the 35-40 lbs (~110 cm) range

**Do people target certain locations for certain sized fish? What size do you prefer to catch?**

-Sport fisherman are only allowed to catch a maximum 133 cm (~70 lbs) fish

-Once he learned that large fish are predominantly female he was less eager to catch large fish

-He does not like taking anything over 40 lbs (~110 cm) for this reason

**How does the taste differ by size?**

-He likes smaller ones in the range of 25-30 lbs (~100 cm), the grain is tighter and the meat tastes better

**What style traditional hooks did people use in Rivers Inlet?**

-His aunt has some very old yew bentwood hooks

-The hooks were steamed and bent, then roasted over the fire to hold their shape

-There was a piece of bait placed in behind the barb and then there was a small stick propping the hook open

-The barb was made from a piece of bone or wood

**Have you ever tried fishing with them?**

-His brother made some, but they were too pretty to ruin through fishing

**What type of conservation measures existed in the past?**

-Only taking what you need is a huge conservation measure

-Traditionally halibut was not the only food, it was part of a bigger picture

-People used to use a wide variety of foods

-Distributing your take of foods over a broad spectrum buffers the impact

-Commercial catches are so massive now, 100,000 lbs, how can this be sustainable?

**What are your thoughts on traditional hooks catching certain size fish?**

-They probably targeted certain size fish

-Bigger hooks catch bigger fish

-Back in the day he used a larger circle hook than he does today

-He would use a big hook with a large amount of bait, such as a salmon head, to target a huge halibut

-Now after learning about the fecundity of big females he uses small hooks and small bait

**How are you for time, I don't want to take up your whole morning?**

-He is happy to talk about it, halibut are a very important fish for First Nations and for all Canadians

-Halibut are very expensive these days to buy

-The commercial fishery needs a change

-Fishing in Rivers Inlet, people have small boats and can only fish nearshore halibut banks, “chicken patches”

-The commercial boats will come and lay down their gear where they see the local guys fishing, even though they have the ability to go far offshore

**How important is the current food fishery at Rivers Inlet?**

-Halibut are very important to the Wuikinuxv as First Nations people

-How do you differentiate between Salmon and halibut?

-Salmon come at a certain time of year, you are busy preparing the fish for the winter then when it is done you can move onto something else

-Spring is when you can fish halibut, there is good weather to air dry fish to make halibut jerky

-Halibut is fished seasonally, you can fish halibut at the same time as you are gathering limpets or seaweed etc.

**Often in archaeological sites halibut bones don't show up compared with their obvious importance. Do you have any thoughts about this?**

-Halibut meat is sliced very thin and dried

-Typically his family used to leave some meat on the bones and smoke them, then make soup

-Boiling the bones makes them soft and brittle

-Halibut heads were boiled too

-People obviously were eating lots of halibut, traditional hooks were not just for decoration

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- Halibut fishing needs to be a Canadian thing
- The government likes to divide and conquer, pitting sport fishermen, recreational fishermen and commercial fishermen against each other
- The problem with the commercial fishery are 'slipper skippers' who sit at home and rent out their quota
- It should be that if you have a licence issued by the government either you fish it or you lose it
- The current situation is like his brother or sister sitting next to him in his vehicle and they don't have a licence, but because they are in the vehicle they can drive it.

**How do the licences change the way halibut get fished?**

- You can own a commercial boat but no quota
- Someone owns a quota and doesn't want to or can't fish anymore so they lease it out
- It is just not right
- There is not supposed to be a monopoly on anything
- Jimmy Pattison has a monopoly on Salmon in British Columbia
- He is not against economic power but how was that allowed to happen?

**What do you think about more localized management?**

- He is all for it
- He went to a few early meetings about buying back licences from white fishermen for First Nations
- But this requires a business plan
- How can you make a business plan when the stocks are so low, and there are fish farms all over the coast?

- The government is not putting money back into protecting rivers/restocking
- It is very hard to make a business plan for this scenario
- How does someone from a First Nation with no economic opportunity come up with the dollars?
- You can't get a loan from the bank with your house on reserve
- This system was made to fail
- If there is no effort put into protection and restocking of local waters...
- He only speaks for Rivers Inlet
- Rivers Inlet used to be the second or third biggest sockeye producing system in British Columbia
- DFO has put no money into restocking this sockeye population which crashed in 1987
- If DFO would allow local First Nations communities to manage their fish...
- Look at the Nimpkish River for example, if there were Sockeye coming back there, they wouldn't have to fish on the Fraser River.
- It is a big vicious circle
- People from all over are fishing the Fraser stocks
- They traditionally fished their own stock but because of gross mismanagement by DFO and forestry etc. now they have to fish the Fraser
- So many local systems have been totally logged off
- Human greed
- We can't just point our fingers at one thing
- You must make sure there is one finger pointed at yourself

**What type of solutions do you think we need?**

- Our federal government needs to put back protections for watershed management
- Fish habitat needs to be protected
- Fish farms need to be out of the open ocean
- Fish farms are one of the biggest issues we have moving forward
- Drag nets are raping and pillaging the bottom
- We need to move back to hook and line like both of our ancestors (settler and Indigenous)
- The Newfoundland cod fishery persisted for years with hook and line
- We need to be more selective in our fishing
- Fish caught in a more selective way can be marketed as sustainable fish for a higher price

**What do you think about transferring more quota to sport fishing, to bring more money into smaller communities?**

- That is something he will always fight for
  - These economies are very important for small communities
  - Changes in fishing season length can drastically affect small operations
  - Shorter seasons make small operation's lives a lot harder
  - Commercial fishers having someone else fish their quota are open to much less risk
- 

- Some of the Wuikinuxv shell middens are absolutely covered in fish bones, mussel shells, clam shells etc.
- He needs to fish halibut in very deep water these days (300 ft)
- He is sure his ancestors did not have to fish that deep for them

- He guesses that all the stocks which used to spawn in shallower waters have been fished off
- Halibut are moving to deeper and deeper water
- Some things need to change
- We need to start with government
- Get protections put in place
- Pink salmon are so important for the entire system
- They provide food for the river for an entire year
- They feed all the microorganisms seals, bears, trout, trees, etc.
- DFO is very heavily Ottawa weighted, trying to manage both coasts out of one office

**What is the role of archaeology in all this?**

- It can show that precontact it was just as important of a fishery as it is today for First Nations people
- There are only two rivers in the world which produce very large Chinook salmon, the Wannock and the Kitsumkalum
- The Wannock river needs to be very carefully protected
- Look at the Campbell River for example. Fish have declined greatly in size
- The Tyee club now rarely gets new members
- It is a prime example of something which doesn't work over the long term
- Killing the large fish is not sustainable
- On the Wannock river they release all chinook. They don't try to pick a certain size
- They don't play god because as humans we are not good at it

**Why do you think there are so many arrowtooth flounder in archaeological sites despite them being hard to eat?**

- Arrowtooth flounder make very good halibut bait
- Pink salmon is not mushy if you eat it the same day you catch it
- Perhaps arrowtooth are fine to eat if you eat them right away
- Pinks were not liked by early canneries because they have too much oil in their flesh and go mushy quickly
- People were brainwashed into not liking pinks by canneries which pushed sockeye which was more stable for canning
- Rivers Inlet used to have 12 canneries

*End of interview*

**Charles Menzies PhD**

Dr. Charles Menzies is a professor of anthropology at the University of British Columbia and a member of the Gitxaala First Nation. He has researched and published on fishing-related topics, and has a long family history of halibut fishing, particularly on BC's north coast. Dr. Menzies has caught halibut both commercially and for personal use. Notes from my conversation with Dr. Menzies are presented below.

**What is your personal relationship/background with halibut fishing?**

- Commercially fished and fished for home consumption
- Modern fishery has changed a lot in his lifetime
- Dividing commercial and personal fish is a new thing
- Used to be able to keep commercially caught fish for consumption

- Now halibut are fished on the ITQ system
- You pay for your quota not what you land
- You can rent quota from other people
- Renting you owe ~\$6.50 per pound. If you are taking fish home for consumption you are robbing yourself
- Fish belong to fish processor
- There is now an artificial divide between commercial and subsistence fishing
- There is less need for skilled labour these days
- Changes in gear used have also changed the skillset needed

**What do you think the impacts of reduced future quotas will be?**

- In the past fish prices have stayed the same or gone up

**Is it harder for small scale operations these days?**

- There is little to no small scale commercial halibut fishing these days
- To be productive you need very large amounts, 100,000 lbs to afford to pay for lease
- Complicated economics
- Small First Nation's operations working with a community quota can be a better economic situation for the fishers
- Future fishery could involve changes to the quota structure
- Currently offshore investment possibly buying halibut quota
- Licences are not actually property but are being traded like property
- The Crown could revoke the privilege at any time
- The recreational sector are now able to lease commercial quota. They are able to afford higher lease rates

**What are your thoughts on changing halibut size-at-age?**

- Regulations have been effective at aiding recovery from early drastic declines
- In the 70's it was not even worth fishing in BC, then it re-bounded
- The drag fleet prior to regulations hit halibut very hard
- When the Russian fleet was banned, serious rebound followed
- Then the quota system came
- Fishers were willing to accept it because they felt like it was the only option
- Initially you couldn't transfer licences
- Skippers would get together and cooperate

**Why are halibut bones rare in archaeological sites relative to their obvious importance?**

- Could be preservation issues
- Halibut bones are smoked with a bit of meat left on, these were being eaten
- Boiling or steaming foods has different effects on preservation
- Remember that processing techniques change over time
- Recreational fishers often waste a lot when filleting
- With lots of halibut around perhaps you are paying less attention to the bones
- In Gitxaala territory people are harvesting halibut in May at the same time they are gathering seaweed, out away from main habitation sites
- Fishers could have been taking back just meat with no bones
- Technology changes what you are able to do, for example a steel knife allows you to cut closer to the bone
- With more halibut in the past fish were coming in closer to the shore

- With very high abundance levels you could have totally different harvesting techniques
- You could target halibut with a harpoon/stick
- If you caught a very very large fish perhaps you didn't keep the bones

### **What size halibut are best to catch?**

- In his commercial practice, the size of fish depended on the size limit and also the buyer
- There are commercial preferences for slightly larger fish
- The fish size being targeted is determined by many different factors
- Really small fish are less efficient
- Efficiency/productivity is an important consideration
- Halibut are variable in size
- Salmon are a much more uniform sized food unit
- Two foot (~60 cm) fish are a comfortable size to process
- Cutting fish thin for drying has different considerations
- Halibut is a leaner fish but bones are greasy
- There is a layer of fat under the skin

### **Are lean or fatty fish best for drying?**

- Lean fish are less likely to get mouldy

### **Do you think people would have rendered halibut bones for fat?**

- Fat was a very valuable food
- How productive are halibut bones versus other fish?
- He has never heard it mentioned but it could be something people did
- Hard to know unless there was a specific taste people wanted
- You have to look for a linguistic linkage between halibut and grease

**Do you have any thoughts on traditional halibut hooks and size-selectivity?**

- Traditional hooks would hook fish on the way out of the mouth
- In his commercial practice he used circle hooks about 2-3 inches in size
- Larger hooks restrict smaller fish but halibut have very large mouths
- A small hook does not exclude big fish, but a big hook excludes smaller fish
- With abalone it is best to harvest a middle age range using a maximum size limit
- If this sort of ecological knowledge was being utilized in the past it is hard to tell
- The constraints of processing/use are a much more likely reason for past fishers choosing certain sized halibut

**Species selectivity?**

- Commercial hooks catch anything around, skates etc.

**Is sport fishing a better way to bring revenue from fishing to small communities?**

- It really depends on the operation
- Some operations exclude the local economy
- The question is, does the money really stay in the local economy?
- Making hotel wages not industrial wages
- He would like to see a real economic comparison

**Has people's ability to use halibut for food been negatively impacted by industrial fishing?**

- Not necessarily
- Subsistence harvest levels are lower than in the past but this is also due to changes in socioeconomic factors etc.

-Jigging is fun but if you are going to fish for food it makes much more sense to run a groundline

-Something about physically lifting individual fish into a boat is very satisfying

-Commercial and sport fishers are very different

### *End of Interview*

These two knowledgeable fishers, coming from different backgrounds and different relationships with fishing (Ted for personal use and sport guiding, Dr. Menzies for personal use and commercial harvest) both provided important insight into the practice and history of halibut fishing. These conversations informed my research and writing of this thesis, both through providing specific detail and general pragmatic knowledge.

### **Informal Conversations**

Conversations about halibut fishing had in boats, in living rooms, in offices, on the beach, while fishing, etc., were immensely important sources of information.

Numerous individuals shared their knowledge of halibut fishing with over the last two years. Some key individuals are listed below:

-  Edgar Smith - Nuchatlaht
-  Johnny Johnson - Wuikinuxv
-  Maxwell Johnson - Heiltsuk
-  Fred Seiber - Ditidaht
-  Joe Peterson - Makah Fisheries Groundfish Biologist
-  Jon Scordino - Makah Fisheries Marine Mammal Biologist
-  Rebekah Monette - Makah Cultural and Research Center

## Appendix B: Experimental Construction of Traditional Halibut Fishing Equipment

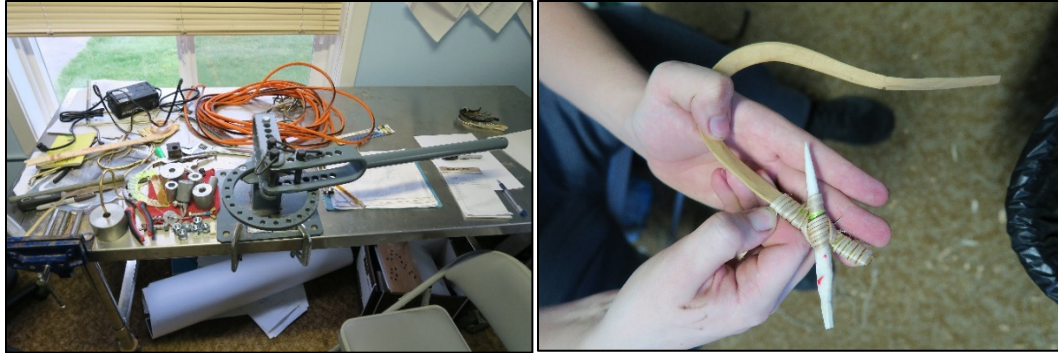
“Every property of materials is a condensed story” (Ingold 2007:14)

To better understand the interspecies material logic of this technology (Robb 2015), and to think thorough making, that is—to increase my own embodied understanding of halibut hooks by pragmatically engaging with their material qualities (Bunn 2011; Ingold 2007, 2012, 2013; Keller 2001), I experimented with hook construction, interacting directly with the process and constituent materials.

Northwest Coast Indigenous fishers have traditions of practice developed through millennia long relations with species (e.g., Brown and Brown 2009; Claxton and Elliott 1994; Menzies and Butler 2007; White 2011). Techniques, and knowledge necessary to produce halibut fishing equipment and engender it with potent fish catching ability are passed on between skilled practitioners (e.g., Arima 1975). As an example, Pacheedaht hereditary chief Charles Jones was able to recognize hooks made in different local regions by slight stylistic alterations unrecognizable to the uninitiated (Stewart 1977:32). Jones’ father Chief *Quis:tox* was able to identify the type of wood hooks were made from by the particular way they floated underwater (Arima 1975:68). Lave and Wenger (1991) argue that learning from experts through participation within a community of skilled practitioners is the only way to gain a true understanding of a technology such as this. Initially, not having access to a community or tradition of practice, I drew on sources such as Arima (1975), Turner et al. (1971; 1983), and Stewart (1977, 2009) who had spent time with skilled practitioners and made detailed observations. I also drew on my own observations of museum specimens, and ethnographically documented information

as outlined in Chapter 2. Situated on Vancouver Island, in the southern Northwest Coast, I followed the local tradition of bentwood halibut hooks (e.g., Arima 1975; Waterman 1920).

Ultimately, I was able to spend time with skilled hook makers at Neah Bay in the Makah reservation in Washington state. Jonathan Scordino, marine mammal biologist for the Makah tribe, following up on the idea of work study student Larry Buzzel V, has led an in-depth study of the functional properties of *čibu-d* (traditional Makah halibut hooks) (Scordino et al. 2017). Part of this project involved a comparison of the fish catching abilities of hooks made in three different ways; wood, injection moulded plastic replicas of wooden hooks, and traditional metal hooks. Constructing hundreds of replica hooks made from various materials in consultation with Makah elders and through observation of archaeological halibut hooks from Ozette housed at the MCRC, as well as catching hundreds of halibut with *čibu-d*, has allowed Jon and his collaborators to become highly proficient at making functional hooks. In February of 2018, I was invited by Jon and colleague Joe Peterson (Makah Groundfish biologist) to visit for a few days and have an informal halibut and halibut hook think tank. Part of this visit involved making hooks, and skilled Makah hook maker Reggie Buttram was kind enough to spend some time giving me pointers along with Jon and Joe.



**Figure 29:** Makah fisheries metal *čibu-d* setup on left and Reggie demonstrating wooden hook barb placement and spruce root lashing technique on right.



**Figure 30:** Reggie binding a recently bent hemlock hook around a jig.

My experimental process began with the collection of required materials (Table 17). Collecting supplies required many important initial decisions, such as the correct type of material, harvest techniques, and seasonality.

**Table 17:** Materials used in experimentation.

| Material   | Required Action   |
|--|---|
| oceanspray ( <i>Holodiscus discolor</i> )                              | Cutting, carving, steaming, bending                             |
| Pacific yew<br>( <i>Taxus brevifolia</i> )                             | Cutting, carving, steaming, bending                             |
| western red cedar ( <i>Thuja plicata</i> ):<br>bark, roots, and withes | Stripping, processing, peeling, heating, splitting,<br>wrapping |
| Sitka spruce roots ( <i>Picea sitchensis</i> )                         | Heating, peeling, splitting, wrapping                           |
| crabapple<br>( <i>Malus fusca</i> )                                    | Cutting, carving, steaming, bending                             |
| bull kelp ( <i>Nereocystis</i> )                                       | Soaking, stretching, knotting, drying, re-hydrating             |
| Douglas fir knots (reaction wood)<br>( <i>Pseudotsuga menziesii</i> )  | Cutting, carving, steaming bending                              |

Attempting to harvest cedar bark led to an important moment of personal humility. In my archaeological work I have often recorded, measured, and quantified culturally modified trees (CMTs). CMTs are trees which have been modified by humans, usually for bark or wood extraction (British Columbia Archaeology Branch 2001). Having been trained to recognize, differentiate, and record CMTs, I believed I had a firm understanding of these features and how they worked. However, my categorical knowledge was fundamentally overlooking the intergenerational embodied knowledge involved in harvesting cedar (Figure 31) (e.g., Turner and Lepofsky 2013). In my initial attempts, I was trying to strip bark the wrong way in the wrong season, and only with the hands-on help of Jennifer Walkus (Wuikinuxv), a skilled practitioner drawing on a long family tradition, who patiently walked me through the required steps, was I able to gain a very basic understanding of this practice.



**Figure 31:** A non-skilled practitioner's attempts at cedar bark stripping (mine) contrasted with a much more skilled practitioner (Jennifer Walkus) on the right.

At this early stage of gathering materials, I appreciated that making halibut fishing equipment requires a large amount of diffuse knowledge. Things such as what shade of kelp is strongest, and how to best strip the bark off spruce roots. I appreciated that these subtle embodied considerations cannot be easily explained and are best learned through hands-on participation and instruction.

I first tried to make bull kelp (*nereocystis*) fishing line, following Stewart's (1977) description of preparation methods. I collected fresh kelp stipes from the beach, soaked stipes in fresh water for 24 hours, stretched them, then knotted the ends together with a fisherman's knot. Gaps in Stewart's detailed written descriptions brought about further questions, such as how best to orient stipes when tying them together. I tried various arrangements: thick end to thin end produced the most homogenous line, but thick end to thick end may produce stronger joints (Waterman 1920). Lacking the correct

subtle knowledge, I was unable to judge which stipes to select for optimal strength. Once dry, the kelp shrank to almost a quarter of its original diameter (Figure 32), disrupting the knots I had tied. However, once re-hydrated, the line became flexible and regained its original size in a few hours, in the process snugging the knots back up. This quality allows for an entire line to be stored dry then quickly re-hydrated for fishing. Although the kelp could be tied to itself to make a line, it could not be easily tied to the smooth wood of a hook. A leader of some other materials to interface between the hook and the kelp is necessary. Although the process of collecting, soaking, processing, and drying stipes is time consuming, it is not particularly labour intensive. After this procedure, stipes can be knotted together quickly to produce a long line. This method of line manufacturing is more expedient than producing cedar fishing line, and produced a very robust final product (see LaBarbera 1985).



**Figure 32:** Wet versus dry kelp fishing line.

To make hooks, I attempted to steam-bend oceanspray, yew, and fir knots. I carved material into ~1.5 cm by 30 cm pieces. Carving these blanks with a metal knife took approximately 30 minutes each. Subtle material qualities are of paramount importance when selecting wood. Considerations such as how long to age green wood, if at all, are critical. If the pith (Figure 33) was too large in oceanspray pieces, they would not bend properly. This is likely determined by growing conditions, age of the wood, and seasonality. All steam-bending attempts initially ended up broken (Figure 33). Later conversations with the *čibu-d* making team led me to realize these blanks should have been split into quarters or eighths like those recovered from the Ozette excavations, rather than carved down to a round shape.



**Figure 33:** Left image showing oceanspray with different pith thicknesses. Right image showing failed steam-bending attempt.

Eventually, I obtained the help of a skilled woodworker. John Salmen, is a master carpenter with 35 years of experience woodworking, however like myself, he lacks a relationship with an Indigenous fishing tradition. Using a bandsaw, we profiled yew, crabapple, and oceanspray into 1.5 cm x 30 cm pieces. We built a jig replicating the inner dimensions of a bentwood hook from the UBC Museum of Anthropology (A6536). This

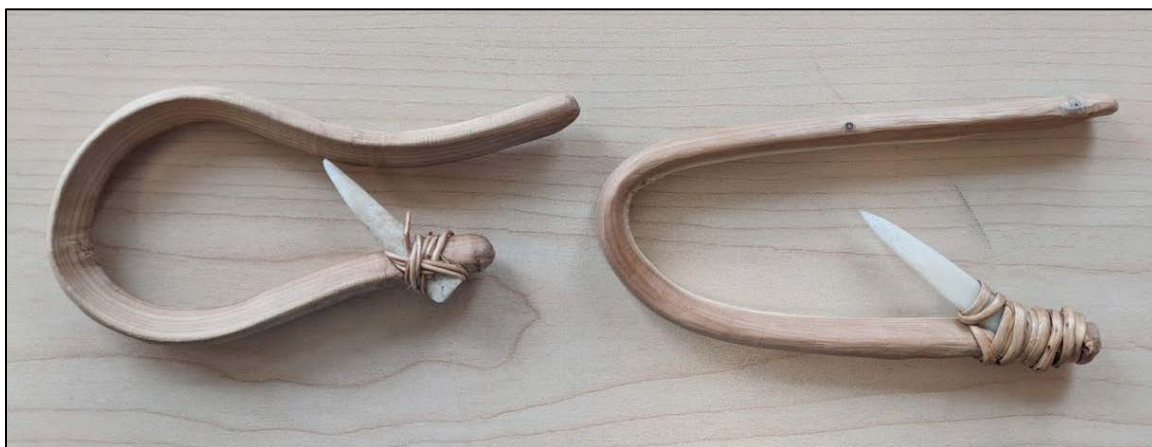
hook came from Haida Gwaii and offers a good example of the bentwood style. We immersed these blanks in a large vessel of hot water just under boiling temperature for an hour then bent them around the jig (Figure 34), clamping them in place. These were then dried in an oven for 20 minutes at 200 °C to retain their shape. Many of these pieces did not survive the bending process. Based on our observations, the grain of the wood had to be straight and blanks with knots or other imperfections broke. Oceanspray and crabapple blanks split, while only yew pieces survived, likely due to the greater strength and elasticity of this wood. Eventually, we were able to produce five bent hook blanks (Figure 34). Later conversations with knowledgeable hook makers made me realize these blanks should have been split, not cut with a saw to maintain the strength of the grain.



**Figure 34:** Jig on left and bent yew wood hook blank on right.

Hook blanks were finished by carving them to final shape and smoothing the surface with pieces of broken glass. This process took approximately two hours per hook. Following what I had seen with incomplete museum specimens and archaeological

hooks, grooves were cut into the shank to allow the barb to be securely bound into place. Bone barbs were made from split deer metapodials, which were prone to shattering and had to be broken carefully. Barbs were then ground to shape and sharpened using sandstone. I employed the assistance of UVic archaeological field school students for this step, to distribute processing time. Shaping broken bone pieces took approximately 1.5 hours per barb. Finally, barbs were bound on with split spruce or cedar roots, making a very strong joint. I was unsure of the best pattern to follow with this root binding, but was later shown the pattern Makah hook makers had learned from the Ozette archaeological examples.



**Figure 35:** Finished halibut hooks made from yew wood. Note that the hook on the left closed in on itself over time.

### **Experimental Observations**

Making precious things usually only seen in museums allows for them to be deconstructed, broken, and manipulated, and through these processes further understood (Weismantel 2012). The technological aids I drew on such as clamps, the oven, and the bandsaw, replaced skill, tradition, and learned memory of material properties and their interactive capacities, with mechanical force and computer-controlled temperature stability. Although I am cautious of investing too heavily in a unilateral

phenomenological approach (Fowles 2010), making hooks and line was fruitful for increasing intangible subjective understanding of the technology (Bunn 2011; Ingold 2007), which informed other types of hook analysis carried out in Chapter 3. Perhaps the most important conclusion gained through this process is that the knowledge and skill required to make and then catch fish with wooden fishing equipment should not be underestimated. Thousands of intangible small pieces of cultural knowledge: gestures, techniques, skills, and innovations are present in this technology, which are crucial components its functionality. Considerations such as the acceptable amount of pith in a section of oceanspray, the correct temperature for steam bending different woods, knowing when wood is about to bend and not break, the best technique for split root wrapping etc. are crucial. This knowledge is difficult or even impossible to learn from descriptions alone.

If made with skill, halibut fishing equipment has the capacity to be extremely strong. As mentioned, LaBarbera (1985) found kelp fishing line to have an equivalent ‘test’ of 128 lbs. When firmly lashed into place with split roots, bone barbs are able to withstand substantial attempts to move them. Bentwood yew hooks are very tough, (Pacific yew has a modulus of rupture<sup>33</sup> of 15,200 lb<sub>f</sub>/in<sup>2</sup> (Meir n.d.) while still being flexible (modulus of elasticity is 1,320,000 lb<sub>f</sub>/in<sup>2</sup>). Based on my observations, the robusticity of this technology is not a limiting factor in the size of fish caught. Despite technological aids, creating hooks as an inexperienced practitioner was quite time consuming and it could take the better part of a full day to make a hook. I conclude by

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<sup>33</sup> As measured in pounds-force per square inch

observing that catching halibut with traditional technology requires significant time spent learning and making the equipment before fishing can even begin.

## Appendix C: Pacific Halibut Taphonomy

A limitation of the archaeological occurrence of halibut are various taphonomic effects acting on skeletal remains preserved in the archaeological record. For halibut, this results in a lower than expected proportional abundance of halibut and a higher percentage of vertebral elements versus cranial elements, despite the fact that vertebrae only represent only 32% of identifiable skeletal elements (Wigen and Stucki 1988; Smith 2008; Orchard and Wigen 2016). Taphonomy was not a driving question of this thesis but is a considerable feature of previous scholarship on the archaeology of halibut fishing (See Chapter 2). In the process of undertaking research on this species, I identified halibut elements and located vertebrae to their approximate place in the vertebral column (Chapter 4), talked to experienced halibut fishers (Appendix A), and reviewed historical data (Chapter 2). Thus, my data has a few taphonomic implications which fit into larger conversations about past fishing practices, and halibut element survivorship (e.g., Croes 1992; McKechnie and Moss 2016:7; Orchard and Wigen 2016; Smith 2008; Wigen and Stucki 1988). Several different lines of evidence must be considered to unravel the complex natural and cultural factors influencing halibut's entry into, and survivorship within, archaeological contexts; as well as through the processes of excavation, curation, and identification (Gifford-Gonzalez 1991; Peres 2010; Nims and Butler 2018). Here, to further investigate halibut taphonomy I compare the relative representation of different halibut elements in the archaeological dataset used for Chapter 4. I then discuss my findings in the context of previously published work, the ethnographic and ethnohistoric data reviewed in Chapter 2, and link these with my interview responses from knowledgeable fishers (Appendix A).

Halibut vertebral elements made up 97% of the sample of elements included for vertebral/cranial comparison (Table 18). This is consistent with the relative percentages of vertebrae observed by Wigen and Stucki (1988:108) (78-100%), as well as Croes (1992:349) (92%) and Smith (2008) (78-90%). As Smith (2008) observes, the magnitude of these differences cannot be explained with bone density values (i.e., differential preservation of more compact bone), and other factors such as cultural treatment of cranial and vertebral elements, (i.e., chowders, smoke drying) must be considered.

**Table 18:** Proportions of vertebral and cranial halibut skeletal elements identified for Chapter 4.<sup>34</sup>

| Site              | Percent Vert | Percent Cranial |
|-------------------|--------------|-----------------|
| All<br>(n=504)    | 97%          | 3%              |
| 45CA1<br>(n=11)   | 100%         | 0%              |
| 45CA204<br>(n=49) | 96%          | 4%              |
| 45CA25<br>(n=320) | 99%          | 1%              |
| 45CA213<br>(n=35) | 100%         | 0%              |
| 45CA21<br>(n=24)  | 87%          | 13%             |
| EjTa-1<br>(n=53)  | 91%          | 9%              |
| EjTa-4<br>(n=12)  | 100%         | 0%              |

Although vertebral representation was approximately similar to the natural distribution in most of the sites, as measured with Spearman's rank order correlation coefficient, there is a significant difference between the natural distribution of vertebral categories and the average archaeological distribution of vertebrae across sites ( $R = 0.3$ ,  $p = 0.5$ ) (Table 19/Figure 36). Individual archaeological assemblages also displayed

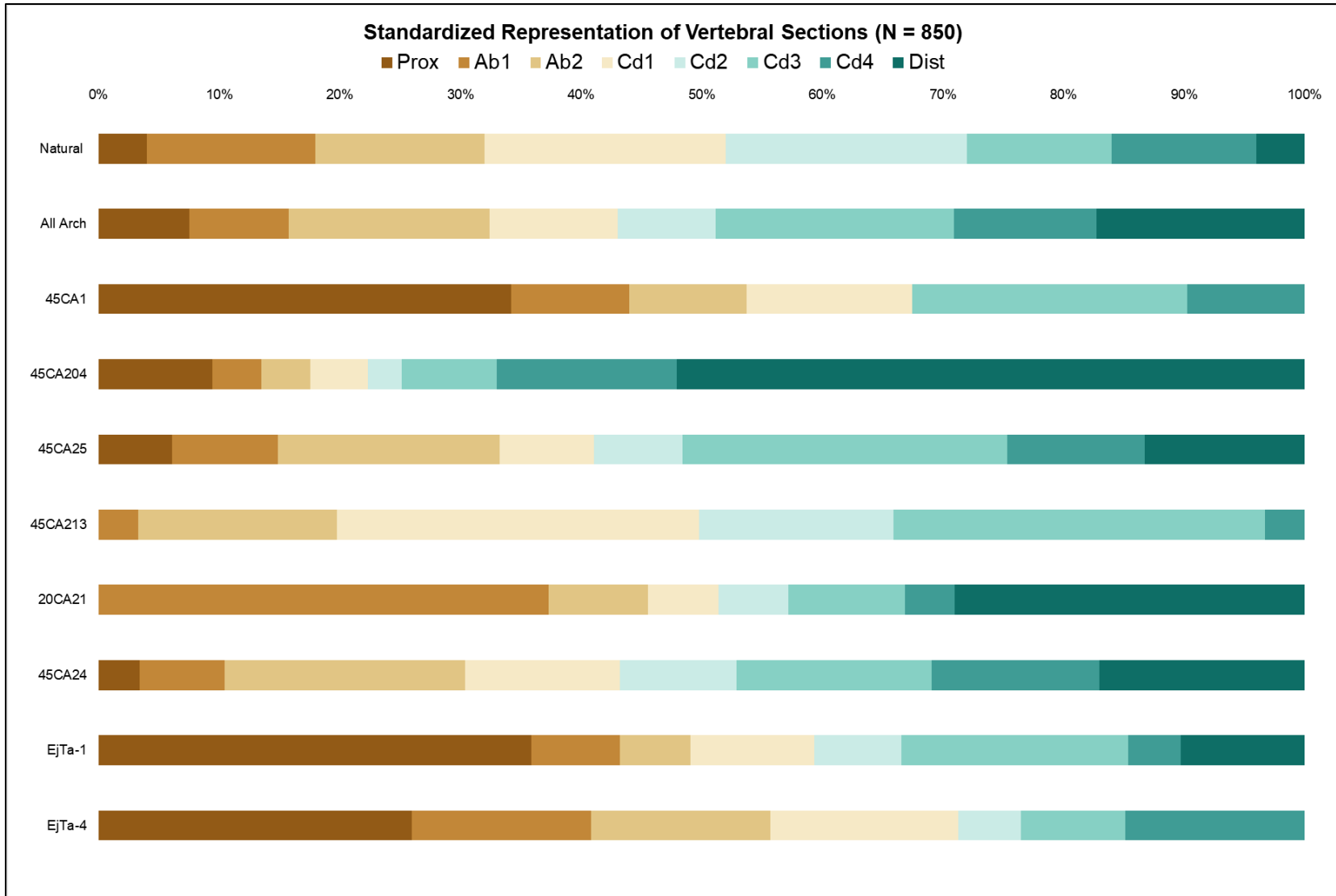
<sup>34</sup> Element measurements obtained by David Huelsbeck in the 1980's (n=596) intentionally targeted only halibut vertebrae, so a comparison of vertebral versus cranial elements can only be carried out on elements I identified (n=504).

significantly different distributions than the natural distribution ( $R < 0.5$   $p > 0.08$ ). Distal, caudal 3, and proximal vertebra ranked higher or equal to their natural rank order in 6, 5, and 4 of 8 assemblages respectively. Notably, more than 50% of all vertebrae were distal in 45CA204.

**Table 19:** Standardized percent representation of vertebral categories with rank order by site. The top row represents the natural vertebral distribution. See Figure 20 in Chapter 4 for vertebral subdivisions.<sup>35</sup>

| Site                     | Prox | Ab1 | Ab2 | Cd1 | Cd2 | Cd3 | Cd4 | Dist |
|--------------------------|------|-----|-----|-----|-----|-----|-----|------|
| <b>Natural</b>           | 4%   | 14% | 14% | 20% | 20% | 12% | 12% | 4%   |
| <b>Rank Order</b>        | 4    | 2   | 2   | 1   | 1   | 3   | 3   | 4    |
| <b>All</b><br>(n=850)    | 8%   | 8%  | 17% | 11% | 8%  | 20% | 12% | 17%  |
| <b>Rank Order</b>        | 5    | 5   | 5   | 3   | 5   | 1   | 4   | 2    |
| <b>45CA1</b><br>(n=8)    | 34%  | 10% | 10% | 14% | 0%  | 23% | 10% | 0%   |
| <b>Rank Order</b>        | 1    | 4   | 4   | 3   | 5   | 2   | 4   | 5    |
| <b>45CA204</b><br>(n=43) | 9%   | 4%  | 4%  | 5%  | 3%  | 8%  | 15% | 52%  |
| <b>Rank Order</b>        | 3    | 6   | 6   | 5   | 7   | 4   | 2   | 1    |
| <b>45CA25</b><br>(N=304) | 6%   | 9%  | 18% | 8%  | 7%  | 27% | 11% | 13%  |
| <b>Rank Order</b>        | 8    | 5   | 2   | 6   | 7   | 1   | 4   | 3    |
| <b>45CA213</b><br>(n=35) | 0%   | 3%  | 16% | 30% | 16% | 31% | 3%  | 0%   |
| <b>Rank Order</b>        | 5    | 4   | 3   | 2   | 3   | 1   | 4   | 5    |
| <b>20CA21</b><br>(n=19)  | 0%   | 37% | 8%  | 6%  | 6%  | 10% | 4%  | 29%  |
| <b>Rank Order</b>        | 7    | 1   | 3   | 5   | 5   | 4   | 6   | 2    |
| <b>45CA24</b><br>(n=381) | 3%   | 7%  | 20% | 13% | 10% | 16% | 14% | 17%  |
| <b>Rank Order</b>        | 8    | 7   | 1   | 5   | 6   | 3   | 4   | 2    |
| <b>EjTa-1</b><br>(n=48)  | 36%  | 7%  | 6%  | 10% | 7%  | 19% | 4%  | 10%  |
| <b>Rank Order</b>        | 1    | 4   | 5   | 3   | 4   | 2   | 6   | 3    |
| <b>EjTa-4</b><br>(n=12)  | 26%  | 15% | 15% | 16% | 5%  | 9%  | 15% | 0%   |
| <b>Rank Order</b>        | 1    | 3   | 3   | 2   | 5   | 4   | 3   | 6    |

<sup>35</sup> To standardize different size vertebral categories for comparison (for example our 'Proximal' category only includes two elements while our 'Caudal One' category includes 10) element count in each category was divided by the number of possible elements in each category, these were then converted to percent by dividing by the total standardized element count from each site.



**Figure 36:** Standardized representation of different vertebral categories across all sites investigated for Chapter 4.

These differences can be accounted for by both natural and cultural taphonomic factors. In terms of natural factors, Smith (2008:60) found differences in element density between vertebra, with proximal and distal vertebrae having slightly higher density than caudal vertebrae. In terms of cultural factors, it is possible that proximal and distal vertebra disproportionately ‘come along for the ride’ when heads and tails are separated from the vertebral column; however, elements such as basioccipital, and ultimate vertebrae were not frequently observed. When preparing halibut reference specimens (see Appendix D), I often found it quite difficult to separate individual vertebral elements. Thus, fresh vertebral columns would likely remain intact unless intentionally cut apart.

The ethnographic and ethnohistoric material examined in Chapter 2 (Table 20), indicates the prevalence of cultural factors which would substantially reduce halibut’s presence in archaeological contexts. However, these accounts do not explain a relative lack of cranial elements compared with vertebrae, or the unequal representation of different vertebral elements. Both cranial and vertebral elements were described being cooked in ways which would impact their survivability, such as boiling. Once halibut are fileted, considerable flesh remains between the vertebral processes or ‘ribs’. Boas (1921:249) described women cutting processes off to access this meat. This quality may have made vertebrae more attractive as food packages than heads which are full of meat, but generally need further processing to access their full food value. Whole halibut heads are quite different meals than fileted vertebral columns, and perhaps the oblong shape of cranial elements compared with the ‘spikey’ shape of vertebral elements made them more attractive for direct consumption while present in soup.

**Table 20:** Ethnographic descriptions of destructive treatment of halibut elements. Previously seen as Table 2.

| Region                         | Group         | Treatment   | Reference                 |
|--------------------------------|---------------|---|---------------------------|
| Cape Flattery                  | Makah         | -Flesh cut thinly and dried<br>-Vertebrae dried and stored<br>-Vertebrae and heads boiled   | Swan 1868:22              |
| Salish Sea                     | Coast Salish  | -Flesh cut thinly and dried<br>-Tails fins and other bones roasted over fire or boiled for soup   | Barnett 1955:62           |
| Haro and Rosario Straits       | Straits       | -Vertebrae cooked and eaten   | Suttles 1974:173          |
| Barkley Sound Vancouver Island | Tseshah       | -Halibut heads eaten after halibut fishing trip   | Sapir and Swadesh 1955:41 |
| Yuquot Vancouver Island        | Mowachaht     | -Halibut heads and tails steam cooked   | Jewitt 1986:108,151       |
| Northern Vancouver Island      | Kwakwaka'wakw | -Flesh cut thinly and dried<br>-Processes cut off vertebrae<br>-Heads tails and vertebrae dried<br>-Heads and vertebrae chopped up and boiled for soup then chewed<br>-Heads boiled | Boas 1921:249, 357-359    |
| Haida Gwaii                    | Haida         | -Halibut heads left in the intertidal to soften before consuming  | Dawson 1880:111           |
| Alaska                         | Tlingit       | -Halibut heads fins and tail cooked and eaten   | Newton and Moss 2005:13   |

Both of my interview participants (Appendix A) offered explanations about why halibut bones might not be represented well in archaeological contexts, despite the obvious importance of the species. Wuikinuxv hereditary chief Ted Walkus explained that his family used to leave some meat on vertebral columns and then smoke them. These would be made into soup. Halibut heads were also boiled for soup.

Dr. Charles Menzies (Gitxaala) recounted halibut bones being smoked with a bit of meat left on them. He made the observation that cultural taphonomic factors such as butchery practices are not static. For example, if you have a glut of halibut all at once, you might be less interested in the components which involve more processing such as heads. In Gitxaala territory (North Coast of British Columbia) people harvest halibut in May while they are out harvesting seaweed away from home. Unless elements are purposely transported back home they will be left at the fishing location.

In sum, with the sample of elements I compiled for Chapter 4, cranial elements were observed much less frequently than vertebrae. Previously published evidence also indicates this is likely due mostly to cultural practices of halibut consumption. However, my analytical framework of selecting elements only sufficiently intact to measure using one of the 43 different dimensions, the majority of which are vertebral (36), is likely affecting this observation to some degree. Analysis of standardized representation of vertebral elements suggests taphonomic factors are influencing the survival of certain elements, particularly proximal, caudal 3, and distal vertebrae, however these precise mechanisms remain uncertain. Ethnographic and ethnohistoric accounts as well as my interviews with knowledgeable fishers provided the richest sources of explanation for why halibut may not be as represented in archaeological contexts as they would be if not “culturally filtered out” (Orchard and Mackie 2004:64). Practices such as cooking typically reduce the survivorship of archaeological materials by weakening or destroying bone structure (Nicholson 1996; Zohar et al. 2016), although calcined bone can preserve very well (Steffen and Mackie 2005). Notably, while preparing halibut reference specimens, a large amount of grease was produced as a by-product (Appendix D). In

particular, the final stage of skeletonizing in a caustic enzyme bath produced a thick layer of rich yellow oil (Figure 37). As Smith (2008:34) notes, halibut bones seem to be particularly greasy and it makes sense that oily elements would be more prone to destructive cultural practices (cf. Monks 2003), as well as natural factors such as scavenging or microbial activity. Further work quantifying the grease value of different elements and different species could shed further light on this matter.



**Figure 37:** Oil rendered from a pacific halibut reference specimen while skeletonizing

Taken all together, my taphonomic investigations support Orchard and Wigen's (2016) observation that halibut was likely more important to past fishers than its representation in Northwest Coast archaeological deposits currently suggests. This appears to be largely due to cultural factors such as cooking impacting the survival of halibut elements. Further work reviewing ethnographic descriptions of the treatment of a wide variety of species could strengthen this finding.

## **Appendix D: Pacific Halibut Defleshing and Skeletal Preparation Methodology: Preparation of Reference Specimens**

This appendix outlines the methodology used to render 12 Pacific halibut carcasses into stable osteological reference specimens. This can be used as a methodological resource for future skeletal preparation efforts, particularly for the skeletonization of multiple large bodied fish. This process involved two main steps, initial removal of flesh from elements through simmering, then skeletonization using a warm water caustic enzyme bath. The use of inexpensive and easily obtainable dishwasher detergent as the chemical agent makes this methodology cost effective and practical.

### **Defleshing**

12 Pacific halibut specimens ranging in length from 92 to 135 cm were obtained from sport fishermen at the 2017 Island Outfitters halibut derby in Victoria BC. These fish were measured and weighed then fileted. Each fileted carcass was tagged with its length, weight, and a unique identification number, and any extra flesh cut off. Carcasses were then frozen in a chest freezer for storage. Frozen fish were thawed then individually simmered in a large aluminum pot on a propane ring (Figure 39). Large halibut (>110 cm) had to be processed in multiple batches. After light simmering for approximately 30 minutes depending on the level of thaw, carcasses were poured out into a large mesh strainer. Elements were removed by hand and the remaining puree was thoroughly sorted through to retrieve all small bones (Figure 40). Elements typically retained some connecting tissue and were very greasy. Bones were then bagged for later degreasing and drying (Figure 41).



**Figure 38:** Halibut being fileted at the derby.



**Figure 39:** Halibut specimen in the process of being defleshed. Other specimens are visible in the rear of the photo in black garbage bags.



**Figure 40:** Product of initial simmering. This puree is then hand sorted to retrieve elements.



**Figure 41:** Sorted elements bagged and awaiting final skeletonization. Note that length was occasionally recorded in inches by the derby staff.

### **Skeletonization**

Following the methodology established by Lewis et al. (2017) for Pacific Herring, Western Family dishwasher detergent was used as a reactant (Figure 42). Western Family detergent contains a variety of caustic salts as well as citric acid and unspecified enzymes. Lewis et al. (2017) found that this specific detergent could act as an alternative to the commonly used digestive enzyme trypsin which is prohibitively expensive, particularly at the volumes required for multiple large bodied fish. Halibut elements were placed in large glass vessels with warm water and detergent at a concentration of 20 grams per litre. These jars were then incubated at 36 °C in a fume hood for five to seven days. During this period grease and tissue was broken down by the detergent (Figure 43). The resulting grease was then poured off and elements were rinsed with warm water. Next elements were soaked in a dilute bath of Sodium hypochlorite (household bleach) for five minutes to kill any remaining protease. Elements were then thoroughly rinsed and laid out to dry on paper towel. The resulting specimens are light in color, contain minimal grease and no tissues (Figure 44). Measurements were taken to assess shrinking during the drying process which could cause error in later biometric procedures, and shrinkage was deemed to be minimal.



**Figure 42:** Most effective dishwasher detergent, as determined by Lewis et al. 2017.

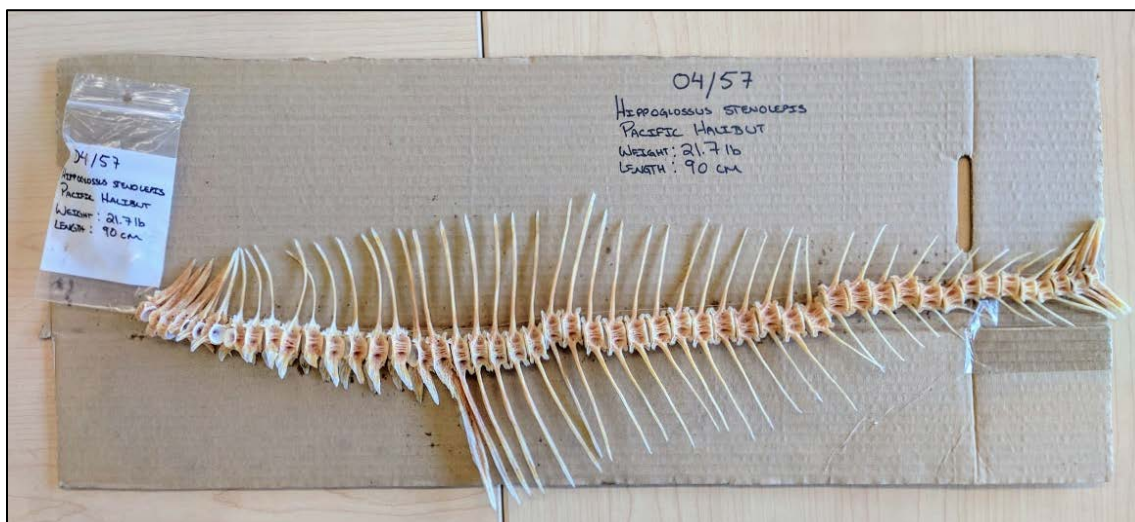


**Figure 43:** Halibut elements immediately after incubation. Note the thick layer of grease present on top.



**Figure 44:** Halibut elements drying after bleaching and washing. Note that these are all from a single fish.

In sum, although processing 12 large Pacific halibut into osteological reference specimens was a lengthy and at times odorous task, these methods were found to make the process fairly straightforward. The resulting specimens are durable, have low odour, and are stable, although many halibut elements continue to extrude grease (Figure 45).



**Figure 45:** Example Pacific halibut osteological reference specimen.

## Appendix E: Hook Measurement Data

(Measurements in mm, Bite Marks: P = Possible, Y=Yes, N=No)

| Location | Object Identifier | Provenience    | Material | Bite Marks | Style | A     | B   | C    | D      | E      | F     | G     |
|----------|-------------------|----------------|----------|------------|-------|-------|-----|------|--------|--------|-------|-------|
| MOA      | NB 1.474          |                | W        | P          | U     |       |     |      |        |        | 100   | 40.2  |
| MOA      | A5318             |                | W        | N          | U     | 12    |     | 37.3 | 58.7   | 70     | 140   | 48    |
| MOA      | A1577             | Haida Gwaii    | W        | N          | U     | 17.6  |     | 32.8 | 57.6   | 67     | 146.7 | 70    |
| MOA      | A6536             | Haida Gwaii    | W        | Y          | U     | 15.65 |     | 33.7 | 51     | 68.7   | 153   | 67    |
| MOA      | 1768/19           | BC             | W        | N          | U     | 17.5  |     | 32   | 66     | 75     | 156.9 | 60    |
| MOA      | A3717             | Bamfield       | W        | N          | U     |       |     |      |        |        | 155   |       |
| MOA      | A1420             | Nass River     | W        | N          | V     |       |     |      |        |        | 325   | 140   |
| MOA      | 3000/15           | BC             | W        | Y          | H     | 12    |     | 35.6 | 69     | 83.1   | 200   | 93.5  |
| MOA      | A7452             | Kingcome Inlet | W        | Y          | V     | 13.6  |     | 27.2 | 59.9   | 95.3   | 250   | 83.5  |
| MOA      | A2434             | Tlingit        | W        | Y          | V     | 15.8  |     | 39.5 | 81.4   | 98     | 300   | 98.1  |
| MOA      | A3438             | BC             | W        | P          | V     | 14.7  |     | 36.6 | 64.4   | 101.3  | 280   | 108.2 |
| MOA      | A1411             | Kitkatla       | W        | Y          | V     | 14.7  |     | 33.7 | 64.8   | 90.6   | 250   | 85.4  |
| MOA      | A135              | Haida Gwaii    | W        | Y          | V     | 14.9  |     | 28.5 | 50.4   | 96.4   | 260   | 88.4  |
| MOA      | A137              | BC             | W        | P          | V     | 13.2  |     | 31.7 | 71.2   | 81.45  | 260   | 75.3  |
| MOA      | A7112             | Haida Gwaii    | W        | Y          | V     | 28.5  |     | 54.5 | 107.36 | 85.6   | 318   | 91.1  |
| MOA      | 1283/22           | Tsimshian      | W        | P          | V     | 18.4  |     | 26.3 | 67.7   | 90.3   | 270   | 86.2  |
| MOA      | A2254             | BC             | W        | P          | V     | 9.28  |     | 42.1 | 24.7   | 68.23  | 156.9 | 90.8  |
| MOA      | Nb470             | BC             | W        | Y          | V     | 14.5  |     | 45   | 64.9   | 86.2   | 240   | 82.1  |
| MOA      | A6537             | BC             | W        | Y          | U     | 10.09 |     | 54   | 72.8   | 113.76 | 233   | 78.6  |
| MOA      | 1768/20           | BC             | W        | N          | U     | 10.12 |     | 69   | 73.3   | 68.4   | 155.6 | 62.4  |
| MOA      | 1768/22           | BC             | W        | N          | U     | 27.68 |     | 39.6 | 68.02  | 59.7   | 134.8 | 82.2  |
| RBCM     | 10962             |                | W        | N          | V     | 17    | 111 | 2.7  | 63     | 42     | 243   | 111   |
| RBCM     | 14329             | Nisga'a        | W        | N          | V     | 22    | 130 | 33   | 34     | 42     | 238   | 146   |
| RBCM     | 14533             |                | W        | P          | U     | 25    | 64  | 31   | 51     | 43     | 107   | 57    |
| RBCM     | 15842             |                | W        | Y          | V     | 17    | 70  | 29   | 57     | 36     | 245   | 89    |
| RBCM     | 16203             |                | W        | N          | H     | 20    | 86  | 34   | 71     | 43     | 209   | 66    |
| RBCM     | 19158             |                | W        | N          | V     | 21    | 70  | 25   | 62     | 37     | 210   | 86    |

|      |       |                         |   |     |   |    |     |    |     |    |     |     |
|------|-------|-------------------------|---|-----|---|----|-----|----|-----|----|-----|-----|
| RBCM | 699   | Haida                   | W | N   | V | 19 | 96  | 46 | 60  | 76 | 240 | 120 |
| RBCM | 16415 | Kyuquot                 | W | N   | U | 16 | 97  | 42 | 66  | 50 | 167 | 74  |
| RBCM | 10601 | Coast Salish            | W | N   | U | 22 | 90  | 37 | 47  | 60 | 140 | 111 |
| RBCM | 1303  | Tsimshian               | W | Y   | V | 12 | 77  | 22 | 85  | 33 | 245 | 80  |
| RBCM | 13097 |                         | W | Y   | V | 25 | 100 | 11 | 60  | 50 | 260 | 85  |
| RBCM | 1327  | Coast Salish Victoria   | W | Y   | U | 15 | 80  | 30 | 55  | 60 | 140 | 70  |
| RBCM | 13307 |                         | W | Y   | V | 16 | 125 | 25 | 53  | 70 | 285 | 110 |
| RBCM | 1465  | Haida Skidigate         | W | Y   | H | 25 | 55  | 36 | 63  | 80 | 240 | 115 |
| RBCM | 1467  | Haida Masset            | W | N   | V | 20 | 65  | 33 | 73  | 45 | 225 | 91  |
| RBCM | 1468  | Haida Masset            | W | Y   | V | 16 | 95  | 25 | 64  | 45 | 240 | 80  |
| RBCM | 1469  | Haida Masset            | W | Y   | V | 15 | 98  | 31 | 76  | 50 | 265 | 105 |
| RBCM | 1471  | Haida Masset            | W | Y   | H | 12 | 75  | 30 | 55  | 40 | 160 | 60  |
| RBCM | 1472  | Haida Masset            | W | Y   | H | 12 | 78  | 36 | 63  | 44 | 93  | 71  |
| RBCM | 1628  | Tsimshian Port Simpson  | W | Y   | V | 12 | 90  | 34 | 80  | 47 | 245 | 86  |
| RBCM | 1629  | Port Simpson            | W | Y   | V | 15 | 120 | 34 | 63  | 90 | 260 | 101 |
| RBCM | 17963 |                         | W | N   | H | 15 | 85  | 33 | 103 | 55 | 170 | 110 |
| RBCM | 18240 | Prince Rupert           | W | Y   | H | 24 | 100 | 43 | 82  | 75 | 205 | 70  |
| RBCM | 18645 |                         | W | Y   | H | 17 | 100 | 30 | 59  | 62 | 230 | 110 |
| RBCM | 2209  | Huu-ay-aht Dodgers Cove | W | N/A | U | 11 | 120 | 34 | 55  | 60 | 180 | 65  |
| RBCM | 2438  | Cowichan                | W | N   | U | 10 | 85  | 40 | 55  | 75 | 65  | 50  |
| RBCM | 4136  |                         | W | Y   | H | 19 | 73  | 35 | 73  | 43 | 190 | 91  |
| RBCM | 4358  |                         | W | Y   | V | 15 | 87  | 35 | 74  | 47 | 245 | 106 |
| RBCM | 4359  |                         | W | N   | H | 10 | 110 | 37 | 65  | 66 | 220 | 76  |
| RBCM | 6214  | Quatsino Sound          | W | Y   | V | 17 | 90  | 30 | 80  | 50 | 290 | 90  |
| RBCM | 6216  | Coast Salish            | W | N   | U | 11 | 95  | 11 | 54  | 65 | 175 | 57  |
| RBCM | 6686  |                         | W | Y   | V | 14 | 110 | 32 | 76  | 52 | 250 | 111 |
| RBCM | 6811  | Kwakwak a'wakw          | W | N   | V | 23 | 135 | 33 | 70  | 80 | 280 | 79  |
| RBCM | 708 B | Haida                   | W | P   | U | 19 | 76  | 44 | 66  | 81 | 152 | 88  |
| RBCM | 709   | Haida                   | W | Y   | U | 13 | 57  | 49 | 57  | 75 | 167 | 105 |
| RBCM | 711   | Bella Coola             | W | Y   | V | 20 | 78  | 17 | 63  | 45 | 235 | 90  |
| RBCM | 712   | Bella Coola             | W | Y   | V | 11 | 85  | 33 | 65  | 55 | 230 | 110 |

|      |                  |                                       |   |   |   |            |            |            |            |            |             |            |
|------|------------------|---------------------------------------|---|---|---|------------|------------|------------|------------|------------|-------------|------------|
| RBCM | 713              | Bella<br>Coola                        | W | Y | H | 17         | 120        | 65         | 75         | 80         | 280         | 135        |
| RBCM | 714              | Kwakwak<br>a'wakw                     | W | Y | H | 21         | 91         | 38         | 60         | 71         | 215         | 85         |
| RBCM | 715              | Heiltsuk<br>Bella Bella               | W | N | H | 19         | 110        | 45         | 110        | 5          | 290         | 130        |
| RBCM | 716              | Heiltsuk<br>Bella Bella               | W | Y | H | 16         | 70         | 50         | 110        | 60         | 240         | 90         |
| RBCM | 7161             |                                       | W | N | U | 15         | 80         | 31         | 68         | 52         | 160         | 50         |
| RBCM | 718              | Heiltsuk<br>Bella Bella               | W | N | H | 20         | 90         | 53         | 93         | 70         | 240         | 99         |
| RBCM | 722              | Haida<br>Gwaii                        | W | N | U | 15         | 75         | 40         | 50         | 60         | 145         | 55         |
| RBCM | 719              | Heiltsuk<br>Bella Bella               | W | Y | H | 9          | 120        | 40         | 22         | 50         | 185         | 85         |
| RBCM | 7673             |                                       | W | Y | H | 11         | 105        | 46         | 62         | 82         | 230         | 100        |
| RBCM | 8019             | Nuu-chah-<br>nulth                    | W | Y | U | 17         | 70         | 40         | 47         | 52         | 140         | 90         |
| RBCM | 9755             | CTs'ishaa<br>7ath<br>Barkely<br>Sound | W | N | U | 14         | 125        | 41         | 58         | 73         | 190         | 40         |
| RBCM | 9791             | Masset                                | W | N | H | 20         | 85         | 25         | 55         | 60         | 170         | 195        |
| RBCM | 9792 A           | Skidegate                             | W | N | H | 22         | 90         | 42         | 70         | 65         | 210         | 98         |
| RBCM | 9792 B           | Skidegate                             | W | N | H | 16         | 110        | 30         | 53         | 70         | 210         | 103        |
| RBCM | 9793 A           | Skidegate                             | W | Y | U | 11         | 105        | 45         | 65         | 75         | 200         | 55         |
| RBCM | 9793 B           | Skidegate                             | W | N | U | 6          | 80         | 35         | 80         | 63         | 180         | 45         |
| RBCM | 9794             | Masset                                | W | Y | U | 13         | 90         | 36         | 71         | 65         | 180         | 45         |
| RBCM | 9820             | Masset                                | W | Y | V | 19         | 95         | 40         | 105        | 38         | 295         | 103        |
| RBCM | 9821             | Masset                                | W | Y | V | 25         | 80         | 33         | 101        | 30         | 280         | 85         |
| RBCM | 9941             | Masset                                | W | N | V | 17         | 95         | 50         | 98         | 90         | 255         | 130        |
| RBCM | 9942             | Masset                                | W | Y | H | 14         | 90         | 33         | 60         | 43         | 220         | 79         |
| RBCM | 9943             | Masset                                | W | Y | V | 11         | 70         | 26         | 45         | 40         | 210         | 190        |
| RBCM | 9944             | Masset                                | W | N | H | 16         | 95         | 35         | 60         | 60         | 240         | 75         |
| RBCM | 13386            | Tlingit                               | W | N | V | 18         | 90         | 29         | 66         | 60         | 75          | 105        |
| RBCM | 970.23<br>3.2    |                                       | W | N | U | 22         |            | 41         | 72         |            | 135         |            |
| RBCM | 970.23<br>3.1    |                                       | W | N | U | 19         |            | 46         | 55         |            | 125         |            |
| RRN  | 98237            |                                       | W | Y | U | 10.6       | 80.6       | 31.2       | 64.8       | 60.8       | 147.<br>2   | 61.8       |
| RRN  | 1924.6<br>2.7 .2 | Haida                                 | W | Y | U | 16         | 90         | 33         | 57.8       | 59.9       | 155.<br>7   | 70         |
| RRN  | 1924.6<br>2.7 .1 | Haida                                 | W | Y | U | 11.3       | 89.4<br>2  | 32.1<br>7  | 65.2<br>1  | 51.8<br>3  | 160.<br>67  | 56.2<br>9  |
| RRN  | 1923.7<br>1.44   | Masset                                | W | P | V | 18.0<br>2  | 109.<br>94 | 41.5<br>8  | 41.2<br>1  | 63.7       | 208.<br>5   | 95.1       |
| RRN  | 1954.9.<br>77    | Haida                                 | W | P | U | 14.8       | 84.0<br>2  | 27.3<br>2  | 58.6<br>68 | 48.7<br>05 | 158.<br>513 | 64.9<br>35 |
| RRN  | 1900.1<br>4.3    | Haida                                 | W | N | U | 14.3<br>55 | 73.7<br>15 | 36.5<br>88 | 49.8<br>96 | 52.7<br>52 | 134.<br>451 | 69.9<br>33 |
| RRN  | E7264<br>8-0     | Makah                                 | W | Y | U | 9.15       | 83.1<br>58 | 36.5<br>06 | 46.1<br>43 | 49.9<br>09 | 136.<br>858 | 81.6<br>62 |

|     |               |                    |   |   |   |            |             |            |            |            |             |             |
|-----|---------------|--------------------|---|---|---|------------|-------------|------------|------------|------------|-------------|-------------|
| RRN | E3365<br>85-0 | Cape<br>Flattery   | W | N | U | 16.1<br>1  | 93.8<br>9   | 35         | 72.9<br>69 | 59.2       | 178.<br>149 | 95.0<br>03  |
| RRN | E9103-<br>0   | Alaska             | W | N | V | 16.2<br>47 | 105.<br>622 | 32.1<br>75 | 46.9<br>23 | 53.8<br>64 | 289.<br>178 | 115.<br>886 |
| RRN | E1034<br>56-0 | Alaska             | W | Y | V | 14.2<br>19 | 127.<br>292 | 29.3<br>75 | 98.9<br>58 | 36.3<br>63 | 353.<br>958 | 128.<br>126 |
| RRN | E4297<br>6-0  | Sitka<br>Alaska    | W | Y | V | 16.0<br>01 | 109.<br>875 | 22.1<br>21 | 44.4<br>68 | 40.0<br>97 | 271.<br>996 | 104.<br>778 |
| RRN | E6017<br>7-0  | Hoonah<br>Alaska   | W | Y | V | 16.5       | 109.<br>392 | 24.5<br>27 | 67.3<br>48 | 39.6<br>98 | 290.<br>092 | 97.3<br>92  |
| RRN | E3365<br>84-0 | Makah              | W | N | U | 14.9<br>75 | 80.8<br>8   | 39.4<br>24 | 65.2<br>16 | 52.5<br>98 | 168.<br>981 | 109.<br>852 |
| RRN | E1631<br>5-0  | Baranoff<br>Island | W | Y | V | 16.3       | 112.<br>549 | 26.4<br>83 | 67.6<br>81 | 49.7<br>78 | 301.<br>511 | 93.7<br>2   |

## Appendix F: Reference Collection Measurements for Vertebral Regression Formulae

| Specimen | Fork Length (cm) | Vertebral Element     | Vert Number | Vert Sub Category | Anterior Height (mm) | Anterior Transverse Diameter (mm) | Anterior Length (mm) |
|----------|------------------|-----------------------|-------------|-------------------|----------------------|-----------------------------------|----------------------|
| 90/1     | 149              | Atlas                 | 1           | Prox              | 23.38                | 22.58                             | 11.08                |
| 90/1     | 149              | Axis                  | 2           | Prox              | 22.62                | 23.17                             | 10.66                |
| 90/1     | 149              | Abdominal Vertebra 3  | 3           | Ab1               | 23.63                | 23.88                             | 12.76                |
| 90/1     | 149              | Abdominal Vertebra 4  | 4           | Ab1               | 23.1                 | 24.17                             | 13.08                |
| 90/1     | 149              | Abdominal Vertebra 5  | 5           | Ab1               | 22.88                | 24.6                              | 14.15                |
| 90/1     | 149              | Abdominal Vertebra 6  | 6           | Ab1               | 23.16                | 24.43                             | 14.31                |
| 90/1     | 149              | Abdominal Vertebra 7  | 7           | Ab1               | 22.63                | 24.28                             | 15.57                |
| 90/1     | 149              | Abdominal Vertebra 8  | 8           | Ab1               | 22.68                | 23.97                             | 15.83                |
| 90/1     | 149              | Abdominal Vertebra 9  | 9           | Ab1               | 23.89                | 23.74                             | 16.92                |
| 90/1     | 149              | Abdominal Vertebra 10 | 10          | Ab2               | 23.91                | 24.22                             | 18.29                |
| 90/1     | 149              | Abdominal Vertebra 11 | 11          | Ab2               | 24.11                | 24.04                             | 18.11                |
| 90/1     | 149              | Abdominal Vertebra 12 | 12          | Ab2               | 24.94                | 24.32                             | 19.28                |
| 90/1     | 149              | Abdominal Vertebra 13 | 13          | Ab2               | 25.32                | 24.35                             | 18.82                |
| 90/1     | 149              | Abdominal Vertebra 14 | 14          | Ab2               | 25.15                | 24.28                             | 19.31                |
| 90/1     | 149              | Abdominal Vertebra 15 | 15          | Ab2               | 25.98                | 25.31                             | 19.55                |
| 90/1     | 149              | Abdominal Vertebra 16 | 16          | Ab2               | 25.84                | 24.69                             | 18.7                 |
| 90/1     | 149              | Caudal Vertebra 1     | 17          | Cd1               | 25.76                | 25.26                             | 18.14                |
| 90/1     | 149              | Caudal Vertebra 2     | 18          | Cd1               | 26.85                | 25.59                             | 16.52                |
| 90/1     | 149              | Caudal Vertebra 3     | 19          | Cd1               | 26.82                | 25.79                             | 16.44                |
| 90/1     | 149              | Caudal Vertebra 4     | 20          | Cd1               | 26.5                 | 26.01                             | 16.21                |

|      |     |                       |    |     |       |       |       |
|------|-----|-----------------------|----|-----|-------|-------|-------|
| 90/1 | 149 | Caudal<br>Vertebra 5  | 21 | Cd1 | 26.2  | 26.43 | 17.23 |
| 90/1 | 149 | Caudal<br>Vertebra 6  | 22 | Cd1 | 26.38 | 25.99 | 17.56 |
| 90/1 | 149 | Caudal<br>Vertebra 7  | 23 | Cd1 | 26    | 26.7  | 17.33 |
| 90/1 | 149 | Caudal<br>Vertebra 8  | 24 | Cd1 | 26.42 | 26.5  | 17.41 |
| 90/1 | 149 | Caudal<br>Vertebra 9  | 25 | Cd1 | 26.13 | 26.08 | 18.98 |
| 90/1 | 149 | Caudal<br>Vertebra 10 | 26 | Cd1 | 26.34 | 26.02 | 17.31 |
| 90/1 | 149 | Caudal<br>Vertebra 11 | 27 | Cd2 | 25.89 | 26.04 | 18    |
| 90/1 | 149 | Caudal<br>Vertebra 12 | 28 | Cd2 | 25.54 | 26.53 | 18.2  |
| 90/1 | 149 | Caudal<br>Vertebra 13 | 29 | Cd2 | 26.52 | 27.42 | 18.08 |
| 90/1 | 149 | Caudal<br>Vertebra 14 | 30 | Cd2 | 25.55 | 26.64 | 18.84 |
| 90/1 | 149 | Caudal<br>Vertebra 15 | 31 | Cd2 | 25.88 | 26.81 | 19.18 |
| 90/1 | 149 | Caudal<br>Vertebra 16 | 32 | Cd2 | 25.75 | 26.18 | 19.19 |
| 90/1 | 149 | Caudal<br>Vertebra 17 | 33 | Cd2 | 25.7  | 26.26 | 19.96 |
| 90/1 | 149 | Caudal<br>Vertebra 18 | 34 | Cd2 | 25.48 | 26.1  | 19.06 |
| 90/1 | 149 | Caudal<br>Vertebra 19 | 35 | Cd2 | 25.23 | 26.2  | 19.98 |
| 90/1 | 149 | Caudal<br>Vertebra 20 | 36 | Cd2 | 25.31 | 25.87 | 20.37 |
| 90/1 | 149 | Caudal<br>Vertebra 21 | 37 | Cd3 | 25.37 | 25.15 | 20.35 |
| 90/1 | 149 | Caudal<br>Vertebra 22 | 38 | Cd3 | 24.77 | 25.2  | 20.68 |
| 90/1 | 149 | Caudal<br>Vertebra 23 | 39 | Cd3 | 25    | 25.15 | 20.33 |
| 90/1 | 149 | Caudal<br>Vertebra 24 | 40 | Cd3 | 24.53 | 25.19 | 20.08 |
| 90/1 | 149 | Caudal<br>Vertebra 25 | 41 | Cd3 | 23.66 | 23.78 | 20.26 |
| 90/1 | 149 | Caudal<br>Vertebra 26 | 42 | Cd3 | 23.19 | 23.71 | 19.48 |
| 90/1 | 149 | Caudal<br>Vertebra 27 | 43 | Cd4 | 21.81 | 22.43 | 17.38 |
| 90/1 | 149 | Caudal<br>Vertebra 28 | 44 | Cd4 | 21.24 | 21.65 | 17.03 |
| 90/1 | 149 | Caudal<br>Vertebra 29 | 45 | Cd4 | 20.39 | 21.21 | 16.31 |
| 90/1 | 149 | Caudal<br>Vertebra 30 | 46 | Cd4 | 20.01 | 20.8  | 15.88 |
| 90/1 | 149 | Caudal<br>Vertebra 31 | 47 | Cd4 | 18.43 | 21.08 | 15.4  |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 90/1  | 149 | Caudal<br>Vertebra 32    | 48 | Cd4  | 17.18 | 20.81 | 14.76 |
| 90/1  | 149 | Caudal<br>Vertebra 33    | 49 | Cd4  | 17.1  | 19.62 | 14.41 |
| 90/1  | 149 | Caudal<br>Vertebra 34    | 50 | Dist | 17.24 | 17.9  | 11.41 |
| 90/1  | 149 | Penultimate<br>Vertebrae | 51 | Dist | 13.92 | 13.77 |       |
| 13/05 | 62  | Atlas                    | 1  | Prox | 9.6   | 8.53  | 4.86  |
| 13/05 | 62  | Axis                     | 2  | Prox | 9.55  | 9.08  | 4.43  |
| 13/05 | 62  | Abdominal<br>Vertebra 3  | 3  | Ab1  | 9.6   | 9.48  | 4.96  |
| 13/05 | 62  | Abdominal<br>Vertebra 4  | 4  | Ab1  | 9.48  | 9.49  | 5.31  |
| 13/05 | 62  | Abdominal<br>Vertebra 5  | 5  | Ab1  | 9.51  | 9.55  | 5.84  |
| 13/05 | 62  | Abdominal<br>Vertebra 6  | 6  | Ab1  | 9.78  | 9.66  | 5.85  |
| 13/05 | 62  | Abdominal<br>Vertebra 7  | 7  | Ab1  | 9.51  | 9.78  | 6.76  |
| 13/05 | 62  | Abdominal<br>Vertebra 8  | 8  | Ab1  | 9.48  | 9.69  | 6.42  |
| 13/05 | 62  | Abdominal<br>Vertebra 9  | 9  | Ab1  | 9.39  | 9.93  | 7.1   |
| 13/05 | 62  | Abdominal<br>Vertebra 10 | 10 | Ab2  | 9.84  | 10.04 | 7.57  |
| 13/05 | 62  | Abdominal<br>Vertebra 11 | 11 | Ab2  | 9.65  | 9.98  | 7.43  |
| 13/05 | 62  | Abdominal<br>Vertebra 12 | 12 | Ab2  | 10.22 | 10.35 | 7.79  |
| 13/05 | 62  | Abdominal<br>Vertebra 13 | 13 | Ab2  | 10.28 | 10.24 | 7.6   |
| 13/05 | 62  | Abdominal<br>Vertebra 14 | 14 | Ab2  | 10.28 | 10.32 | 8.08  |
| 13/05 | 62  | Abdominal<br>Vertebra 15 | 15 | Ab2  | 10.32 | 10.66 | 8.17  |
| 13/05 | 62  | Abdominal<br>Vertebra 16 | 16 | Ab2  | 10.47 | 10.53 | 7.92  |
| 13/05 | 62  | Caudal<br>Vertebra 1     | 17 | Cd1  | 10.53 | 10.26 | 7.49  |
| 13/05 | 62  | Caudal<br>Vertebra 2     | 18 | Cd1  | 10.97 | 10.33 | 6.96  |
| 13/05 | 62  | Caudal<br>Vertebra 3     | 19 | Cd1  | 11.06 | 10.65 | 7.15  |
| 13/05 | 62  | Caudal<br>Vertebra 4     | 20 | Cd1  | 10.78 | 11.05 | 7.54  |
| 13/05 | 62  | Caudal<br>Vertebra 5     | 21 | Cd1  | 10.82 | 10.8  | 7.58  |
| 13/05 | 62  | Caudal<br>Vertebra 6     | 22 | Cd1  | 11.05 | 11.02 | 8.14  |
| 13/05 | 62  | Caudal<br>Vertebra 7     | 23 | Cd1  | 10.79 | 11.11 | 7.79  |
| 13/05 | 62  | Caudal<br>Vertebra 8     | 24 | Cd1  | 10.92 | 11.06 | 8.01  |

|       |      |                         |    |      |       |       |      |
|-------|------|-------------------------|----|------|-------|-------|------|
| 13/05 | 62   | Caudal<br>Vertebra 9    | 25 | Cd1  | 11.07 | 11.14 | 8.05 |
| 13/05 | 62   | Caudal<br>Vertebra 10   | 26 | Cd1  | 10.92 | 11.17 | 8.08 |
| 13/05 | 62   | Caudal<br>Vertebra 11   | 27 | Cd2  | 10.95 | 11.13 | 8.28 |
| 13/05 | 62   | Caudal<br>Vertebra 12   | 28 | Cd2  | 10.94 | 11.03 | 8.3  |
| 13/05 | 62   | Caudal<br>Vertebra 13   | 29 | Cd2  | 10.85 | 11.04 | 8.41 |
| 13/05 | 62   | Caudal<br>Vertebra 14   | 30 | Cd2  | 10.97 | 10.99 | 8.55 |
| 13/05 | 62   | Caudal<br>Vertebra 15   | 31 | Cd2  | 10.98 | 11.02 | 8.74 |
| 13/05 | 62   | Caudal<br>Vertebra 16   | 32 | Cd2  | 11.01 | 10.88 | 8.86 |
| 13/05 | 62   | Caudal<br>Vertebra 17   | 33 | Cd2  | 11.05 | 10.94 | 9.34 |
| 13/05 | 62   | Caudal<br>Vertebra 18   | 34 | Cd2  | 11.02 | 10.96 | 8.91 |
| 13/05 | 62   | Caudal<br>Vertebra 19   | 35 | Cd2  | 10.91 | 10.77 | 9.42 |
| 13/05 | 62   | Caudal<br>Vertebra 20   | 36 | Cd2  | 11.04 | 10.74 | 9.44 |
| 13/05 | 62   | Caudal<br>Vertebra 21   | 37 | Cd3  | 10.74 | 10.63 | 9.69 |
| 13/05 | 62   | Caudal<br>Vertebra 22   | 38 | Cd3  | 10.66 | 10.35 | 9.66 |
| 13/05 | 62   | Caudal<br>Vertebra 23   | 39 | Cd3  | 10.56 | 10.24 | 9.57 |
| 13/05 | 62   | Caudal<br>Vertebra 24   | 40 | Cd3  | 10.41 | 10.21 | 9.48 |
| 13/05 | 62   | Caudal<br>Vertebra 25   | 41 | Cd3  | 10.16 | 9.83  | 9.3  |
| 13/05 | 62   | Caudal<br>Vertebra 26   | 42 | Cd3  | 9.93  | 9.62  | 8.94 |
| 13/05 | 62   | Caudal<br>Vertebra 27   | 43 | Cd4  | 9.69  | 9.43  | 8.55 |
| 13/05 | 62   | Caudal<br>Vertebra 28   | 44 | Cd4  | 9.47  | 9.35  | 8.03 |
| 13/05 | 62   | Caudal<br>Vertebra 29   | 45 | Cd4  | 8.94  | 9.19  | 7.64 |
| 13/05 | 62   | Caudal<br>Vertebra 30   | 46 | Cd4  | 8.59  | 8.75  | 7.63 |
| 13/05 | 62   | Caudal<br>Vertebra 31   | 47 | Cd4  | 8.12  | 8.73  | 6.98 |
| 13/05 | 62   | Caudal<br>Vertebra 32   | 48 | Cd4  | 7.38  | 8.67  | 7.33 |
| 13/05 | 62   | Caudal<br>Vertebra 33   | 49 | Dist | 7.15  | 8.19  | 7.09 |
| 13/05 | 62   | Penultimate<br>Vertebra | 50 | Dist | 6.57  | 6.28  |      |
| 00/73 | 91.4 | Atlas                   | 1  | Prox | 13.15 | 12.14 | 6.68 |
| 00/73 | 91.4 | Axis                    | 2  | Prox | 13.24 | 13.06 | 6.39 |

|       |      |                          |    |     |       |       |       |
|-------|------|--------------------------|----|-----|-------|-------|-------|
| 00/73 | 91.4 | Abdominal<br>Vertebra 3  | 3  | Ab1 | 12.97 | 13.73 | 6.89  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 4  | 4  | Ab1 | 13.05 | 13.53 | 7.54  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 5  | 5  | Ab1 | 12.85 | 13.84 | 8.19  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 6  | 6  | Ab1 | 13.29 | 13.6  | 8.64  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 13.34 | 13.82 | 9.13  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 13.26 | 13.55 | 10.22 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 13.98 | 14.07 | 10.64 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 13.54 | 13.66 | 10.35 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 14.31 | 14.34 | 11.05 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 14.88 | 14.47 | 11.85 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 14.62 | 14.26 | 11.6  |
| 00/73 | 91.4 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 14.72 | 14.45 | 11.43 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 14.82 | 14.39 | 11.55 |
| 00/73 | 91.4 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 14.96 | 14.8  | 11.22 |
| 00/73 | 91.4 | Caudal<br>Vertebra 1     | 17 | Cd1 | 14.79 | 14.86 | 10.52 |
| 00/73 | 91.4 | Caudal<br>Vertebra 2     | 18 | Cd1 | 15.34 | 14.8  | 10.36 |
| 00/73 | 91.4 | Caudal<br>Vertebra 3     | 19 | Cd1 | 15.86 | 15.08 | 10.81 |
| 00/73 | 91.4 | Caudal<br>Vertebra 4     | 20 | Cd1 | 15.75 | 15.27 | 10.91 |
| 00/73 | 91.4 | Caudal<br>Vertebra 5     | 21 | Cd1 | 15.92 | 15.58 | 11.14 |
| 00/73 | 91.4 | Caudal<br>Vertebra 6     | 22 | Cd1 | 15.87 | 15.52 | 11.29 |
| 00/73 | 91.4 | Caudal<br>Vertebra 7     | 23 | Cd1 | 15.75 | 15.73 | 11.65 |
| 00/73 | 91.4 | Caudal<br>Vertebra 8     | 24 | Cd1 | 15.69 | 15.59 | 11.49 |
| 00/73 | 91.4 | Caudal<br>Vertebra 9     | 25 | Cd1 | 15.59 | 15.79 | 11.54 |
| 00/73 | 91.4 | Caudal<br>Vertebra 10    | 26 | Cd1 | 15.88 | 15.48 | 11.4  |
| 00/73 | 91.4 | Caudal<br>Vertebra 11    | 27 | Cd2 | 15.61 | 15.55 | 11.79 |
| 00/73 | 91.4 | Caudal<br>Vertebra 12    | 28 | Cd2 | 15.6  | 15.45 | 11.79 |
| 00/73 | 91.4 | Caudal<br>Vertebra 13    | 29 | Cd2 | 15.54 | 15.35 | 11.71 |

|       |      |                         |    |      |       |       |       |
|-------|------|-------------------------|----|------|-------|-------|-------|
| 00/73 | 91.4 | Caudal<br>Vertebra 14   | 30 | Cd2  | 15.65 | 15.22 | 11.98 |
| 00/73 | 91.4 | Caudal<br>Vertebra 15   | 31 | Cd2  | 15.57 | 15.14 | 12.01 |
| 00/73 | 91.4 | Caudal<br>Vertebra 16   | 32 | Cd2  | 15.6  | 15.24 | 12.38 |
| 00/73 | 91.4 | Caudal<br>Vertebra 17   | 33 | Cd2  | 15.5  | 14.93 | 13.01 |
| 00/73 | 91.4 | Caudal<br>Vertebra 18   | 34 | Cd2  | 15.63 | 14.98 | 12.62 |
| 00/73 | 91.4 | Caudal<br>Vertebra 19   | 35 | Cd2  | 15.43 | 14.93 | 12.94 |
| 00/73 | 91.4 | Caudal<br>Vertebra 20   | 36 | Cd2  | 15.39 | 14.89 | 13.28 |
| 00/73 | 91.4 | Caudal<br>Vertebra 21   | 37 | Cd3  | 15.22 | 14.57 | 13.23 |
| 00/73 | 91.4 | Caudal<br>Vertebra 22   | 38 | Cd3  | 14.77 | 14.67 | 13.59 |
| 00/73 | 91.4 | Caudal<br>Vertebra 23   | 39 | Cd3  | 15.09 | 14.49 | 13.65 |
| 00/73 | 91.4 | Caudal<br>Vertebra 24   | 40 | Cd3  | 14.33 | 14.05 | 13.16 |
| 00/73 | 91.4 | Caudal<br>Vertebra 25   | 41 | Cd3  | 14.74 | 14.54 | 13.36 |
| 00/73 | 91.4 | Caudal<br>Vertebra 26   | 42 | Cd3  | 14.24 | 14.11 | 12.26 |
| 00/73 | 91.4 | Caudal<br>Vertebra 27   | 43 | Cd4  | 13.92 | 13.36 | 11.87 |
| 00/73 | 91.4 | Caudal<br>Vertebra 28   | 44 | Cd4  | 13.13 | 13.01 | 11.32 |
| 00/73 | 91.4 | Caudal<br>Vertebra 29   | 45 | Cd4  | 12.43 | 12.32 | 10.75 |
| 00/73 | 91.4 | Caudal<br>Vertebra 30   | 46 | Cd4  | 11.81 | 12    | 10.23 |
| 00/73 | 91.4 | Caudal<br>Vertebra 31   | 47 | Cd4  | 11.58 | 12.13 | 9.72  |
| 00/73 | 91.4 | Caudal<br>Vertebra 32   | 48 | Cd4  | 11.03 | 11.54 | 9.81  |
| 00/73 | 91.4 | Caudal<br>Vertebra 33   | 49 | Dist | 10.63 | 10.75 | 8.18  |
| 00/73 | 91.4 | Penultimate<br>Vertebra | 50 | Dist | 9.28  | 8.67  |       |
| 15/21 | 19.5 | Atlas                   | 1  | Prox | 3.11  | 2.86  | 1.62  |
| 15/21 | 19.5 | Axis                    | 2  | Prox | 3.02  | 2.99  | 1.54  |
| 15/21 | 19.5 | Abdominal<br>Vertebra 3 | 3  | Ab1  | 3.03  | 3.2   | 1.9   |
| 15/21 | 19.5 | Abdominal<br>Vertebra 4 | 4  | Ab1  | 2.92  | 3.23  | 1.82  |
| 15/21 | 19.5 | Abdominal<br>Vertebra 5 | 5  | Ab1  | 2.93  | 3.17  | 1.98  |
| 15/21 | 19.5 | Abdominal<br>Vertebra 6 | 6  | Ab1  | 2.87  | 3.08  | 2.15  |
| 15/21 | 19.5 | Abdominal<br>Vertebra 7 | 7  | Ab1  | 2.88  | 3.01  | 2.49  |

|       |      |                          |    |     |      |      |      |
|-------|------|--------------------------|----|-----|------|------|------|
| 15/21 | 19.5 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 2.91 | 3.09 | 2.36 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 2.97 | 3.04 | 2.51 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 3.01 | 3.15 | 2.73 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 3.05 | 3.14 | 2.76 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 3.04 | 3.15 | 2.72 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 3.2  | 3.22 | 2.92 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 3.31 | 3.25 | 2.81 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 3.29 | 3.23 | 2.87 |
| 15/21 | 19.5 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 3.32 | 3.3  | 2.71 |
| 15/21 | 19.5 | Caudal<br>Vertebra 1     | 17 | Cd1 | 3.49 | 3.29 | 2.63 |
| 15/21 | 19.5 | Caudal<br>Vertebra 2     | 18 | Cd1 | 3.54 | 3.36 | 2.38 |
| 15/21 | 19.5 | Caudal<br>Vertebra 3     | 19 | Cd1 | 3.5  | 3.42 | 2.49 |
| 15/21 | 19.5 | Caudal<br>Vertebra 4     | 20 | Cd1 | 3.54 | 3.61 | 2.58 |
| 15/21 | 19.5 | Caudal<br>Vertebra 5     | 21 | Cd1 | 3.49 | 3.55 | 2.59 |
| 15/21 | 19.5 | Caudal<br>Vertebra 6     | 22 | Cd1 | 3.45 | 3.48 | 2.52 |
| 15/21 | 19.5 | Caudal<br>Vertebra 7     | 23 | Cd1 | 3.61 | 3.36 | 2.6  |
| 15/21 | 19.5 | Caudal<br>Vertebra 8     | 24 | Cd1 | 3.55 | 3.48 | 2.59 |
| 15/21 | 19.5 | Caudal<br>Vertebra 9     | 25 | Cd1 | 3.52 | 3.59 | 2.69 |
| 15/21 | 19.5 | Caudal<br>Vertebra 10    | 26 | Cd1 | 3.54 | 3.57 | 2.66 |
| 15/21 | 19.5 | Caudal<br>Vertebra 11    | 27 | Cd2 | 3.58 | 3.41 | 2.75 |
| 15/21 | 19.5 | Caudal<br>Vertebra 12    | 28 | Cd2 | 3.53 | 3.43 | 2.83 |
| 15/21 | 19.5 | Caudal<br>Vertebra 13    | 29 | Cd2 | 3.45 | 3.43 | 2.97 |
| 15/21 | 19.5 | Caudal<br>Vertebra 14    | 30 | Cd2 | 3.49 | 3.36 | 2.89 |
| 15/21 | 19.5 | Caudal<br>Vertebra 15    | 31 | Cd2 | 3.46 | 3.47 | 2.92 |
| 15/21 | 19.5 | Caudal<br>Vertebra 16    | 32 | Cd2 | 3.38 | 3.33 | 3.07 |
| 15/21 | 19.5 | Caudal<br>Vertebra 17    | 33 | Cd2 | 3.39 | 3.29 | 3.14 |
| 15/21 | 19.5 | Caudal<br>Vertebra 18    | 34 | Cd2 | 3.42 | 3.44 | 3.04 |

|       |       |                          |    |      |       |       |       |
|-------|-------|--------------------------|----|------|-------|-------|-------|
| 15/21 | 19.5  | Caudal<br>Vertebra 19    | 35 | Cd2  | 3.31  | 3.29  | 3.18  |
| 15/21 | 19.5  | Caudal<br>Vertebra 20    | 36 | Cd2  | 3.28  | 3.32  | 3.26  |
| 15/21 | 19.5  | Caudal<br>Vertebra 21    | 37 | Cd3  | 3.23  | 3.35  | 3.22  |
| 15/21 | 19.5  | Caudal<br>Vertebra 22    | 38 | Cd3  | 3.18  | 3.33  | 3.19  |
| 15/21 | 19.5  | Caudal<br>Vertebra 23    | 39 | Cd3  | 3.1   | 3.25  | 3.18  |
| 15/21 | 19.5  | Caudal<br>Vertebra 24    | 40 | Cd3  | 3.09  | 3.24  | 3.22  |
| 15/21 | 19.5  | Caudal<br>Vertebra 25    | 41 | Cd3  | 2.95  | 2.86  | 2.91  |
| 15/21 | 19.5  | Caudal<br>Vertebra 26    | 42 | Cd3  | 2.9   | 2.83  | 2.77  |
| 15/21 | 19.5  | Caudal<br>Vertebra 27    | 43 | Cd4  | 3.06  | 3.17  | 3.22  |
| 15/21 | 19.5  | Caudal<br>Vertebra 28    | 44 | Cd4  | 2.86  | 2.99  | 2.79  |
| 15/21 | 19.5  | Caudal<br>Vertebra 29    | 45 | Cd4  | 2.97  | 3.06  | 3.12  |
| 15/21 | 19.5  | Caudal<br>Vertebra 30    | 46 | Cd4  | 2.82  | 3.09  | 2.95  |
| 15/21 | 19.5  | Caudal<br>Vertebra 31    | 47 | Cd4  | 2.81  | 2.65  | 2.72  |
| 15/21 | 19.5  | Caudal<br>Vertebra 32    | 48 | Cd4  | 2.68  | 2.64  | 2.43  |
| 15/21 | 19.5  | Caudal<br>Vertebra 33    | 49 | Dist | 2.44  | 2.51  | 2.42  |
| 15/21 | 19.5  | Penultimate<br>Vertebra  | 50 | Dist | 2.27  | 2.03  |       |
| 00/82 | 103.5 | Atlas                    | 1  | Prox | 15.84 | 13.09 | 6.93  |
| 00/82 | 103.5 | Axis                     | 2  | Prox | 14.96 | 14.96 | 7.85  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 14.47 | 15.61 | 8.63  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 14.41 | 15.97 | 8.95  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 14.48 | 16.02 | 9.42  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 14.64 | 15.88 | 9.98  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 15.26 | 15.82 | 11.05 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 15.48 | 15.92 | 10.49 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 15.92 | 15.77 | 11.79 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 15.54 | 16.27 | 12.78 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 16.03 | 16.24 | 12.65 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 16.42 | 16.26 | 13.02 |

|       |       |                          |    |     |       |       |       |
|-------|-------|--------------------------|----|-----|-------|-------|-------|
| 00/82 | 103.5 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 16.76 | 15.86 | 13.05 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 16.85 | 16.24 | 13.41 |
| 00/82 | 103.5 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 17.22 | 16.36 | 13.2  |
| 00/82 | 103.5 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 17.51 | 16.38 | 12.88 |
| 00/82 | 103.5 | Caudal<br>Vertebra 1     | 17 | Cd1 | 17.29 | 17.24 | 12.51 |
| 00/82 | 103.5 | Caudal<br>Vertebra 2     | 18 | Cd1 | 17.73 | 17.46 | 11.51 |
| 00/82 | 103.5 | Caudal<br>Vertebra 3     | 19 | Cd1 | 17.49 | 17.35 | 11.02 |
| 00/82 | 103.5 | Caudal<br>Vertebra 4     | 20 | Cd1 | 18.25 | 17.74 | 11.52 |
| 00/82 | 103.5 | Caudal<br>Vertebra 5     | 21 | Cd1 | 18.05 | 17.93 | 12.08 |
| 00/82 | 103.5 | Caudal<br>Vertebra 6     | 22 | Cd1 | 18.16 | 17.67 | 12.04 |
| 00/82 | 103.5 | Caudal<br>Vertebra 7     | 23 | Cd1 | 18.15 | 17.85 | 12.57 |
| 00/82 | 103.5 | Caudal<br>Vertebra 8     | 24 | Cd1 | 18.17 | 17.93 | 13.08 |
| 00/82 | 103.5 | Caudal<br>Vertebra 9     | 25 | Cd1 | 18.16 | 18.04 | 13.01 |
| 00/82 | 103.5 | Caudal<br>Vertebra 10    | 26 | Cd1 | 18.17 | 17.98 | 12.87 |
| 00/82 | 103.5 | Caudal<br>Vertebra 11    | 27 | Cd2 | 18.14 | 18.06 | 13.07 |
| 00/82 | 103.5 | Caudal<br>Vertebra 12    | 28 | Cd2 | 18.21 | 18.14 | 13.31 |
| 00/82 | 103.5 | Caudal<br>Vertebra 13    | 29 | Cd2 | 18.38 | 17.97 | 13.38 |
| 00/82 | 103.5 | Caudal<br>Vertebra 14    | 30 | Cd2 | 18.27 | 17.91 | 13.84 |
| 00/82 | 103.5 | Caudal<br>Vertebra 15    | 31 | Cd2 | 18.37 | 17.86 | 14.11 |
| 00/82 | 103.5 | Caudal<br>Vertebra 16    | 32 | Cd2 | 18.22 | 17.61 | 14.08 |
| 00/82 | 103.5 | Caudal<br>Vertebra 17    | 33 | Cd2 | 18.32 | 17.71 | 14.68 |
| 00/82 | 103.5 | Caudal<br>Vertebra 18    | 34 | Cd2 | 18.34 | 17.83 | 14.84 |
| 00/82 | 103.5 | Caudal<br>Vertebra 19    | 35 | Cd2 | 18.02 | 17.68 | 14.9  |
| 00/82 | 103.5 | Caudal<br>Vertebra 20    | 36 | Cd2 | 18.27 | 17.77 | 15.26 |
| 00/82 | 103.5 | Caudal<br>Vertebra 21    | 37 | Cd3 | 18.22 | 17.44 | 15.54 |
| 00/82 | 103.5 | Caudal<br>Vertebra 22    | 38 | Cd3 | 17.84 | 16.84 | 15.43 |
| 00/82 | 103.5 | Caudal<br>Vertebra 23    | 39 | Cd3 | 17.54 | 17.15 | 15.91 |

|       |       |                          |    |      |       |       |       |
|-------|-------|--------------------------|----|------|-------|-------|-------|
| 00/82 | 103.5 | Caudal<br>Vertebra 24    | 40 | Cd3  | 17.02 | 16.54 | 15.46 |
| 00/82 | 103.5 | Caudal<br>Vertebra 25    | 41 | Cd3  | 16.04 | 16.21 | 13.59 |
| 00/82 | 103.5 | Caudal<br>Vertebra 26    | 42 | Cd3  | 16.7  | 16.14 | 14.37 |
| 00/82 | 103.5 | Caudal<br>Vertebra 27    | 43 | Cd4  | 15.56 | 15.41 | 12.81 |
| 00/82 | 103.5 | Caudal<br>Vertebra 28    | 44 | Cd4  | 14.95 | 15.14 | 12.16 |
| 00/82 | 103.5 | Caudal<br>Vertebra 29    | 45 | Cd4  | 14.41 | 14.27 | 11.85 |
| 00/82 | 103.5 | Caudal<br>Vertebra 30    | 46 | Cd4  | 13.81 | 14.12 | 11.41 |
| 00/82 | 103.5 | Caudal<br>Vertebra 31    | 47 | Cd4  | 13.15 | 13.71 | 11.66 |
| 00/82 | 103.5 | Caudal<br>Vertebra 32    | 48 | Cd4  | 12.12 | 12.59 | 11.02 |
| 00/82 | 103.5 | Caudal<br>Vertebra 33    | 49 | Dist | 11.86 | 11.27 | 9.68  |
| 00/82 | 103.5 | Penultimate<br>Vertebra  | 50 | Dist | 10.26 | 9.53  |       |
| 12/04 | 62    | Atlas                    | 1  | Prox | 9.03  | 7.84  | 4.29  |
| 12/04 | 62    | Axis                     | 2  | Prox | 9.49  | 8.17  | 4.59  |
| 12/04 | 62    | Abdominal<br>Vertebra 3  | 3  | Ab1  | 9.06  | 8.71  | 4.76  |
| 12/04 | 62    | Abdominal<br>Vertebra 4  | 4  | Ab1  | 9.02  | 8.98  | 5.13  |
| 12/04 | 62    | Abdominal<br>Vertebra 5  | 5  | Ab1  | 8.79  | 8.79  | 5.27  |
| 12/04 | 62    | Abdominal<br>Vertebra 6  | 6  | Ab1  | 8.98  | 8.89  | 5.63  |
| 12/04 | 62    | Abdominal<br>Vertebra 7  | 7  | Ab1  | 8.95  | 8.74  | 5.97  |
| 12/04 | 62    | Abdominal<br>Vertebra 8  | 8  | Ab1  | 9.02  | 8.89  |       |
| 12/04 | 62    | Abdominal<br>Vertebra 9  | 9  | Ab1  | 9.09  | 8.86  | 6.29  |
| 12/04 | 62    | Abdominal<br>Vertebra 10 | 10 | Ab2  | 9.19  | 9.02  | 6.87  |
| 12/04 | 62    | Abdominal<br>Vertebra 11 | 11 | Ab2  | 9.27  | 9.01  | 7.04  |
| 12/04 | 62    | Abdominal<br>Vertebra 12 | 12 | Ab2  | 9.38  | 9.07  | 6.91  |
| 12/04 | 62    | Abdominal<br>Vertebra 13 | 13 | Ab2  | 9.55  | 9.24  | 7.07  |
| 12/04 | 62    | Abdominal<br>Vertebra 14 | 14 | Ab2  | 9.56  | 9.21  | 7.36  |
| 12/04 | 62    | Abdominal<br>Vertebra 15 | 15 | Ab2  | 9.61  | 9.36  | 7.28  |
| 12/04 | 62    | Abdominal<br>Vertebra 16 | 16 | Ab2  | 9.67  | 9.34  | 7.13  |
| 12/04 | 62    | Caudal<br>Vertebra 1     | 17 | Cd1  | 9.93  | 9.28  | 6.71  |

|       |    |                       |    |     |       |       |      |
|-------|----|-----------------------|----|-----|-------|-------|------|
| 12/04 | 62 | Caudal<br>Vertebra 2  | 18 | Cd1 | 10.26 | 9.76  | 7.58 |
| 12/04 | 62 | Caudal<br>Vertebra 3  | 19 | Cd1 | 10.1  | 9.98  | 7.53 |
| 12/04 | 62 | Caudal<br>Vertebra 4  | 20 | Cd1 | 10.11 | 9.56  | 6.98 |
| 12/04 | 62 | Caudal<br>Vertebra 5  | 21 | Cd1 | 10.19 | 9.52  | 6.61 |
| 12/04 | 62 | Caudal<br>Vertebra 6  | 22 | Cd1 | 10.22 | 9.42  | 6.34 |
| 12/04 | 62 | Caudal<br>Vertebra 7  | 23 | Cd1 | 10.31 | 9.61  | 6.75 |
| 12/04 | 62 | Caudal<br>Vertebra 8  | 24 | Cd1 | 9.98  | 9.65  | 7.34 |
| 12/04 | 62 | Caudal<br>Vertebra 9  | 25 | Cd1 | 10.13 | 9.82  | 7.32 |
| 12/04 | 62 | Caudal<br>Vertebra 10 | 26 | Cd1 | 10.14 | 9.63  | 7.91 |
| 12/04 | 62 | Caudal<br>Vertebra 11 | 27 | Cd2 | 10.18 | 9.94  | 7.86 |
| 12/04 | 62 | Caudal<br>Vertebra 12 | 28 | Cd2 | 10.08 | 10.07 | 7.78 |
| 12/04 | 62 | Caudal<br>Vertebra 13 | 29 | Cd2 | 10.18 | 10.04 | 8.23 |
| 12/04 | 62 | Caudal<br>Vertebra 14 | 30 | Cd2 | 10.17 | 10.03 | 8.18 |
| 12/04 | 62 | Caudal<br>Vertebra 15 | 31 | Cd2 | 10.32 | 9.72  | 8.36 |
| 12/04 | 62 | Caudal<br>Vertebra 16 | 32 | Cd2 | 10.3  | 8.84  | 7.88 |
| 12/04 | 62 | Caudal<br>Vertebra 17 | 33 | Cd2 | 10.23 | 10.06 | 8.64 |
| 12/04 | 62 | Caudal<br>Vertebra 18 | 34 | Cd2 | 10.16 | 10.05 | 8.99 |
| 12/04 | 62 | Caudal<br>Vertebra 19 | 35 | Cd2 | 10.19 | 9.95  | 8.88 |
| 12/04 | 62 | Caudal<br>Vertebra 20 | 36 | Cd2 | 10.19 | 9.85  | 9.22 |
| 12/04 | 62 | Caudal<br>Vertebra 21 | 37 | Cd3 | 10.21 | 10.11 | 8.93 |
| 12/04 | 62 | Caudal<br>Vertebra 22 | 38 | Cd3 | 9.59  | 9.84  | 8.89 |
| 12/04 | 62 | Caudal<br>Vertebra 23 | 39 | Cd3 | 10.02 | 9.51  | 9.08 |
| 12/04 | 62 | Caudal<br>Vertebra 24 | 40 | Cd3 | 9.79  | 9.18  | 8.88 |
| 12/04 | 62 | Caudal<br>Vertebra 25 | 41 | Cd3 | 9.45  | 9.27  | 8.44 |
| 12/04 | 62 | Caudal<br>Vertebra 26 | 42 | Cd3 | 9.21  | 8.85  | 8.1  |
| 12/04 | 62 | Caudal<br>Vertebra 27 | 43 | Cd4 | 9.12  | 8.63  | 7.8  |
| 12/04 | 62 | Caudal<br>Vertebra 28 | 44 | Cd4 | 8.79  | 8.22  | 7.41 |

|       |    |                          |    |      |       |       |       |
|-------|----|--------------------------|----|------|-------|-------|-------|
| 12/04 | 62 | Caudal<br>Vertebra 29    | 45 | Cd4  | 8.36  | 8.06  | 7.12  |
| 12/04 | 62 | Caudal<br>Vertebra 30    | 46 | Cd4  | 7.95  | 7.96  | 6.96  |
| 12/04 | 62 | Caudal<br>Vertebra 31    | 47 | Cd4  | 7.35  | 7.74  | 6.69  |
| 12/04 | 62 | Caudal<br>Vertebra 32    | 48 | Cd4  | 7.14  | 7.42  | 5.89  |
| 12/04 | 62 | Caudal<br>Vertebra 33    | 49 | Dist | 6.85  | 6.77  | 5.17  |
| 12/04 | 62 | Penultimate<br>Vertebra  | 50 | Dist | 6.91  | 6.36  | 5.23  |
| 92/16 | 94 | Atlas                    | 1  | Prox | 16.32 | 14.4  | 6.76  |
| 92/16 | 94 | Axis                     | 2  | Prox | 15.74 | 15.42 | 8.23  |
| 92/16 | 94 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 15.33 | 16.59 | 8.81  |
| 92/16 | 94 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 15.28 | 16.09 | 9.16  |
| 92/16 | 94 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 15.41 | 15.69 | 9.69  |
| 92/16 | 94 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.27 | 15.75 | 10.28 |
| 92/16 | 94 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 16.54 | 15.46 | 11.09 |
| 92/16 | 94 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 16.44 | 15.58 | 11.78 |
| 92/16 | 94 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 16.82 | 15.82 | 12.23 |
| 92/16 | 94 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 16.94 | 16.27 | 12.56 |
| 92/16 | 94 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 17.27 | 16.27 | 13.16 |
| 92/16 | 94 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 17.61 | 16.34 | 13.12 |
| 92/16 | 94 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 18.01 | 16.66 | 13.48 |
| 92/16 | 94 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 17.84 | 17.11 | 13.11 |
| 92/16 | 94 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 18.04 | 15.65 | 12.58 |
| 92/16 | 94 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 18.24 | 16.85 | 13.1  |
| 92/16 | 94 | Caudal<br>Vertebra 1     | 17 | Cd1  | 17.91 | 17.34 | 12.45 |
| 92/16 | 94 | Caudal<br>Vertebra 2     | 18 | Cd1  | 18.36 | 17.52 | 11.24 |
| 92/16 | 94 | Caudal<br>Vertebra 3     | 19 | Cd1  | 18.62 | 17.37 | 11.62 |
| 92/16 | 94 | Caudal<br>Vertebra 4     | 20 | Cd1  | 18.97 | 18.46 | 12.16 |
| 92/16 | 94 | Caudal<br>Vertebra 5     | 21 | Cd1  | 18.91 | 18.62 | 12.46 |
| 92/16 | 94 | Caudal<br>Vertebra 6     | 22 | Cd1  | 18.73 | 18.87 | 13.09 |

|       |    |                       |    |     |       |       |       |
|-------|----|-----------------------|----|-----|-------|-------|-------|
| 92/16 | 94 | Caudal<br>Vertebra 7  | 23 | Cd1 | 19.26 | 18.76 | 13.28 |
| 92/16 | 94 | Caudal<br>Vertebra 8  | 24 | Cd1 | 19.33 | 19.16 | 13.83 |
| 92/16 | 94 | Caudal<br>Vertebra 9  | 25 | Cd1 | 19.43 | 13.05 | 13.17 |
| 92/16 | 94 | Caudal<br>Vertebra 10 | 26 | Cd1 | 19.36 | 18.79 | 13.46 |
| 92/16 | 94 | Caudal<br>Vertebra 11 | 27 | Cd2 | 19.48 | 18.85 | 14.28 |
| 92/16 | 94 | Caudal<br>Vertebra 12 | 28 | Cd2 | 19.61 | 19.28 | 12.41 |
| 92/16 | 94 | Caudal<br>Vertebra 13 | 29 | Cd2 | 19.48 | 18.93 | 14.37 |
| 92/16 | 94 | Caudal<br>Vertebra 14 | 30 | Cd2 | 19.6  | 18.38 | 14.18 |
| 92/16 | 94 | Caudal<br>Vertebra 15 | 31 | Cd2 | 19.57 | 18.91 | 14.32 |
| 92/16 | 94 | Caudal<br>Vertebra 16 | 32 | Cd2 | 19.52 | 18.56 | 14.54 |
| 92/16 | 94 | Caudal<br>Vertebra 17 | 33 | Cd2 | 19.41 | 18.67 | 14.59 |
| 92/16 | 94 | Caudal<br>Vertebra 18 | 34 | Cd2 | 19.58 | 18.71 | 14.94 |
| 92/16 | 94 | Caudal<br>Vertebra 19 | 35 | Cd2 | 19.61 | 18.74 | 15.21 |
| 92/16 | 94 | Caudal<br>Vertebra 20 | 36 | Cd2 | 19.47 | 18.53 | 15.38 |
| 92/16 | 94 | Caudal<br>Vertebra 21 | 37 | Cd3 | 19.43 | 18.19 | 17.91 |
| 92/16 | 94 | Caudal<br>Vertebra 22 | 38 | Cd3 | 19.22 | 17.74 | 15.84 |
| 92/16 | 94 | Caudal<br>Vertebra 23 | 39 | Cd3 | 19.05 | 17.59 | 15.68 |
| 92/16 | 94 | Caudal<br>Vertebra 24 | 40 | Cd3 | 18.66 | 17.67 | 15.51 |
| 92/16 | 94 | Caudal<br>Vertebra 25 | 41 | Cd3 | 18.44 | 16.76 | 15.44 |
| 92/16 | 94 | Caudal<br>Vertebra 26 | 42 | Cd3 | 18.02 | 16.41 | 14.27 |
| 92/16 | 94 | Caudal<br>Vertebra 27 | 43 | Cd4 | 17.54 | 15.91 | 13.44 |
| 92/16 | 94 | Caudal<br>Vertebra 28 | 44 | Cd4 | 16.33 | 15.29 | 12.29 |
| 92/16 | 94 | Caudal<br>Vertebra 29 | 45 | Cd4 | 16.92 | 15.19 | 12.59 |
| 92/16 | 94 | Caudal<br>Vertebra 30 | 46 | Cd4 | 14.61 | 14.34 | 10.71 |
| 92/16 | 94 | Caudal<br>Vertebra 31 | 47 | Cd4 | 15.48 | 15.33 | 11.41 |
| 92/16 | 94 | Caudal<br>Vertebra 32 | 48 | Cd4 | 13.86 | 15.74 | 10.87 |
| 92/16 | 94 | Caudal<br>Vertebra 33 | 49 | Cd4 | 12.64 | 15.13 | 10.82 |

|       |    |                          |    |      |       |       |      |
|-------|----|--------------------------|----|------|-------|-------|------|
| 92/16 | 94 | Caudal<br>Vertebra 34    | 50 | Dist | 12.29 | 14.02 | 9.66 |
| 92/16 | 94 | Penultimate<br>Vertebra  | 51 | Dist | 10.98 | 10.9  |      |
| 13/06 | 61 | Atlas                    | 1  | Prox | 8.88  | 8.39  | 5.03 |
| 13/06 | 61 | Axis                     | 2  | Prox | 9.17  | 8.77  | 4.45 |
| 13/06 | 61 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 8.83  | 9.13  | 4.75 |
| 13/06 | 61 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 8.62  | 9.13  | 5.1  |
| 13/06 | 61 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 8.81  | 9.11  | 5.56 |
| 13/06 | 61 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 8.53  | 8.86  | 6.1  |
| 13/06 | 61 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 8.65  | 9.02  | 5.69 |
| 13/06 | 61 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 8.73  | 9     | 6.55 |
| 13/06 | 61 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 8.81  | 9.08  | 6.82 |
| 13/06 | 61 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 9.09  | 9.24  | 7.12 |
| 13/06 | 61 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 9.38  | 9.22  | 9.39 |
| 13/06 | 61 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 9.45  | 9.26  | 7.46 |
| 13/06 | 61 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 9.74  | 9.39  | 7.68 |
| 13/06 | 61 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 9.56  | 9.15  | 7.55 |
| 13/06 | 61 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 9.77  | 9.18  | 7.63 |
| 13/06 | 61 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 9.96  | 9.4   | 7.42 |
| 13/06 | 61 | Caudal<br>Vertebra 1     | 17 | Cd1  | 10.23 | 9.08  | 6.81 |
| 13/06 | 61 | Caudal<br>Vertebra 2     | 18 | Cd1  | 10.35 | 9.13  | 6.78 |
| 13/06 | 61 | Caudal<br>Vertebra 3     | 19 | Cd1  | 10.45 | 9.56  | 6.93 |
| 13/06 | 61 | Caudal<br>Vertebra 4     | 20 | Cd1  | 10.26 | 9.9   | 6.99 |
| 13/06 | 61 | Caudal<br>Vertebra 5     | 21 | Cd1  | 10.21 | 9.62  | 7.01 |
| 13/06 | 61 | Caudal<br>Vertebra 6     | 22 | Cd1  | 10.21 | 9.92  | 6.72 |
| 13/06 | 61 | Caudal<br>Vertebra 7     | 23 | Cd1  | 10.2  | 9.91  | 7.18 |
| 13/06 | 61 | Caudal<br>Vertebra 8     | 24 | Cd1  | 10.12 | 10    | 7.51 |
| 13/06 | 61 | Caudal<br>Vertebra 9     | 25 | Cd1  | 10.26 | 10.06 | 7.41 |
| 13/06 | 61 | Caudal<br>Vertebra 10    | 26 | Cd1  | 9.97  | 10.23 | 7.59 |

|       |    |                         |    |      |       |       |      |
|-------|----|-------------------------|----|------|-------|-------|------|
| 13/06 | 61 | Caudal<br>Vertebra 11   | 27 | Cd2  | 9.97  | 9.96  | 7.63 |
| 13/06 | 61 | Caudal<br>Vertebra 12   | 28 | Cd2  | 10.13 | 10    | 7.6  |
| 13/06 | 61 | Caudal<br>Vertebra 13   | 29 | Cd2  | 10.07 | 9.76  | 7.86 |
| 13/06 | 61 | Caudal<br>Vertebra 14   | 30 | Cd2  | 10.1  | 9.83  | 7.87 |
| 13/06 | 61 | Caudal<br>Vertebra 15   | 31 | Cd2  | 9.99  | 9.68  | 8.29 |
| 13/06 | 61 | Caudal<br>Vertebra 16   | 32 | Cd2  | 10.06 | 9.7   | 7.89 |
| 13/06 | 61 | Caudal<br>Vertebra 17   | 33 | Cd2  | 9.93  | 9.61  | 8.29 |
| 13/06 | 61 | Caudal<br>Vertebra 18   | 34 | Cd2  | 9.87  | 9.52  | 8.53 |
| 13/06 | 61 | Caudal<br>Vertebra 19   | 35 | Cd2  | 9.7   | 9.33  | 8.65 |
| 13/06 | 61 | Caudal<br>Vertebra 20   | 36 | Cd2  | 9.81  | 9.58  | 8.55 |
| 13/06 | 61 | Caudal<br>Vertebra 21   | 37 | Cd3  | 9.55  | 9.44  | 8.7  |
| 13/06 | 61 | Caudal<br>Vertebra 22   | 38 | Cd3  | 9.46  | 9.29  | 8.77 |
| 13/06 | 61 | Caudal<br>Vertebra 23   | 39 | Cd3  | 9.33  | 9.36  | 8.78 |
| 13/06 | 61 | Caudal<br>Vertebra 24   | 40 | Cd3  | 9.26  | 8.91  | 8.85 |
| 13/06 | 61 | Caudal<br>Vertebra 25   | 41 | Cd3  | 9.08  | 8.6   | 8.71 |
| 13/06 | 61 | Caudal<br>Vertebra 26   | 42 | Cd3  | 8.45  | 8.62  | 8.06 |
| 13/06 | 61 | Caudal<br>Vertebra 27   | 43 | Cd4  | 8.47  | 8.33  | 7.68 |
| 13/06 | 61 | Caudal<br>Vertebra 28   | 44 | Cd4  | 8.73  | 8.71  | 8.49 |
| 13/06 | 61 | Caudal<br>Vertebra 29   | 45 | Cd4  | 8.2   | 8.04  | 7.46 |
| 13/06 | 61 | Caudal<br>Vertebra 30   | 46 | Cd4  | 7.7   | 7.85  | 7.07 |
| 13/06 | 61 | Caudal<br>Vertebra 31   | 47 | Cd4  | 7.56  | 7.84  | 6.9  |
| 13/06 | 61 | Caudal<br>Vertebra 32   | 48 | Cd4  | 7.13  | 7.56  | 6.48 |
| 13/06 | 61 | Caudal<br>Vertebra 33   | 49 | Dist | 6.96  | 7.02  | 6.5  |
| 13/06 | 61 | Penultimate<br>Vertebra | 50 | Dist | 5.65  | 5.83  |      |
| 04/57 | 90 | Atlas                   | 1  | Prox | 12.87 | 11.58 | 6.94 |
| 04/57 | 90 | Axis                    | 2  | Prox | 12.09 | 12.56 | 7.12 |
| 04/57 | 90 | Abdominal<br>Vertebra 3 | 3  | Ab1  | 12.11 | 13.22 | 7.35 |
| 04/57 | 90 | Abdominal<br>Vertebra 4 | 4  | Ab1  | 12.2  | 13.36 | 7.59 |

|       |    |                          |    |     |       |       |       |
|-------|----|--------------------------|----|-----|-------|-------|-------|
| 04/57 | 90 | Abdominal<br>Vertebra 5  | 5  | Ab1 | 12.27 | 13.18 | 8.29  |
| 04/57 | 90 | Abdominal<br>Vertebra 6  | 6  | Ab1 | 12.35 | 13.21 | 9.03  |
| 04/57 | 90 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 12.45 | 13.5  | 9.21  |
| 04/57 | 90 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 13.06 | 13.51 | 10.19 |
| 04/57 | 90 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 13.54 | 13.57 | 10.92 |
| 04/57 | 90 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 14.07 | 13.72 | 11.53 |
| 04/57 | 90 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 13.57 | 13.99 | 11.07 |
| 04/57 | 90 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 14.19 | 13.58 | 11.93 |
| 04/57 | 90 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 14.58 | 14.1  | 11.85 |
| 04/57 | 90 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 15.12 | 14.15 | 11.95 |
| 04/57 | 90 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 14.37 | 14.03 | 12.11 |
| 04/57 | 90 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 15.45 | 14.49 | 11.89 |
| 04/57 | 90 | Caudal<br>Vertebra 1     | 17 | Cd1 | 15.32 | 14.6  | 11.61 |
| 04/57 | 90 | Caudal<br>Vertebra 2     | 18 | Cd1 | 16.01 | 14.45 | 11    |
| 04/57 | 90 | Caudal<br>Vertebra 3     | 19 | Cd1 | 15.73 | 15.14 | 11.36 |
| 04/57 | 90 | Caudal<br>Vertebra 4     | 20 | Cd1 | 16.01 | 15.28 | 11.59 |
| 04/57 | 90 | Caudal<br>Vertebra 5     | 21 | Cd1 | 16.1  | 15.77 | 11.81 |
| 04/57 | 90 | Caudal<br>Vertebra 6     | 22 | Cd1 | 15.93 | 15.2  | 12.04 |
| 04/57 | 90 | Caudal<br>Vertebra 7     | 23 | Cd1 | 15.95 | 15.44 | 12.2  |
| 04/57 | 90 | Caudal<br>Vertebra 8     | 24 | Cd1 | 15.78 | 14.75 | 11.97 |
| 04/57 | 90 | Caudal<br>Vertebra 9     | 25 | Cd1 | 16    | 15.66 | 12.34 |
| 04/57 | 90 | Caudal<br>Vertebra 10    | 26 | Cd1 | 15.91 | 15.49 | 12.87 |
| 04/57 | 90 | Caudal<br>Vertebra 11    | 27 | Cd2 | 15.96 | 15.51 | 12.91 |
| 04/57 | 90 | Caudal<br>Vertebra 12    | 28 | Cd2 | 16.29 | 14.76 | 13.47 |
| 04/57 | 90 | Caudal<br>Vertebra 13    | 29 | Cd2 | 15.96 | 15.17 | 13.12 |
| 04/57 | 90 | Caudal<br>Vertebra 14    | 30 | Cd2 | 16.05 | 15.59 | 12.95 |
| 04/57 | 90 | Caudal<br>Vertebra 15    | 31 | Cd2 | 16.43 | 15.46 | 13.72 |

|       |    |                          |    |      |       |       |       |
|-------|----|--------------------------|----|------|-------|-------|-------|
| 04/57 | 90 | Caudal<br>Vertebra 16    | 32 | Cd2  | 16.26 | 15.34 | 14.06 |
| 04/57 | 90 | Caudal<br>Vertebra 17    | 33 | Cd2  | 16.43 | 14.88 | 14.36 |
| 04/57 | 90 | Caudal<br>Vertebra 18    | 34 | Cd2  | 16.45 | 15.1  | 13.94 |
| 04/57 | 90 | Caudal<br>Vertebra 19    | 35 | Cd2  | 16.11 | 14.89 | 14.62 |
| 04/57 | 90 | Caudal<br>Vertebra 20    | 36 | Cd2  | 16.42 | 15.22 | 14.9  |
| 04/57 | 90 | Caudal<br>Vertebra 21    | 37 | Cd3  | 16.13 | 14.87 | 14.86 |
| 04/57 | 90 | Caudal<br>Vertebra 22    | 38 | Cd3  | 15.69 | 14.49 | 14.6  |
| 04/57 | 90 | Caudal<br>Vertebra 23    | 39 | Cd3  | 15.41 | 14.79 | 14.71 |
| 04/57 | 90 | Caudal<br>Vertebra 24    | 40 | Cd3  | 15.2  | 13.9  | 14.35 |
| 04/57 | 90 | Caudal<br>Vertebra 25    | 41 | Cd3  | 14.4  | 13.27 | 13.37 |
| 04/57 | 90 | Caudal<br>Vertebra 26    | 42 | Cd3  | 14.02 | 13.22 | 12.34 |
| 04/57 | 90 | Caudal<br>Vertebra 27    | 43 | Cd4  | 13.1  | 12.54 | 12.22 |
| 04/57 | 90 | Caudal<br>Vertebra 28    | 44 | Cd4  | 12.43 | 11.98 | 11.63 |
| 04/57 | 90 | Caudal<br>Vertebra 29    | 45 | Cd4  | 12.44 | 11.88 | 10.57 |
| 04/57 | 90 | Caudal<br>Vertebra 30    | 46 | Cd4  | 11.46 | 11.15 | 10.61 |
| 04/57 | 90 | Caudal<br>Vertebra 31    | 47 | Cd4  | 11.46 | 11.15 | 10.9  |
| 04/57 | 90 | Caudal<br>Vertebra 32    | 48 | Dist | 10.93 | 10.54 | 9.7   |
| 04/57 | 90 | Penultimate<br>Vertebra  | 49 | Dist | 10.54 | 10.22 | 9.07  |
| 04/53 | 97 | Atlas                    | 1  | Prox | 15.88 | 14.95 | 9.87  |
| 04/53 | 97 | Axis                     | 2  | Prox | 15.32 | 15.98 | 8.04  |
| 04/53 | 97 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 15.09 | 16.65 | 9.21  |
| 04/53 | 97 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 15.25 | 17.04 | 9.59  |
| 04/53 | 97 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 15.5  | 16.54 | 9.56  |
| 04/53 | 97 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 15.48 | 16.18 | 10.02 |
| 04/53 | 97 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 15.32 | 16.4  | 10.53 |
| 04/53 | 97 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 15.66 | 16.21 | 11.08 |
| 04/53 | 97 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 15.74 | 16.53 | 11.43 |
| 04/53 | 97 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 15.6  | 16.35 | 12.06 |

|       |    |                          |    |     |       |       |       |
|-------|----|--------------------------|----|-----|-------|-------|-------|
| 04/53 | 97 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 15.77 | 16.95 | 12.26 |
| 04/53 | 97 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 16.37 | 16.84 | 12.95 |
| 04/53 | 97 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 16.63 | 16.62 | 13.14 |
| 04/53 | 97 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 16.8  | 16.9  | 13.51 |
| 04/53 | 97 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 17.01 | 17.4  | 13.09 |
| 04/53 | 97 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 16.95 | 16.94 | 13.09 |
| 04/53 | 97 | Caudal<br>Vertebra 1     | 17 | Cd1 | 16.76 | 17.67 | 12.19 |
| 04/53 | 97 | Caudal<br>Vertebra 2     | 18 | Cd1 | 17.58 | 16.91 | 11.7  |
| 04/53 | 97 | Caudal<br>Vertebra 3     | 19 | Cd1 | 18.05 | 17.41 | 11.8  |
| 04/53 | 97 | Caudal<br>Vertebra 4     | 20 | Cd1 | 17.25 | 18.17 | 12.33 |
| 04/53 | 97 | Caudal<br>Vertebra 5     | 21 | Cd1 | 16.73 | 18.48 | 12.08 |
| 04/53 | 97 | Caudal<br>Vertebra 6     | 22 | Cd1 | 17.26 | 18.73 | 12.44 |
| 04/53 | 97 | Caudal<br>Vertebra 7     | 23 | Cd1 | 17.37 | 18.4  | 12.29 |
| 04/53 | 97 | Caudal<br>Vertebra 8     | 24 | Cd1 | 17.63 | 18.59 | 12.47 |
| 04/53 | 97 | Caudal<br>Vertebra 9     | 25 | Cd1 | 17.45 | 18.69 | 12.95 |
| 04/53 | 97 | Caudal<br>Vertebra 10    | 26 | Cd1 | 17.38 | 18.82 | 12.56 |
| 04/53 | 97 | Caudal<br>Vertebra 11    | 27 | Cd2 | 17.46 | 19.28 | 13.02 |
| 04/53 | 97 | Caudal<br>Vertebra 12    | 28 | Cd2 | 17.64 | 18.97 | 13.34 |
| 04/53 | 97 | Caudal<br>Vertebra 13    | 29 | Cd2 | 17.3  | 18.47 | 13.45 |
| 04/53 | 97 | Caudal<br>Vertebra 14    | 30 | Cd2 | 17.58 | 18.07 | 13.46 |
| 04/53 | 97 | Caudal<br>Vertebra 15    | 31 | Cd2 | 17.49 | 18.14 | 14.11 |
| 04/53 | 97 | Caudal<br>Vertebra 16    | 32 | Cd2 | 17.65 | 17.82 | 14.06 |
| 04/53 | 97 | Caudal<br>Vertebra 17    | 33 | Cd2 | 17.05 | 17.56 | 14.22 |
| 04/53 | 97 | Caudal<br>Vertebra 18    | 34 | Cd2 | 17.51 | 17.18 | 14.54 |
| 04/53 | 97 | Caudal<br>Vertebra 19    | 35 | Cd2 | 17.04 | 17.73 | 14.87 |
| 04/53 | 97 | Caudal<br>Vertebra 20    | 36 | Cd2 | 17.05 | 17.51 | 14.63 |
| 04/53 | 97 | Caudal<br>Vertebra 21    | 37 | Cd3 | 16.65 | 16.95 | 14.66 |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 04/53 | 97  | Caudal<br>Vertebra 22    | 38 | Cd3  | 16.59 | 17.33 | 14.67 |
| 04/53 | 97  | Caudal<br>Vertebra 23    | 39 | Cd3  | 16.08 | 16.92 | 14.68 |
| 04/53 | 97  | Caudal<br>Vertebra 24    | 40 | Cd3  | 15.73 | 16.52 | 14.16 |
| 04/53 | 97  | Caudal<br>Vertebra 25    | 41 | Cd3  | 15.51 | 15.82 | 12.88 |
| 04/53 | 97  | Caudal<br>Vertebra 26    | 42 | Cd3  | 14.9  | 15.85 | 12.54 |
| 04/53 | 97  | Caudal<br>Vertebra 27    | 43 | Cd4  | 14.61 | 14.66 | 11.53 |
| 04/53 | 97  | Caudal<br>Vertebra 28    | 44 | Cd4  | 14.15 | 14.61 | 11.36 |
| 04/53 | 97  | Caudal<br>Vertebra 29    | 45 | Cd4  | 13.54 | 14.54 | 11.23 |
| 04/53 | 97  | Caudal<br>Vertebra 30    | 46 | Cd4  | 12.93 | 14.74 | 11.05 |
| 04/53 | 97  | Caudal<br>Vertebra 31    | 47 | Cd4  | 12.87 | 14.63 | 11.29 |
| 04/53 | 97  | Caudal<br>Vertebra 32    | 48 | Dist | 12.52 | 14.24 | 11.44 |
| 04/53 | 97  | Penultimate<br>Vertebra  | 49 | Dist | 11.67 | 12.43 | 10.72 |
| 04/45 | 120 | Atlas                    | 1  | Prox | 18.66 | 17.17 | 10.06 |
| 04/45 | 120 | Axis                     | 2  | Prox | 17.43 | 17.73 | 9.08  |
| 04/45 | 120 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 16.77 | 18.72 | 10.03 |
| 04/45 | 120 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 17.48 | 19.04 | 10.6  |
| 04/45 | 120 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 17.26 | 18.96 | 10.86 |
| 04/45 | 120 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 17.82 | 18.32 | 11    |
| 04/45 | 120 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 17.78 | 18.7  | 11.67 |
| 04/45 | 120 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 17.84 | 17.82 | 12.55 |
| 04/45 | 120 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.32 | 19.03 | 13.16 |
| 04/45 | 120 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.34 | 19.21 | 13.58 |
| 04/45 | 120 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 18.88 | 19.68 | 14.22 |
| 04/45 | 120 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 18.91 | 19.54 | 15.04 |
| 04/45 | 120 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 19.67 | 19.5  | 15.25 |
| 04/45 | 120 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 19.3  | 19.87 | 15.51 |
| 04/45 | 120 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 19.5  | 19.39 | 15.19 |
| 04/45 | 120 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 19.89 | 20.11 | 15.08 |

|       |     |                       |    |     |       |       |       |
|-------|-----|-----------------------|----|-----|-------|-------|-------|
| 04/45 | 120 | Caudal<br>Vertebra 1  | 17 | Cd1 | 19.91 | 20.01 | 14.38 |
| 04/45 | 120 | Caudal<br>Vertebra 2  | 18 | Cd1 | 20.3  | 19.86 | 13.59 |
| 04/45 | 120 | Caudal<br>Vertebra 3  | 19 | Cd1 | 20.48 | 19.81 | 13.77 |
| 04/45 | 120 | Caudal<br>Vertebra 4  | 20 | Cd1 | 20.22 | 20.22 | 14.43 |
| 04/45 | 120 | Caudal<br>Vertebra 5  | 21 | Cd1 | 20.23 | 20.82 | 15.36 |
| 04/45 | 120 | Caudal<br>Vertebra 6  | 22 | Cd1 | 20.39 | 20.19 | 13.81 |
| 04/45 | 120 | Caudal<br>Vertebra 7  | 23 | Cd1 | 20.65 | 20.56 | 14.65 |
| 04/45 | 120 | Caudal<br>Vertebra 8  | 24 | Cd1 | 20.55 | 20.82 | 15.4  |
| 04/45 | 120 | Caudal<br>Vertebra 9  | 25 | Cd1 | 20.32 | 21.12 | 14.92 |
| 04/45 | 120 | Caudal<br>Vertebra 10 | 26 | Cd1 | 20.72 | 20.68 | 14.72 |
| 04/45 | 120 | Caudal<br>Vertebra 11 | 27 | Cd2 | 20.52 | 20.84 | 15.35 |
| 04/45 | 120 | Caudal<br>Vertebra 12 | 28 | Cd2 | 20.84 | 21.15 | 16.14 |
| 04/45 | 120 | Caudal<br>Vertebra 13 | 29 | Cd2 | 20.51 | 21.53 | 15.71 |
| 04/45 | 120 | Caudal<br>Vertebra 14 | 30 | Cd2 | 20.54 | 21.39 | 15.16 |
| 04/45 | 120 | Caudal<br>Vertebra 15 | 31 | Cd2 | 20.46 | 20.71 | 16.1  |
| 04/45 | 120 | Caudal<br>Vertebra 16 | 32 | Cd2 |       |       | 16.05 |
| 04/45 | 120 | Caudal<br>Vertebra 17 | 33 | Cd2 | 20.96 | 20.23 | 16.99 |
| 04/45 | 120 | Caudal<br>Vertebra 18 | 34 | Cd2 | 20.88 | 19.92 | 17.26 |
| 04/45 | 120 | Caudal<br>Vertebra 19 | 35 | Cd2 | 21.1  | 19.93 | 17    |
| 04/45 | 120 | Caudal<br>Vertebra 20 | 36 | Cd2 | 21.05 | 20.87 | 17.41 |
| 04/45 | 120 | Caudal<br>Vertebra 21 | 37 | Cd3 | 20.77 | 19.74 | 17.5  |
| 04/45 | 120 | Caudal<br>Vertebra 22 | 38 | Cd3 | 20.23 | 19.45 | 17.99 |
| 04/45 | 120 | Caudal<br>Vertebra 23 | 39 | Cd3 | 20.5  | 19.92 | 17.63 |
| 04/45 | 120 | Caudal<br>Vertebra 24 | 40 | Cd3 | 20.08 | 19.13 | 17.46 |
| 04/45 | 120 | Caudal<br>Vertebra 25 | 41 | Cd3 | 19.36 | 18.96 | 16.67 |
| 04/45 | 120 | Caudal<br>Vertebra 26 | 42 | Cd3 | 18.65 | 18.1  | 15.71 |
| 04/45 | 120 | Caudal<br>Vertebra 27 | 43 | Cd4 | 18.25 | 18.14 | 14.95 |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 04/45 | 120 | Caudal<br>Vertebra 28    | 44 | Cd4  | 17.46 | 16.94 | 13.75 |
| 04/45 | 120 | Caudal<br>Vertebra 29    | 45 | Cd4  | 16.39 | 16.78 | 13.33 |
| 04/45 | 120 | Caudal<br>Vertebra 30    | 46 | Cd4  | 15.52 | 16.68 | 12.71 |
| 04/45 | 120 | Caudal<br>Vertebra 31    | 47 | Cd4  | 15    | 16.66 | 13.04 |
| 04/45 | 120 | Caudal<br>Vertebra 32    | 48 | Dist | 14.12 | 16.34 | 12.62 |
| 04/45 | 120 | Penultimate<br>Vertebra  | 49 | Dist | 13.48 | 15.22 | 12.38 |
| 04/91 | 158 | Atlas                    | 1  | Prox | 23.94 | 21.89 |       |
| 04/91 | 158 | Axis                     | 2  | Prox |       |       |       |
| 04/91 | 158 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 21.89 | 24.69 | 13.11 |
| 04/91 | 158 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 22.86 | 24.25 | 13.77 |
| 04/91 | 158 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 23.65 | 25.22 | 14.01 |
| 04/91 | 158 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 22.61 | 24.56 | 15.28 |
| 04/91 | 158 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 22.78 | 25.11 | 16.78 |
| 04/91 | 158 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 23.46 | 24.94 | 17.85 |
| 04/91 | 158 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 23.35 | 24.99 | 18.29 |
| 04/91 | 158 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 23.75 | 25.29 | 19.31 |
| 04/91 | 158 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 23.83 | 25.22 | 19.55 |
| 04/91 | 158 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 24.35 | 25.61 | 19.4  |
| 04/91 | 158 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 24.51 | 26.2  | 19.91 |
| 04/91 | 158 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 25.66 | 26.49 | 20.65 |
| 04/91 | 158 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 25.68 | 27.33 | 20.92 |
| 04/91 | 158 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 25.48 | 27.27 | 19.03 |
| 04/91 | 158 | Caudal<br>Vertebra 1     | 17 | Cd1  | 24.67 | 27.34 | 18.62 |
| 04/91 | 158 | Caudal<br>Vertebra 2     | 18 | Cd1  | 25.37 | 26.69 | 16.81 |
| 04/91 | 158 | Caudal<br>Vertebra 3     | 19 | Cd1  | 25.35 | 27.49 | 18.11 |
| 04/91 | 158 | Caudal<br>Vertebra 4     | 20 | Cd1  | 26.59 | 27.02 | 18.47 |
| 04/91 | 158 | Caudal<br>Vertebra 5     | 21 | Cd1  |       |       | 19.16 |
| 04/91 | 158 | Caudal<br>Vertebra 6     | 22 | Cd1  | 26.26 | 28.01 | 18.68 |

|       |     |                         |    |      |       |       |       |
|-------|-----|-------------------------|----|------|-------|-------|-------|
| 04/91 | 158 | Caudal<br>Vertebra 7    | 23 | Cd1  | 25.93 | 27.7  | 19.78 |
| 04/91 | 158 | Caudal<br>Vertebra 8    | 24 | Cd1  | 26.12 | 27.72 | 19.86 |
| 04/91 | 158 | Caudal<br>Vertebra 9    | 25 | Cd1  | 25.97 | 27.52 | 19.42 |
| 04/91 | 158 | Caudal<br>Vertebra 10   | 26 | Cd1  | 25.99 | 26.48 | 20.49 |
| 04/91 | 158 | Caudal<br>Vertebra 11   | 27 | Cd2  | 25.78 | 27.08 | 20.85 |
| 04/91 | 158 | Caudal<br>Vertebra 12   | 28 | Cd2  | 25.85 | 27.23 | 20.26 |
| 04/91 | 158 | Caudal<br>Vertebra 13   | 29 | Cd2  | 26.13 | 27.11 | 20.83 |
| 04/91 | 158 | Caudal<br>Vertebra 14   | 30 | Cd2  | 26.18 | 26.18 | 21.23 |
| 04/91 | 158 | Caudal<br>Vertebra 15   | 31 | Cd2  | 25.88 | 25.74 | 22.42 |
| 04/91 | 158 | Caudal<br>Vertebra 16   | 32 | Cd2  | 26.45 | 25.83 | 22.15 |
| 04/91 | 158 | Caudal<br>Vertebra 17   | 33 | Cd2  | 26.03 | 26.11 | 21.51 |
| 04/91 | 158 | Caudal<br>Vertebra 18   | 34 | Cd2  | 26.39 | 26.01 | 23.31 |
| 04/91 | 158 | Caudal<br>Vertebra 19   | 35 | Cd2  | 25.93 | 26.37 | 23.29 |
| 04/91 | 158 | Caudal<br>Vertebra 20   | 36 | Cd2  | 26.12 | 26.89 | 23.92 |
| 04/91 | 158 | Caudal<br>Vertebra 21   | 37 | Cd3  | 25.49 | 26.17 | 23.27 |
| 04/91 | 158 | Caudal<br>Vertebra 22   | 38 | Cd3  | 25.69 | 25.75 | 24.01 |
| 04/91 | 158 | Caudal<br>Vertebra 23   | 39 | Cd3  | 26.13 | 25.32 | 23.82 |
| 04/91 | 158 | Caudal<br>Vertebra 24   | 40 | Cd3  | 25.12 | 25.52 | 23.84 |
| 04/91 | 158 | Caudal<br>Vertebra 25   | 41 | Cd3  | 24.8  | 24.31 | 22.86 |
| 04/91 | 158 | Caudal<br>Vertebra 26   | 42 | Cd3  | 23.54 | 23.1  | 20.72 |
| 04/91 | 158 | Caudal<br>Vertebra 27   | 43 | Cd4  | 23.93 | 23.82 | 22.02 |
| 04/91 | 158 | Caudal<br>Vertebra 28   | 44 | Cd4  | 22.95 | 22.81 | 19.31 |
| 04/91 | 158 | Caudal<br>Vertebra 29   | 45 | Cd4  | 21.78 | 22.55 | 18.53 |
| 04/91 | 158 | Caudal<br>Vertebra 30   | 46 | Cd4  | 20.33 | 22.15 | 17.16 |
| 04/91 | 158 | Caudal<br>Vertebra 31   | 47 | Cd4  | 19.32 | 22.16 | 17.63 |
| 04/91 | 158 | Caudal<br>Vertebra 32   | 48 | Dist | 17.77 | 21.25 | 17.47 |
| 04/91 | 158 | Penultimate<br>Vertebra | 49 | Dist | 17.64 | 19.07 | 17.65 |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 04/40 | 163 | Atlas                    | 1  | Prox | 26.14 | 26.69 | 13.36 |
| 04/40 | 163 | Axis                     | 2  | Prox | 24.59 | 27.61 | 13.95 |
| 04/40 | 163 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 25.38 | 27.26 | 14.91 |
| 04/40 | 163 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 25.16 | 28.83 | 15.9  |
| 04/40 | 163 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 25.39 | 28.1  | 17.22 |
| 04/40 | 163 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 26.2  | 27.71 | 17.17 |
| 04/40 | 163 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 26.35 | 27.67 | 17.85 |
| 04/40 | 163 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 26.64 | 27.72 | 19.66 |
| 04/40 | 163 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 26.59 | 27.29 | 20.18 |
| 04/40 | 163 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 26.78 | 28.72 | 21.09 |
| 04/40 | 163 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 27.95 | 29.08 | 22.5  |
| 04/40 | 163 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 28.13 | 29.32 | 22.04 |
| 04/40 | 163 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 29.08 | 28.91 | 22.45 |
| 04/40 | 163 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 29.76 | 27.42 | 21.65 |
| 04/40 | 163 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 30.23 | 30.68 | 22.29 |
| 04/40 | 163 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 30.11 | 30.06 | 20.9  |
| 04/40 | 163 | Caudal<br>Vertebra 1     | 17 | Cd1  | 29.15 | 28.99 | 20.4  |
| 04/40 | 163 | Caudal<br>Vertebra 2     | 18 | Cd1  | 30.54 | 28.13 | 19.66 |
| 04/40 | 163 | Caudal<br>Vertebra 3     | 19 | Cd1  | 31.27 | 29.51 | 18.41 |
| 04/40 | 163 | Caudal<br>Vertebra 4     | 20 | Cd1  | 31.19 | 29.32 | 18.72 |
| 04/40 | 163 | Caudal<br>Vertebra 5     | 21 | Cd1  | 30.37 | 28.79 | 19.48 |
| 04/40 | 163 | Caudal<br>Vertebra 6     | 22 | Cd1  | 30.51 | 30.15 | 19.3  |
| 04/40 | 163 | Caudal<br>Vertebra 7     | 23 | Cd1  | 30.21 | 29.42 | 19.78 |
| 04/40 | 163 | Caudal<br>Vertebra 8     | 24 | Cd1  | 30.52 | 30.12 | 19.21 |
| 04/40 | 163 | Caudal<br>Vertebra 9     | 25 | Cd1  | 29.97 | 30.46 | 20.71 |
| 04/40 | 163 | Caudal<br>Vertebra 10    | 26 | Cd1  | 29.72 | 31.7  | 20.18 |
| 04/40 | 163 | Caudal<br>Vertebra 11    | 27 | Cd2  | 29.79 | 30.95 | 21.3  |
| 04/40 | 163 | Caudal<br>Vertebra 12    | 28 | Cd2  | 29.37 | 30.91 | 21.21 |

|       |     |                         |    |      |       |       |       |
|-------|-----|-------------------------|----|------|-------|-------|-------|
| 04/40 | 163 | Caudal<br>Vertebra 13   | 29 | Cd2  | 30.02 | 31.04 | 21.25 |
| 04/40 | 163 | Caudal<br>Vertebra 14   | 30 | Cd2  | 29.59 | 30.62 | 21.45 |
| 04/40 | 163 | Caudal<br>Vertebra 15   | 31 | Cd2  | 29.75 | 30.87 | 22.52 |
| 04/40 | 163 | Caudal<br>Vertebra 16   | 32 | Cd2  | 29.8  | 30.56 | 21.35 |
| 04/40 | 163 | Caudal<br>Vertebra 17   | 33 | Cd2  | 29.38 | 29.84 | 22.76 |
| 04/40 | 163 | Caudal<br>Vertebra 18   | 34 | Cd2  | 29.63 | 29.27 | 22.3  |
| 04/40 | 163 | Caudal<br>Vertebra 19   | 35 | Cd2  | 30.21 | 30.58 | 23.18 |
| 04/40 | 163 | Caudal<br>Vertebra 20   | 36 | Cd2  | 29.85 | 29.54 | 23.43 |
| 04/40 | 163 | Caudal<br>Vertebra 21   | 37 | Cd3  | 29.14 | 28.97 | 23.36 |
| 04/40 | 163 | Caudal<br>Vertebra 22   | 38 | Cd3  | 29.34 | 27.73 | 23.23 |
| 04/40 | 163 | Caudal<br>Vertebra 23   | 39 | Cd3  | 29.51 | 28.69 | 24.61 |
| 04/40 | 163 | Caudal<br>Vertebra 24   | 40 | Cd3  | 27.42 | 28.02 | 21.94 |
| 04/40 | 163 | Caudal<br>Vertebra 25   | 41 | Cd3  | 28.04 | 28.29 | 23.79 |
| 04/40 | 163 | Caudal<br>Vertebra 26   | 42 | Cd3  | 26.99 | 27.64 | 20.4  |
| 04/40 | 163 | Caudal<br>Vertebra 27   | 43 | Cd4  | 26.11 | 27.15 | 19.2  |
| 04/40 | 163 | Caudal<br>Vertebra 28   | 44 | Cd4  | 24.47 | 26.19 | 17.9  |
| 04/40 | 163 | Caudal<br>Vertebra 29   | 45 | Cd4  | 23.34 | 24.81 | 17.41 |
| 04/40 | 163 | Caudal<br>Vertebra 30   | 46 | Cd4  | 22.01 | 24.72 | 16.5  |
| 04/40 | 163 | Caudal<br>Vertebra 31   | 47 | Cd4  | 20.73 | 24    | 16.01 |
| 04/40 | 163 | Caudal<br>Vertebra 32   | 48 | Dist | 19.59 | 23.51 | 16.1  |
| 04/40 | 163 | Penultimate<br>Vertebra | 49 | Dist | 19.3  | 20.64 | 14.95 |
| 04/55 | 122 | Atlas                   | 1  | Prox | 19.28 | 17.22 | 10    |
| 04/55 | 122 | Axis                    | 2  | Prox | 17.85 | 18.92 | 9.85  |
| 04/55 | 122 | Abdominal<br>Vertebra 3 | 3  | Ab1  | 17.61 | 19.85 | 10.5  |
| 04/55 | 122 | Abdominal<br>Vertebra 4 | 4  | Ab1  | 17.66 | 19.87 |       |
| 04/55 | 122 | Abdominal<br>Vertebra 5 | 5  | Ab1  | 18.18 | 19.29 | 11.93 |
| 04/55 | 122 | Abdominal<br>Vertebra 6 | 6  | Ab1  | 18.53 | 19.39 | 11.87 |
| 04/55 | 122 | Abdominal<br>Vertebra 7 | 7  | Ab1  | 18.47 | 19.82 | 13.01 |

|       |     |                          |    |     |       |       |       |
|-------|-----|--------------------------|----|-----|-------|-------|-------|
| 04/55 | 122 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 18.77 | 20.07 | 13.55 |
| 04/55 | 122 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 18.81 | 19.97 |       |
| 04/55 | 122 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 19.15 | 20.19 | 15.2  |
| 04/55 | 122 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 19.45 | 20.62 | 15.63 |
| 04/55 | 122 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 19.53 | 20.37 | 15.64 |
| 04/55 | 122 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 20.19 | 19.95 | 15.77 |
| 04/55 | 122 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 20.18 | 20.85 | 16.28 |
| 04/55 | 122 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 19.85 | 21.21 | 16.1  |
| 04/55 | 122 | Caudal<br>Vertebra 1     | 16 | Cd1 | 20.47 | 21.24 | 15.1  |
| 04/55 | 122 | Caudal<br>Vertebra 2     | 17 | Cd1 | 20.48 | 19.59 | 15    |
| 04/55 | 122 | Caudal<br>Vertebra 3     | 18 | Cd1 | 21.1  | 21.28 | 16.03 |
| 04/55 | 122 | Caudal<br>Vertebra 4     | 19 | Cd1 | 20.93 | 20.31 | 15.54 |
| 04/55 | 122 | Caudal<br>Vertebra 5     | 20 | Cd1 | 21.41 | 21.93 | 16.52 |
| 04/55 | 122 | Caudal<br>Vertebra 6     | 21 | Cd1 | 20.59 | 21.57 | 15.88 |
| 04/55 | 122 | Caudal<br>Vertebra 7     | 22 | Cd1 | 21.03 | 22.21 | 17.32 |
| 04/55 | 122 | Caudal<br>Vertebra 8     | 23 | Cd1 | 20.91 | 21.75 | 16.72 |
| 04/55 | 122 | Caudal<br>Vertebra 9     | 24 | Cd1 | 20.78 | 21.71 | 16.28 |
| 04/55 | 122 | Caudal<br>Vertebra 10    | 25 | Cd1 | 20.75 | 21.82 | 16.73 |
| 04/55 | 122 | Caudal<br>Vertebra 11    | 26 | Cd2 | 20.93 | 22.21 | 17.35 |
| 04/55 | 122 | Caudal<br>Vertebra 12    | 27 | Cd2 | 21.08 | 22.01 | 17.19 |
| 04/55 | 122 | Caudal<br>Vertebra 13    | 28 | Cd2 | 21.3  | 21.67 | 17.38 |
| 04/55 | 122 | Caudal<br>Vertebra 14    | 29 | Cd2 | 21.46 | 21.89 | 17.7  |
| 04/55 | 122 | Caudal<br>Vertebra 15    | 30 | Cd2 | 21.07 | 22.77 | 17.62 |
| 04/55 | 122 | Caudal<br>Vertebra 16    | 31 | Cd2 | 21.36 | 22.23 | 18.14 |
| 04/55 | 122 | Caudal<br>Vertebra 17    | 32 | Cd2 | 21.64 | 22.59 | 18.82 |
| 04/55 | 122 | Caudal<br>Vertebra 18    | 33 | Cd2 | 21.5  | 22.49 | 19.68 |
| 04/55 | 122 | Caudal<br>Vertebra 19    | 34 | Cd2 | 21.82 | 22    | 19.42 |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 04/55 | 122 | Caudal<br>Vertebra 20    | 35 | Cd2  | 21.5  | 22.04 | 17.59 |
| 04/55 | 122 | Caudal<br>Vertebra 21    | 36 | Cd3  | 21.24 | 22.83 | 18.14 |
| 04/55 | 122 | Caudal<br>Vertebra 22    | 37 | Cd3  | 20.96 | 21.59 | 19.7  |
| 04/55 | 122 | Caudal<br>Vertebra 23    | 38 | Cd3  | 21.22 | 21.47 | 19.87 |
| 04/55 | 122 | Caudal<br>Vertebra 24    | 39 | Cd3  | 21.15 | 20.83 | 19.35 |
| 04/55 | 122 | Caudal<br>Vertebra 25    | 40 | Cd3  | 20.6  | 20.69 | 18.52 |
| 04/55 | 122 | Caudal<br>Vertebra 26    | 41 | Cd3  | 20.08 | 19.66 | 17.68 |
| 04/55 | 122 | Caudal<br>Vertebra 27    | 42 | Cd4  | 19.18 | 18.56 | 16.28 |
| 04/55 | 122 | Caudal<br>Vertebra 28    | 43 | Cd4  | 18.73 | 18.54 | 15.55 |
| 04/55 | 122 | Caudal<br>Vertebra 29    | 44 | Cd4  | 17.68 | 17.92 | 15.4  |
| 04/55 | 122 | Caudal<br>Vertebra 30    | 45 | Cd4  | 17.01 | 17.4  | 14.42 |
| 04/55 | 122 | Caudal<br>Vertebra 31    | 46 | Cd4  | 15.99 | 16.8  | 13.77 |
| 04/55 | 122 | Caudal<br>Vertebra 32    | 47 | Cd4  | 14.87 | 17.52 | 13.38 |
| 04/55 | 122 | Caudal<br>Vertebra 33    | 48 | Dist | 14.44 | 16.95 | 12.06 |
| 04/55 | 122 | Penultimate<br>Vertebra  | 49 | Dist | 13.69 | 15.71 | 10.42 |
| 04/54 | 78  | Atlas                    | 1  | Prox | 12.31 | 11.37 | 6.96  |
| 04/54 | 78  | Axis                     | 2  | Prox | 12.38 | 12.24 | 6.76  |
| 04/54 | 78  | Abdominal<br>Vertebra 3  | 3  | Ab1  | 12.38 | 12.74 | 7.65  |
| 04/54 | 78  | Abdominal<br>Vertebra 4  | 4  | Ab1  | 12.5  | 12.58 | 7.86  |
| 04/54 | 78  | Abdominal<br>Vertebra 5  | 5  | Ab1  | 12.33 | 12.09 | 8     |
| 04/54 | 78  | Abdominal<br>Vertebra 6  | 6  | Ab1  | 12.14 | 12.57 | 8.21  |
| 04/54 | 78  | Abdominal<br>Vertebra 7  | 7  | Ab1  | 12.27 | 12.42 | 8.9   |
| 04/54 | 78  | Abdominal<br>Vertebra 8  | 8  | Ab1  | 12.57 | 12.2  | 9.4   |
| 04/54 | 78  | Abdominal<br>Vertebra 9  | 9  | Ab1  | 12.29 | 12.28 | 9.79  |
| 04/54 | 78  | Abdominal<br>Vertebra 10 | 10 | Ab2  | 12.92 | 12.94 | 10.65 |
| 04/54 | 78  | Abdominal<br>Vertebra 11 | 11 | Ab2  | 12.87 | 12.63 | 10.1  |
| 04/54 | 78  | Abdominal<br>Vertebra 12 | 12 | Ab2  | 12.86 | 12.67 | 10.45 |
| 04/54 | 78  | Abdominal<br>Vertebra 13 | 13 | Ab2  | 13.8  | 13.15 | 10.97 |

|       |    |                          |    |     |       |       |       |
|-------|----|--------------------------|----|-----|-------|-------|-------|
| 04/54 | 78 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 13.39 | 12.57 | 10.69 |
| 04/54 | 78 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 13.65 | 12.83 | 10.92 |
| 04/54 | 78 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 14.17 | 13.19 | 10.62 |
| 04/54 | 78 | Caudal<br>Vertebra 1     | 17 | Cd1 | 14.22 | 12.96 | 10.32 |
| 04/54 | 78 | Caudal<br>Vertebra 2     | 18 | Cd1 | 14.24 | 13.65 | 9.65  |
| 04/54 | 78 | Caudal<br>Vertebra 3     | 19 | Cd1 | 14.28 | 13.66 | 10.06 |
| 04/54 | 78 | Caudal<br>Vertebra 4     | 20 | Cd1 | 14.15 | 14.01 | 10.26 |
| 04/54 | 78 | Caudal<br>Vertebra 5     | 21 | Cd1 | 13.99 | 14.3  | 10.05 |
| 04/54 | 78 | Caudal<br>Vertebra 6     | 22 | Cd1 | 13.72 | 14.17 | 10.66 |
| 04/54 | 78 | Caudal<br>Vertebra 7     | 23 | Cd1 | 14.05 | 14.33 | 10.67 |
| 04/54 | 78 | Caudal<br>Vertebra 8     | 24 | Cd1 | 13.7  | 14.24 | 10.94 |
| 04/54 | 78 | Caudal<br>Vertebra 9     | 25 | Cd1 | 13.97 | 14.24 | 10.95 |
| 04/54 | 78 | Caudal<br>Vertebra 10    | 26 | Cd1 | 13.78 | 14.25 | 11.33 |
| 04/54 | 78 | Caudal<br>Vertebra 11    | 27 | Cd2 | 14.04 | 14.13 | 11.14 |
| 04/54 | 78 | Caudal<br>Vertebra 12    | 28 | Cd2 | 14.4  | 14.65 | 11.26 |
| 04/54 | 78 | Caudal<br>Vertebra 13    | 29 | Cd2 | 14.32 | 14.55 | 11.38 |
| 04/54 | 78 | Caudal<br>Vertebra 14    | 30 | Cd2 | 14.16 | 14.53 | 11.4  |
| 04/54 | 78 | Caudal<br>Vertebra 15    | 31 | Cd2 | 14.54 | 14.3  | 11.77 |
| 04/54 | 78 | Caudal<br>Vertebra 16    | 32 | Cd2 | 14.13 | 14.56 | 12.05 |
| 04/54 | 78 | Caudal<br>Vertebra 17    | 33 | Cd2 | 14.01 | 14.21 | 12.07 |
| 04/54 | 78 | Caudal<br>Vertebra 18    | 34 | Cd2 | 14.42 | 14.18 | 12.37 |
| 04/54 | 78 | Caudal<br>Vertebra 19    | 35 | Cd2 | 14.5  | 14.03 | 12.39 |
| 04/54 | 78 | Caudal<br>Vertebra 20    | 36 | Cd2 | 13.93 | 14.16 | 12.65 |
| 04/54 | 78 | Caudal<br>Vertebra 21    | 37 | Cd3 | 14.09 | 14.13 | 12.65 |
| 04/54 | 78 | Caudal<br>Vertebra 22    | 38 | Cd3 | 13.73 | 14.17 | 12.88 |
| 04/54 | 78 | Caudal<br>Vertebra 23    | 39 | Cd3 | 13.36 | 13.62 | 13.05 |
| 04/54 | 78 | Caudal<br>Vertebra 24    | 40 | Cd3 | 13.79 | 13.38 | 12.69 |

|       |    |                          |    |      |       |       |       |
|-------|----|--------------------------|----|------|-------|-------|-------|
| 04/54 | 78 | Caudal<br>Vertebra 25    | 41 | Cd3  | 13.41 | 13.53 | 12.44 |
| 04/54 | 78 | Caudal<br>Vertebra 26    | 42 | Cd3  | 13.19 | 13.38 | 11.78 |
| 04/54 | 78 | Caudal<br>Vertebra 27    | 43 | Cd4  | 12.83 | 12.66 | 10.71 |
| 04/54 | 78 | Caudal<br>Vertebra 28    | 44 | Cd4  | 11.16 | 11.93 | 9.58  |
| 04/54 | 78 | Caudal<br>Vertebra 29    | 45 | Cd4  | 12.52 | 12.07 | 10.32 |
| 04/54 | 78 | Caudal<br>Vertebra 30    | 46 | Cd4  | 10.78 | 11.43 | 9.22  |
| 04/54 | 78 | Caudal<br>Vertebra 31    | 47 | Cd4  | 11.87 | 12.08 | 9.97  |
| 04/54 | 78 | Caudal<br>Vertebra 32    | 48 | Cd4  | 10.67 | 11.39 | 8.5   |
| 04/54 | 78 | Caudal<br>Vertebra 33    | 49 | Dist | 10.04 | 10.9  | 8.28  |
| 04/54 | 78 | Penultimate<br>Vertebra  | 50 | Dist | 9.4   | 9.69  | 8.11  |
| 04/56 | 90 | Atlas                    | 1  | Prox | 12.86 | 14.14 | 7.33  |
| 04/56 | 90 | Axis                     | 2  | Prox | 13.84 | 12.2  | 7.39  |
| 04/56 | 90 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 13.15 | 13.43 | 6.79  |
| 04/56 | 90 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 12.89 | 13.9  | 7.65  |
| 04/56 | 90 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 12.6  | 13.42 | 7.95  |
| 04/56 | 90 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 13.01 | 13.53 | 8.09  |
| 04/56 | 90 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 12.77 | 13.19 | 8.75  |
| 04/56 | 90 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 12.62 | 13.6  | 9.4   |
| 04/56 | 90 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 12.95 | 13.86 | 9.93  |
| 04/56 | 90 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 13.07 | 13.98 | 10.17 |
| 04/56 | 90 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 13.38 | 13.82 | 10.76 |
| 04/56 | 90 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 13.79 | 13.96 | 11.03 |
| 04/56 | 90 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 13.85 | 13.85 | 11.21 |
| 04/56 | 90 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 13.97 | 13.63 | 11.07 |
| 04/56 | 90 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 14.02 | 13.63 | 11.57 |
| 04/56 | 90 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 14.1  | 13.59 | 11.08 |
| 04/56 | 90 | Caudal<br>Vertebra 1     | 17 | Cd1  | 14.11 | 13.36 | 10.48 |
| 04/56 | 90 | Caudal<br>Vertebra 2     | 18 | Cd1  | 14.36 | 13.07 | 10.17 |

|       |    |                       |    |     |       |       |       |
|-------|----|-----------------------|----|-----|-------|-------|-------|
| 04/56 | 90 | Caudal<br>Vertebra 3  | 19 | Cd1 | 14.84 | 13.58 | 10.55 |
| 04/56 | 90 | Caudal<br>Vertebra 4  | 20 | Cd1 | 14.47 | 14.57 | 11.12 |
| 04/56 | 90 | Caudal<br>Vertebra 5  | 21 | Cd1 | 14.87 | 14.68 | 10.91 |
| 04/56 | 90 | Caudal<br>Vertebra 6  | 22 | Cd1 | 14.44 | 15.24 | 11.25 |
| 04/56 | 90 | Caudal<br>Vertebra 7  | 23 | Cd1 | 14.72 | 14.13 | 10.53 |
| 04/56 | 90 | Caudal<br>Vertebra 8  | 24 | Cd1 | 14.42 | 15.15 | 11.3  |
| 04/56 | 90 | Caudal<br>Vertebra 9  | 25 | Cd1 | 14.5  | 15.2  | 11.24 |
| 04/56 | 90 | Caudal<br>Vertebra 10 | 26 | Cd1 | 14.42 | 14.95 |       |
| 04/56 | 90 | Caudal<br>Vertebra 11 | 27 | Cd2 | 14.53 | 15.38 | 11.45 |
| 04/56 | 90 | Caudal<br>Vertebra 12 | 28 | Cd2 | 14.37 | 15.39 | 11.7  |
| 04/56 | 90 | Caudal<br>Vertebra 13 | 29 | Cd2 | 14.53 | 15.34 | 11.44 |
| 04/56 | 90 | Caudal<br>Vertebra 14 | 30 | Cd2 | 14.5  | 15.15 | 11.91 |
| 04/56 | 90 | Caudal<br>Vertebra 15 | 31 | Cd2 | 14.33 | 15.05 | 11.98 |
| 04/56 | 90 | Caudal<br>Vertebra 16 | 32 | Cd2 | 14.39 | 14.55 | 12.07 |
| 04/56 | 90 | Caudal<br>Vertebra 17 | 33 | Cd2 | 14.73 | 14.74 | 12.46 |
| 04/56 | 90 | Caudal<br>Vertebra 18 | 34 | Cd2 | 14.47 | 14.67 | 12.27 |
| 04/56 | 90 | Caudal<br>Vertebra 19 | 35 | Cd2 | 14.31 | 14.46 | 12.95 |
| 04/56 | 90 | Caudal<br>Vertebra 20 | 36 | Cd2 | 14.53 | 14.51 | 12.48 |
| 04/56 | 90 | Caudal<br>Vertebra 21 | 37 | Cd3 | 14.13 | 14.32 | 12.91 |
| 04/56 | 90 | Caudal<br>Vertebra 22 | 38 | Cd3 | 14.22 | 14.45 | 12.85 |
| 04/56 | 90 | Caudal<br>Vertebra 23 | 39 | Cd3 | 13.89 | 13.88 | 12.59 |
| 04/56 | 90 | Caudal<br>Vertebra 24 | 40 | Cd3 | 13.67 | 13.85 | 12.35 |
| 04/56 | 90 | Caudal<br>Vertebra 25 | 41 | Cd3 | 13.12 | 13.37 | 11.62 |
| 04/56 | 90 | Caudal<br>Vertebra 26 | 42 | Cd3 | 12.73 | 12.97 | 11.15 |
| 04/56 | 90 | Caudal<br>Vertebra 27 | 43 | Cd4 | 12.5  | 12.51 | 10.41 |
| 04/56 | 90 | Caudal<br>Vertebra 28 | 44 | Cd4 | 12.13 | 12.27 | 10.55 |
| 04/56 | 90 | Caudal<br>Vertebra 29 | 45 | Cd4 | 11.57 | 12    | 10.05 |

|       |     |                          |    |      |       |       |       |
|-------|-----|--------------------------|----|------|-------|-------|-------|
| 04/56 | 90  | Caudal<br>Vertebra 30    | 46 | Cd4  | 11.12 | 11.62 | 9.52  |
| 04/56 | 90  | Caudal<br>Vertebra 31    | 47 | Cd4  | 10.64 | 11.6  | 9.37  |
| 04/56 | 90  | Caudal<br>Vertebra 32    | 48 | Dist | 10.14 | 11.19 | 8.92  |
| 04/56 | 90  | Penultimate<br>Vertebra  | 49 | Dist | 9.99  | 10.16 | 8.03  |
| 04/41 | 125 | Atlas                    | 1  | Prox | 17.37 | 16.09 |       |
| 04/41 | 125 | Axis                     | 2  | Prox |       |       |       |
| 04/41 | 125 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 15.65 | 17.19 | 8.79  |
| 04/41 | 125 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.07 | 17.58 | 9.67  |
| 04/41 | 125 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 16.26 | 17.1  | 10.63 |
| 04/41 | 125 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.7  | 16.93 | 11.2  |
| 04/41 | 125 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 17.12 | 17.47 | 12.15 |
| 04/41 | 125 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 17.23 | 17.68 | 12.61 |
| 04/41 | 125 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.32 | 17.93 | 14.67 |
| 04/41 | 125 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.05 | 17.82 | 13.59 |
| 04/41 | 125 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 19.11 | 18.4  | 14.95 |
| 04/41 | 125 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 18.26 | 18.83 | 15.17 |
| 04/41 | 125 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 20.11 | 18.5  | 15.64 |
| 04/41 | 125 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 20.67 | 18.66 | 15.64 |
| 04/41 | 125 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 20.6  | 18.15 | 15.5  |
| 04/41 | 125 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 20.73 | 19.14 | 13.99 |
| 04/41 | 125 | Caudal<br>Vertebra 1     | 17 | Cd1  | 18.93 | 19.57 | 13.88 |
| 04/41 | 125 | Caudal<br>Vertebra 2     | 18 | Cd1  | 21.02 | 19.35 | 14.45 |
| 04/41 | 125 | Caudal<br>Vertebra 3     | 19 | Cd1  | 20.04 | 19.83 | 13.54 |
| 04/41 | 125 | Caudal<br>Vertebra 4     | 20 | Cd1  | 20.64 | 19.8  | 13.94 |
| 04/41 | 125 | Caudal<br>Vertebra 5     | 21 | Cd1  | 20.7  | 20.04 | 13.71 |
| 04/41 | 125 | Caudal<br>Vertebra 6     | 22 | Cd1  | 20.91 | 19.87 | 15.32 |
| 04/41 | 125 | Caudal<br>Vertebra 7     | 23 | Cd1  | 20.84 | 20.22 | 14.78 |
| 04/41 | 125 | Caudal<br>Vertebra 8     | 24 | Cd1  | 20.78 | 19.82 | 14.87 |

|        |     |                         |    |      |       |       |       |
|--------|-----|-------------------------|----|------|-------|-------|-------|
| 04/41  | 125 | Caudal<br>Vertebra 9    | 25 | Cd1  | 20.73 | 19.77 | 15.58 |
| 04/41  | 125 | Caudal<br>Vertebra 10   | 26 | Cd1  | 21.26 | 19.77 | 15.88 |
| 04/41  | 125 | Caudal<br>Vertebra 11   | 27 | Cd2  | 20.74 | 20.41 | 16.07 |
| 04/41  | 125 | Caudal<br>Vertebra 12   | 28 | Cd2  | 21.27 | 20.07 | 16.02 |
| 04/41  | 125 | Caudal<br>Vertebra 13   | 29 | Cd2  | 21.16 | 19.61 | 16.02 |
| 04/41  | 125 | Caudal<br>Vertebra 14   | 30 | Cd2  | 21.15 | 19.37 | 16.91 |
| 04/41  | 125 | Caudal<br>Vertebra 15   | 31 | Cd2  | 21.01 | 19.17 | 16.02 |
| 04/41  | 125 | Caudal<br>Vertebra 16   | 32 | Cd2  | 22.1  | 20.16 | 16.37 |
| 04/41  | 125 | Caudal<br>Vertebra 17   | 33 | Cd2  | 21.59 | 19.83 | 17.25 |
| 04/41  | 125 | Caudal<br>Vertebra 18   | 34 | Cd2  | 21.6  | 19.38 | 17.45 |
| 04/41  | 125 | Caudal<br>Vertebra 19   | 35 | Cd2  | 21.35 | 18.96 | 17.77 |
| 04/41  | 125 | Caudal<br>Vertebra 20   | 36 | Cd2  | 21.26 | 19    | 18.22 |
| 04/41  | 125 | Caudal<br>Vertebra 21   | 37 | Cd3  | 21.58 | 18.53 | 18.7  |
| 04/41  | 125 | Caudal<br>Vertebra 22   | 38 | Cd3  | 21.4  | 19.29 | 18    |
| 04/41  | 125 | Caudal<br>Vertebra 23   | 39 | Cd3  | 20.97 | 19.51 | 18.59 |
| 04/41  | 125 | Caudal<br>Vertebra 24   | 40 | Cd3  | 20.31 | 18.44 | 18.12 |
| 04/41  | 125 | Caudal<br>Vertebra 25   | 41 | Cd3  | 19.89 | 18.81 | 17.52 |
| 04/41  | 125 | Caudal<br>Vertebra 26   | 42 | Cd3  | 19.76 | 17.36 | 16.62 |
| 04/41  | 125 | Caudal<br>Vertebra 27   | 43 | Cd4  | 18.69 | 16.73 | 15.24 |
| 04/41  | 125 | Caudal<br>Vertebra 28   | 44 | Cd4  | 17.65 | 15.39 | 14.34 |
| 04/41  | 125 | Caudal<br>Vertebra 29   | 45 | Cd4  | 16.81 | 14.68 | 14.39 |
| 04/41  | 125 | Caudal<br>Vertebra 30   | 46 | Cd4  | 15.82 | 15.16 | 13.67 |
| 04/41  | 125 | Caudal<br>Vertebra 31   | 47 | Cd4  | 14.86 | 15.31 | 13.15 |
| 04/41  | 125 | Caudal<br>Vertebra 32   | 48 | Dist | 13.88 | 15.79 | 13.12 |
| 04/41  | 125 | Penultimate<br>Vertebra | 49 | Dist | 13.32 | 14.73 | 11.76 |
| 17/117 | 99  | Atlas                   | 1  | Prox | 14.39 | 13.7  | 7.61  |
| 17/117 | 99  | Axis                    | 2  | Prox | 14.07 | 14.29 | 7.28  |
| 17/117 | 99  | Abdominal<br>Vertebra 3 | 3  | Ab1  | 13.96 | 14.7  | 8     |

|        |    |                          |    |     |       |       |       |
|--------|----|--------------------------|----|-----|-------|-------|-------|
| 17/117 | 99 | Abdominal<br>Vertebra 4  | 4  | Ab1 | 13.88 | 14.34 | 8.69  |
| 17/117 | 99 | Abdominal<br>Vertebra 5  | 5  | Ab1 | 13.89 | 14.99 | 8.48  |
| 17/117 | 99 | Abdominal<br>Vertebra 6  | 6  | Ab1 | 14.17 | 14.3  | 9.03  |
| 17/117 | 99 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 14.36 | 14.08 | 9.3   |
| 17/117 | 99 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 14.14 | 14.19 | 9.57  |
| 17/117 | 99 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 15.09 | 14.33 | 9.85  |
| 17/117 | 99 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 15.44 | 14.91 | 11.05 |
| 17/117 | 99 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 15.01 | 14.2  | 11.56 |
| 17/117 | 99 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 14.47 | 14.64 | 10.76 |
| 17/117 | 99 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 15.49 | 14.6  | 11.63 |
| 17/117 | 99 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 15.6  | 14.84 | 12.07 |
| 17/117 | 99 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 15.5  | 14.29 | 11.75 |
| 17/117 | 99 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 15.7  | 14.42 | 11.05 |
| 17/117 | 99 | Caudal<br>Vertebra 1     | 17 | Cd1 | 15.65 | 15.43 | 10.72 |
| 17/117 | 99 | Caudal<br>Vertebra 2     | 18 | Cd1 | 15.99 | 15.28 | 9.84  |
| 17/117 | 99 | Caudal<br>Vertebra 3     | 19 | Cd1 | 16.3  | 15.75 | 10.95 |
| 17/117 | 99 | Caudal<br>Vertebra 4     | 20 | Cd1 | 15.96 | 15.63 | 10.31 |
| 17/117 | 99 | Caudal<br>Vertebra 5     | 21 | Cd1 | 15.64 | 16.32 | 11.19 |
| 17/117 | 99 | Caudal<br>Vertebra 6     | 22 | Cd1 | 15.7  | 16.13 | 10.56 |
| 17/117 | 99 | Caudal<br>Vertebra 7     | 23 | Cd1 | 15.75 | 16.23 | 11.27 |
| 17/117 | 99 | Caudal<br>Vertebra 8     | 24 | Cd1 | 16.07 | 16.53 | 11.56 |
| 17/117 | 99 | Caudal<br>Vertebra 9     | 25 | Cd1 | 16.53 | 16.24 | 11.64 |
| 17/117 | 99 | Caudal<br>Vertebra 10    | 26 | Cd1 | 16.1  | 16.19 | 11.89 |
| 17/117 | 99 | Caudal<br>Vertebra 11    | 27 | Cd2 | 16.38 | 16.23 | 12.35 |
| 17/117 | 99 | Caudal<br>Vertebra 12    | 28 | Cd2 | 16.2  | 16.73 | 11.94 |
| 17/117 | 99 | Caudal<br>Vertebra 13    | 29 | Cd2 | 15.88 | 16.62 | 12.15 |
| 17/117 | 99 | Caudal<br>Vertebra 14    | 30 | Cd2 | 16.9  | 16.34 | 13.44 |

|             |       |                         |    |      |       |       |       |
|-------------|-------|-------------------------|----|------|-------|-------|-------|
| 17/117      | 99    | Caudal<br>Vertebra 15   | 31 | Cd2  | 16.33 | 16.24 | 12.7  |
| 17/117      | 99    | Caudal<br>Vertebra 16   | 32 | Cd2  | 16.62 | 15.73 | 13.97 |
| 17/117      | 99    | Caudal<br>Vertebra 17   | 33 | Cd2  | 16.96 | 16.47 | 13.41 |
| 17/117      | 99    | Caudal<br>Vertebra 18   | 34 | Cd2  | 16.75 | 16.21 | 13.28 |
| 17/117      | 99    | Caudal<br>Vertebra 19   | 35 | Cd2  | 16.7  | 15.91 | 13.73 |
| 17/117      | 99    | Caudal<br>Vertebra 20   | 36 | Cd2  | 16.68 | 15.91 | 13.93 |
| 17/117      | 99    | Caudal<br>Vertebra 21   | 37 | Cd3  | 16.38 | 15.36 | 13.84 |
| 17/117      | 99    | Caudal<br>Vertebra 22   | 38 | Cd3  | 16    | 15.71 | 14.15 |
| 17/117      | 99    | Caudal<br>Vertebra 23   | 39 | Cd3  | 15.84 | 16.06 | 13.94 |
| 17/117      | 99    | Caudal<br>Vertebra 24   | 40 | Cd3  | 15.94 | 16.07 | 13.63 |
| 17/117      | 99    | Caudal<br>Vertebra 25   | 41 | Cd3  | 15.41 | 15.27 | 13.57 |
| 17/117      | 99    | Caudal<br>Vertebra 26   | 42 | Cd3  | 14.4  | 14.47 | 12.38 |
| 17/117      | 99    | Caudal<br>Vertebra 27   | 43 | Cd4  | 14.78 | 14.99 | 12.44 |
| 17/117      | 99    | Caudal<br>Vertebra 28   | 44 | Cd4  | 14.02 | 14.48 | 11.3  |
| 17/117      | 99    | Caudal<br>Vertebra 29   | 45 | Cd4  | 13.44 | 14.09 | 11.21 |
| 17/117      | 99    | Caudal<br>Vertebra 30   | 46 | Cd4  | 13.29 | 14.03 | 10.54 |
| 17/117      | 99    | Caudal<br>Vertebra 31   | 47 | Cd4  | 13.15 | 13.24 | 10.22 |
| 17/117      | 99    | Caudal<br>Vertebra 32   | 48 | Cd4  | 12.42 | 13.35 | 9.67  |
| 17/117      | 99    | Caudal<br>Vertebra 33   | 49 | Dist | 11.48 | 12.79 | 8.63  |
| 17/117      | 99    | Penultimate<br>Vertebra | 49 | Dist | 10.97 | 11.62 | 7.84  |
| NMML 0631bn | 28.09 | Atlas                   | 1  | Prox | 5.37  | 4.29  | 2.65  |
| NMML 0631bn | 28.09 | Axis                    | 2  | Prox | 4.92  | 4.39  | 2.4   |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 3 | 3  | Ab1  | 4.63  | 4.65  | 2.59  |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 4 | 4  | Ab1  | 4.44  | 4.69  | 2.57  |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 5 | 5  | Ab1  | 4.41  | 4.8   | 2.7   |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 6 | 6  | Ab1  | 4.49  | 4.77  | 2.98  |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 7 | 7  | Ab1  | 4.45  | 4.7   | 3.32  |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 8 | 8  | Ab1  | 4.43  | 4.63  | 3.24  |

|             |       |                          |    |     |      |      |      |
|-------------|-------|--------------------------|----|-----|------|------|------|
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 4.44 | 4.75 | 3.53 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 4.39 | 4.83 | 3.67 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 4.61 | 4.79 | 3.73 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 4.67 | 4.86 | 3.72 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 4.61 | 4.84 | 3.69 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 4.91 | 5.05 | 3.84 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 4.93 | 5.08 | 3.97 |
| NMML 0631bn | 28.09 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 4.99 | 4.98 | 3.72 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 1     | 17 | Cd1 | 5.2  | 4.97 | 3.64 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 2     | 18 | Cd1 | 5.02 | 5    | 3.4  |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 3     | 19 | Cd1 | 5.06 | 5.05 | 3.46 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 4     | 20 | Cd1 | 5.16 | 5.17 | 3.52 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 5     | 21 | Cd1 | 5.13 | 5.22 | 3.61 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 6     | 22 | Cd1 | 5.17 | 5.17 | 3.7  |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 7     | 23 | Cd1 | 5.09 | 5.13 | 3.86 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 8     | 24 | Cd1 | 5.01 | 5.11 | 3.75 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 9     | 25 | Cd1 | 5.18 | 5.03 | 3.57 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 10    | 26 | Cd1 | 5.01 | 5.08 | 3.78 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 11    | 27 | Cd2 | 5.11 | 5.18 | 3.75 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 12    | 28 | Cd2 | 4.86 | 4.93 | 3.95 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 13    | 29 | Cd2 | 4.97 | 4.79 | 3.81 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 14    | 30 | Cd2 | 4.75 | 4.88 | 4.09 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 15    | 31 | Cd2 | 4.95 | 5.03 | 3.76 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 16    | 32 | Cd2 | 4.82 | 5.06 | 4.17 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 17    | 33 | Cd2 | 4.95 | 4.99 | 4.03 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 18    | 34 | Cd2 | 4.83 | 4.91 | 4.48 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 19    | 35 | Cd2 | 4.83 | 4.89 | 4.35 |

|             |       |                          |    |      |      |      |      |
|-------------|-------|--------------------------|----|------|------|------|------|
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 20    | 36 | Cd2  | 4.66 | 4.72 | 4.53 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 21    | 37 | Cd3  | 4.71 | 4.91 | 4.67 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 22    | 38 | Cd3  | 4.54 | 4.79 | 4.43 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 23    | 39 | Cd3  | 4.61 | 4.73 | 4.4  |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 24    | 40 | Cd3  | 4.38 | 4.7  | 4.41 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 25    | 41 | Cd3  | 4.36 | 4.58 | 4.41 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 26    | 42 | Cd3  | 4.36 | 4.51 | 4.24 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 27    | 43 | Cd4  | 4.23 | 4.63 | 3.96 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 28    | 44 | Cd4  | 4.21 | 4.41 | 3.87 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 29    | 45 | Cd4  | 4.14 | 4.41 | 4.08 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 30    | 46 | Cd4  | 4.04 | 4.2  | 3.68 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 31    | 47 | Cd4  | 3.89 | 4.19 | 3.58 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 32    | 48 | Cd4  | 3.81 | 3.95 | 3.53 |
| NMML 0631bn | 28.09 | Caudal<br>Vertebra 33    | 49 | Dist | 3.72 | 3.84 | 2.95 |
| NMML 0631bn | 28.09 | Penultimate<br>Vertebrae | 50 | Dist | 3.32 | 3.54 | 2.75 |
| NMML0052bn  | 16.7  | Atlas                    | 1  | Prox | 2.81 | 2.4  | 1.53 |
| NMML0052bn  | 16.7  | Axis                     | 2  | Prox | 2.72 | 2.64 | 1.22 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 3  | 3  | Ab1  | 2.49 | 2.64 | 1.25 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 4  | 4  | Ab1  | 2.45 | 2.72 | 1.3  |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 5  | 5  | Ab1  | 2.39 | 2.71 | 1.56 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 6  | 6  | Ab1  | 2.37 | 2.68 | 1.6  |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 7  | 7  | Ab1  | 2.38 | 2.6  | 1.72 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 8  | 8  | Ab1  | 2.4  | 2.58 | 1.82 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 9  | 9  | Ab1  | 2.46 | 2.56 | 1.9  |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 10 | 10 | Ab2  | 2.52 | 2.59 | 2.07 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 11 | 11 | Ab2  | 2.53 | 2.54 | 2.01 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 12 | 12 | Ab2  | 2.57 | 2.64 | 2.07 |
| NMML0052bn  | 16.7  | Abdominal<br>Vertebra 13 | 13 | Ab2  | 2.66 | 2.7  | 2.11 |

|            |      |                          |    |     |      |      |      |
|------------|------|--------------------------|----|-----|------|------|------|
| NMML0052bn | 16.7 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 2.56 | 2.61 | 2.12 |
| NMML0052bn | 16.7 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 2.74 | 2.72 | 2.12 |
| NMML0052bn | 16.7 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 2.71 | 2.72 | 2.08 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 1     | 17 | Cd1 | 2.8  | 2.74 | 1.84 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 2     | 18 | Cd1 | 2.84 | 2.76 | 1.85 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 3     | 19 | Cd1 | 2.81 | 2.77 | 1.88 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 4     | 20 | Cd1 | 2.75 | 2.86 | 1.95 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 5     | 21 | Cd1 | 2.78 | 2.88 | 1.92 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 6     | 22 | Cd1 | 2.76 | 2.95 | 2.01 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 7     | 23 | Cd1 | 2.77 | 2.96 | 2.03 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 8     | 24 | Cd1 | 2.74 | 2.4  | 1.95 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 9     | 25 | Cd1 | 2.71 | 2.92 | 2.06 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 10    | 26 | Cd1 | 2.76 | 2.71 | 2.03 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 11    | 27 | Cd2 | 2.59 | 2.84 | 2.1  |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 12    | 28 | Cd2 | 2.75 | 2.9  | 2.06 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 13    | 29 | Cd2 | 2.73 | 2.8  | 2.09 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 14    | 30 | Cd2 | 2.82 | 2.78 | 2.15 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 15    | 31 | Cd2 | 2.65 | 2.75 | 2.17 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 16    | 32 | Cd2 | 2.61 | 2.8  | 2.23 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 17    | 33 | Cd2 | 2.64 | 2.7  | 2.17 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 18    | 34 | Cd2 | 2.57 | 2.7  | 2.34 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 19    | 35 | Cd2 | 2.54 | 2.71 | 2.41 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 20    | 36 | Cd2 | 2.53 | 2.68 | 2.38 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 21    | 37 | Cd3 | 2.48 | 2.67 | 2.47 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 22    | 38 | Cd3 | 2.47 | 2.64 | 2.47 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 23    | 39 | Cd3 | 2.47 | 2.63 | 2.48 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 24    | 40 | Cd3 | 2.37 | 2.65 | 2.51 |

|            |      |                          |    |      |      |      |      |
|------------|------|--------------------------|----|------|------|------|------|
| NMML0052bn | 16.7 | Caudal<br>Vertebra 25    | 41 | Cd3  | 2.36 | 2.49 | 2.5  |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 26    | 42 | Cd3  | 2.21 | 2.24 | 2.2  |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 27    | 43 | Cd4  | 2.27 | 2.17 | 2.19 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 28    | 44 | Cd4  | 2.33 | 2.45 | 2.41 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 29    | 45 | Cd4  | 2.29 | 2.53 | 2.43 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 30    | 46 | Cd4  | 2.28 | 2.38 | 2.39 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 31    | 47 | Cd4  | 2.23 | 2.41 | 2.35 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 32    | 48 | Cd4  | 2.1  | 2.04 | 1.96 |
| NMML0052bn | 16.7 | Caudal<br>Vertebra 33    | 49 | Dist | 2.11 | 2.03 | 1.81 |
| NMML0052bn | 16.7 | Penultimate<br>Vertebrae | 50 | Dist | 1.97 | 1.78 | 1.79 |
| NMML 043bn | 31.3 | Atlas                    | 1  | Prox | 4.72 | 4.21 | 2.81 |
| NMML 043bn | 31.3 | Axis                     | 2  | Prox | 4.64 | 4.61 | 2.34 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 4.71 | 4.77 | 2.38 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 4.49 | 4.76 | 2.55 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 4.58 | 4.71 | 2.78 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 4.57 | 4.61 | 2.94 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 4.68 | 4.59 | 3.16 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 4.68 | 4.47 | 3.39 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 4.81 | 4.43 | 3.53 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 4.76 | 4.47 | 3.65 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 4.96 | 4.52 | 3.7  |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 4.84 | 4.64 | 3.87 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 4.85 | 4.67 | 3.93 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 4.92 | 4.7  | 3.94 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 5.03 | 4.8  | 3.96 |
| NMML 043bn | 31.3 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 5.07 | 5    | 3.82 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 1     | 17 | Cd1  | 5.17 | 5.06 | 3.6  |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 2     | 18 | Cd1  | 5.22 | 5.09 | 3.42 |

|            |      |                       |    |     |      |      |      |
|------------|------|-----------------------|----|-----|------|------|------|
| NMML 043bn | 31.3 | Caudal<br>Vertebra 3  | 19 | Cd1 | 5.26 | 5.21 | 3.6  |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 4  | 20 | Cd1 | 5.18 | 5.5  | 3.82 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 5  | 21 | Cd1 | 5.25 | 5.35 | 3.69 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 6  | 22 | Cd1 | 5.24 | 5.45 | 3.98 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 7  | 23 | Cd1 | 5.16 | 5.51 | 3.92 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 8  | 24 | Cd1 | 5.27 | 5.52 | 4.26 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 9  | 25 | Cd1 | 5.27 | 5.52 | 4.11 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 10 | 26 | Cd1 | 5.28 | 5.48 | 4.09 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 11 | 27 | Cd2 | 5.27 | 5.55 | 4.19 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 12 | 28 | Cd2 | 5.12 | 5.46 | 4.31 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 13 | 29 | Cd2 | 5.24 | 5.47 | 4.37 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 14 | 30 | Cd2 | 5.17 | 5.33 | 4.55 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 15 | 31 | Cd2 | 5.15 | 5.42 | 4.44 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 16 | 32 | Cd2 | 5.14 | 5.35 | 4.77 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 17 | 33 | Cd2 | 5.19 | 5.48 | 4.62 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 18 | 34 | Cd2 | 5.14 | 5.41 | 4.87 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 19 | 35 | Cd2 | 4.96 | 5.26 | 4.85 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 20 | 36 | Cd2 | 5.02 | 5.33 | 4.9  |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 21 | 37 | Cd3 | 4.98 | 5.2  | 5.09 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 22 | 38 | Cd3 | 4.96 | 5.4  | 5.12 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 23 | 39 | Cd3 | 4.89 | 5.04 | 5.12 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 24 | 40 | Cd3 | 4.8  | 5.03 | 5.1  |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 25 | 41 | Cd3 | 4.66 | 4.88 | 5.17 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 26 | 42 | Cd3 | 4.26 | 4.16 | 4.14 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 27 | 43 | Cd4 | 4.41 | 4.32 | 4.38 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 28 | 44 | Cd4 | 4.57 | 4.68 | 4.67 |
| NMML 043bn | 31.3 | Caudal<br>Vertebra 29 | 45 | Cd4 | 4.68 | 4.88 | 5    |

|            |       |                       |    |      |      |      |      |
|------------|-------|-----------------------|----|------|------|------|------|
| NMML 043bn | 31.3  | Caudal Vertebra 30    | 46 | Cd4  | 4.49 | 4.47 | 4.51 |
| NMML 043bn | 31.3  | Caudal Vertebra 31    | 47 | Cd4  | 4.48 | 4.21 | 4.11 |
| NMML 043bn | 31.3  | Caudal Vertebra 32    | 49 | Dist | 3.91 | 4.29 | 4.1  |
| NMML 043bn | 31.3  | Penultimate Vertebrae | 50 | Dist | 3.88 | 3.81 | 3.95 |
| NMML 208bn | 19.44 | Atlas                 | 1  | Prox | 2.97 | 2.82 | 1.71 |
| NMML 208bn | 19.44 | Axis                  | 2  | Prox | 2.92 | 3.17 | 1.42 |
| NMML 208bn | 19.44 | Abdominal Vertebra 3  | 3  | Ab1  | 2.71 | 3.2  | 1.64 |
| NMML 208bn | 19.44 | Abdominal Vertebra 4  | 4  | Ab1  | 2.62 | 3.16 | 1.8  |
| NMML 208bn | 19.44 | Abdominal Vertebra 5  | 5  | Ab1  | 2.63 | 3.2  | 1.69 |
| NMML 208bn | 19.44 | Abdominal Vertebra 6  | 6  | Ab1  | 2.66 | 3.07 | 1.85 |
| NMML 208bn | 19.44 | Abdominal Vertebra 7  | 7  | Ab1  | 2.73 | 2.84 | 2.12 |
| NMML 208bn | 19.44 | Abdominal Vertebra 8  | 8  | Ab1  | 2.65 | 3.01 | 2.03 |
| NMML 208bn | 19.44 | Abdominal Vertebra 9  | 9  | Ab1  | 2.83 | 2.97 | 2.22 |
| NMML 208bn | 19.44 | Abdominal Vertebra 10 | 10 | Ab2  | 2.82 | 3.01 | 2.29 |
| NMML 208bn | 19.44 | Abdominal Vertebra 11 | 11 | Ab2  | 2.95 | 2.98 | 2.34 |
| NMML 208bn | 19.44 | Abdominal Vertebra 12 | 12 | Ab2  | 3.05 | 2.95 | 2.37 |
| NMML 208bn | 19.44 | Abdominal Vertebra 13 | 13 | Ab2  | 2.96 | 2.84 | 2.35 |
| NMML 208bn | 19.44 | Abdominal Vertebra 14 | 14 | Ab2  | 3.13 | 2.99 | 2.46 |
| NMML 208bn | 19.44 | Abdominal Vertebra 15 | 15 | Ab2  | 3.16 | 3.04 | 2.42 |
| NMML 208bn | 19.44 | Abdominal Vertebra 16 | 16 | Ab2  | 3.22 | 3.05 | 2.31 |
| NMML 208bn | 19.44 | Caudal Vertebra 1     | 17 | Cd1  | 3.2  | 3.13 | 2.13 |
| NMML 208bn | 19.44 | Caudal Vertebra 2     | 18 | Cd1  | 3.28 | 3.25 | 2.04 |
| NMML 208bn | 19.44 | Caudal Vertebra 3     | 19 | Cd1  | 3.33 | 3.25 | 2.14 |
| NMML 208bn | 19.44 | Caudal Vertebra 4     | 20 | Cd1  | 3.26 | 3.36 | 2.16 |
| NMML 208bn | 19.44 | Caudal Vertebra 5     | 21 | Cd1  | 3.32 | 3.33 | 2.11 |
| NMML 208bn | 19.44 | Caudal Vertebra 6     | 22 | Cd1  | 3.28 | 3.29 | 2.27 |
| NMML 208bn | 19.44 | Caudal Vertebra 7     | 23 | Cd1  | 3.31 | 3.48 | 2.23 |
| NMML 208bn | 19.44 | Caudal Vertebra 8     | 24 | Cd1  | 3.24 | 3.33 | 2.23 |

|            |       |                          |    |      |      |      |      |
|------------|-------|--------------------------|----|------|------|------|------|
| NMML 208bn | 19.44 | Caudal<br>Vertebra 9     | 25 | Cd1  | 3.26 | 3.41 | 2.26 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 10    | 26 | Cd1  | 3.27 | 3.41 | 2.21 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 11    | 27 | Cd2  | 3.18 | 3.35 | 2.34 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 12    | 28 | Cd2  | 3.28 | 3.03 | 2.36 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 13    | 29 | Cd2  | 3.24 | 3.2  | 2.38 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 14    | 30 | Cd2  | 3.22 | 3.21 | 2.42 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 15    | 31 | Cd2  | 3.21 | 3.21 | 2.51 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 16    | 32 | Cd2  | 3.12 | 3.12 | 2.51 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 17    | 33 | Cd2  | 3.11 | 3.07 | 2.56 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 18    | 34 | Cd2  | 3.07 | 3.05 | 2.74 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 19    | 35 | Cd2  | 2.99 | 3.12 | 2.66 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 20    | 36 | Cd2  | 2.97 | 3    | 2.75 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 21    | 37 | Cd3  | 2.97 | 2.95 | 2.9  |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 22    | 38 | Cd3  | 2.9  | 2.92 | 2.88 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 23    | 39 | Cd3  | 2.91 | 2.99 | 2.95 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 24    | 40 | Cd3  | 2.84 | 2.91 | 2.93 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 25    | 41 | Cd3  | 2.76 | 2.79 | 2.92 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 26    | 42 | Cd3  | 2.76 | 2.72 | 2.79 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 27    | 43 | Cd4  | 2.67 | 2.63 | 2.72 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 28    | 44 | Cd4  | 2.71 | 2.6  | 2.58 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 29    | 45 | Cd4  | 2.64 | 2.34 | 2.4  |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 30    | 46 | Cd4  | 2.6  | 2.51 | 2.5  |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 31    | 47 | Cd4  | 2.56 | 2.51 | 2.47 |
| NMML 208bn | 19.44 | Caudal<br>Vertebra 32    | 49 | Dist | 2.5  | 2.32 | 2.42 |
| NMML 208bn | 19.44 | Penultimate<br>Vertebrae | 50 | Dist | 2.26 | 2.12 | 2.57 |
| NMML 557bn | 45.93 | Atlas                    | 1  | Prox | 7.25 | 6.61 | 3.79 |
| NMML 557bn | 45.93 | Axis                     | 2  | Prox | 7.18 | 6.87 | 3.39 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 7.14 | 7.14 | 3.62 |

|            |       |                          |    |     |      |      |      |
|------------|-------|--------------------------|----|-----|------|------|------|
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 4  | 4  | Ab1 | 6.81 | 7.36 | 4.17 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 5  | 5  | Ab1 | 6.82 | 7.36 | 4.26 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 6  | 6  | Ab1 | 6.9  | 7.09 | 4.48 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 7.25 | 7.07 | 5.3  |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 7.17 | 7.21 | 5.53 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 7.03 | 6.94 | 4.76 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 7.08 | 7.13 | 5.02 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 7.24 | 7.24 | 5.65 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 7.22 | 7.28 | 5.68 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 7.47 | 7.2  | 5.86 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 7.71 | 7.27 | 5.84 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 7.85 | 7.21 | 5.99 |
| NMML 557bn | 45.93 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 7.99 | 7.33 | 5.73 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 1     | 17 | Cd1 | 8.17 | 7.27 | 5.53 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 2     | 18 | Cd1 | 8.17 | 7.45 | 5.44 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 3     | 19 | Cd1 | 8.19 | 7.47 | 5.59 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 4     | 20 | Cd1 | 7.92 | 7.82 | 5.7  |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 5     | 21 | Cd1 | 8.03 | 7.77 | 5.62 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 6     | 22 | Cd1 | 8.29 | 8.04 | 5.72 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 7     | 23 | Cd1 | 7.89 | 8.05 | 5.74 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 8     | 24 | Cd1 | 7.92 | 8    | 5.93 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 9     | 25 | Cd1 | 7.83 | 8.08 | 6.17 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 10    | 26 | Cd1 | 7.87 | 8.03 | 6.04 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 11    | 27 | Cd2 | 8    | 7.93 | 6.09 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 12    | 28 | Cd2 | 7.93 | 7.95 | 6.19 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 13    | 29 | Cd2 | 7.78 | 7.93 | 6.44 |
| NMML 557bn | 45.93 | Caudal<br>Vertebra 14    | 30 | Cd2 | 7.95 | 7.83 | 6.37 |

|             |       |                          |    |      |      |      |      |
|-------------|-------|--------------------------|----|------|------|------|------|
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 15    | 31 | Cd2  | 7.78 | 7.82 | 6.8  |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 16    | 32 | Cd2  | 7.82 | 7.55 | 6.62 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 17    | 33 | Cd2  | 7.79 | 7.65 | 6.51 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 18    | 34 | Cd2  | 7.81 | 7.66 | 6.96 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 19    | 35 | Cd2  | 7.71 | 7.58 | 6.95 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 20    | 36 | Cd2  | 7.84 | 7.49 | 7.1  |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 21    | 37 | Cd3  | 7.52 | 7.55 | 7.28 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 22    | 38 | Cd3  | 7.46 | 7.84 | 7.4  |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 23    | 39 | Cd3  | 7.43 | 7.43 | 7.44 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 24    | 40 | Cd3  | 7.22 | 7.38 | 7.43 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 25    | 41 | Cd3  | 7.07 | 7.4  | 7.23 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 26    | 42 | Cd3  | 6.94 | 7.12 | 7.03 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 27    | 43 | Cd4  | 6.66 | 6.98 | 6.71 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 28    | 44 | Cd4  | 6.41 | 6.11 | 6.2  |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 29    | 45 | Cd4  | 6.07 | 6.24 | 6.02 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 30    | 46 | Cd4  | 6.69 | 6.78 | 6.37 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 31    | 47 | Cd4  | 5.95 | 6.18 | 5.96 |
| NMML 557bn  | 45.93 | Caudal<br>Vertebra 32    | 49 | Dist | 5.72 | 6.15 | 5.74 |
| NMML 557bn  | 45.93 | Penultimate<br>Vertebrae | 50 | Dist | 5.31 | 5.28 | 5.58 |
| NMML 0632bn | 33    | Atlas                    | 1  | Prox | 5.09 | 4.63 | 2.72 |
| NMML 0632bn | 33    | Axis                     | 2  | Prox | 5.23 | 5.09 | 2.38 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 3  | 3  | Ab1  | 5.07 | 5.21 | 2.71 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 4  | 4  | Ab1  | 5    | 5.21 | 2.93 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 5  | 5  | Ab1  | 4.93 | 5.18 | 2.9  |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 6  | 6  | Ab1  | 4.77 | 4.95 | 3.06 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 7  | 7  | Ab1  | 5    | 5.1  | 3.42 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 8  | 8  | Ab1  | 5.01 | 4.91 | 3.54 |
| NMML 0632bn | 33    | Abdominal<br>Vertebra 9  | 9  | Ab1  | 5.04 | 4.94 | 3.72 |

|             |    |                          |    |     |      |      |      |
|-------------|----|--------------------------|----|-----|------|------|------|
| NMML 0632bn | 33 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 5    | 4.95 | 3.81 |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 5.12 | 4.92 | 3.85 |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 5.18 | 5.08 | 4    |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 5.34 | 5.06 | 4.02 |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 5.39 | 5.1  | 4.02 |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 5.42 | 5.27 | 4.04 |
| NMML 0632bn | 33 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 5.56 | 5.29 | 3.89 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 1     | 17 | Cd1 | 5.56 | 5.2  | 3.52 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 2     | 18 | Cd1 | 5.65 | 5.33 | 3.75 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 3     | 19 | Cd1 | 5.65 | 5.64 | 3.79 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 4     | 20 | Cd1 | 5.68 | 5.65 | 3.84 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 5     | 21 | Cd1 | 5.74 | 5.76 | 3.96 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 6     | 22 | Cd1 | 5.66 | 5.75 | 3.95 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 7     | 23 | Cd1 | 5.64 | 5.79 | 4.32 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 8     | 24 | Cd1 | 5.59 | 5.7  | 4.16 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 9     | 25 | Cd1 | 5.58 | 5.82 | 3.92 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 10    | 26 | Cd1 | 5.66 | 5.69 | 4.1  |
| NMML 0632bn | 33 | Caudal<br>Vertebra 11    | 27 | Cd2 | 5.58 | 5.76 | 4.29 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 12    | 28 | Cd2 | 5.63 | 5.82 | 4.2  |
| NMML 0632bn | 33 | Caudal<br>Vertebra 13    | 29 | Cd2 | 5.52 | 5.67 | 4.43 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 14    | 30 | Cd2 | 5.61 | 5.62 | 4.33 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 15    | 31 | Cd2 | 5.51 | 5.67 | 4.45 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 16    | 32 | Cd2 | 5.46 | 5.6  | 4.53 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 17    | 33 | Cd2 | 5.48 | 5.54 | 4.73 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 18    | 34 | Cd2 | 5.44 | 5.52 | 4.73 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 19    | 35 | Cd2 | 5.21 | 5.58 | 4.86 |
| NMML 0632bn | 33 | Caudal<br>Vertebra 20    | 36 | Cd2 | 5.26 | 5.46 | 4.87 |

|             |        |                          |    |      |       |       |       |
|-------------|--------|--------------------------|----|------|-------|-------|-------|
| NMML 0632bn | 33     | Caudal<br>Vertebra 21    | 37 | Cd3  | 5.24  | 5.4   | 5.11  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 22    | 38 | Cd3  | 5.34  | 5.34  | 5.05  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 23    | 39 | Cd3  | 5.17  | 5.38  | 5.08  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 24    | 40 | Cd3  | 5.1   | 5.44  | 5.09  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 25    | 41 | Cd3  | 5     | 5.46  | 5.09  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 26    | 42 | Cd3  | 4.93  | 5.1   | 5.08  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 27    | 43 | Cd4  | 4.85  | 5.28  | 4.81  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 28    | 44 | Cd4  | 4.72  | 4.96  | 4.6   |
| NMML 0632bn | 33     | Caudal<br>Vertebra 29    | 45 | Cd4  | 4.69  | 4.84  | 4.34  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 30    | 46 | Cd4  | 4.62  | 4.44  | 4.13  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 31    | 47 | Cd4  | 4.27  | 4.27  | 3.73  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 32    | 48 | Cd4  | 4.55  | 4.42  | 3.94  |
| NMML 0632bn | 33     | Caudal<br>Vertebra 33    | 49 | Dist | 4.16  | 4.38  | 4.01  |
| NMML 0632bn | 33     | Penultimate<br>Vertebrae | 50 | Dist | 4.19  | 4.44  | 4.66  |
| 17/118      | 121.92 | Atlas                    | 1  | Prox | 19.22 | 18.35 | 9.84  |
| 17/118      | 121.92 | Axis                     | 2  | Prox | 18.75 | 18.27 | 9.33  |
| 17/118      | 121.92 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 18.47 | 19.07 | 10.66 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 19.09 | 20.05 | 11.14 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 18.66 | 20.12 | 11.18 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 18.69 | 19.5  | 12.27 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 18.68 | 19.62 | 12.6  |
| 17/118      | 121.92 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 18.71 | 20.18 | 13.23 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.4  | 20.75 | 14.1  |
| 17/118      | 121.92 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.99 | 19.93 | 14.1  |
| 17/118      | 121.92 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 19.45 | 19.94 | 14.71 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 19.33 | 20.18 | 14.83 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 19.8  | 21.18 | 15.56 |
| 17/118      | 121.92 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 20.08 | 20.9  | 15.85 |

|        |        |                          |    |     |       |       |       |
|--------|--------|--------------------------|----|-----|-------|-------|-------|
| 17/118 | 121.92 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 20.06 | 20.42 | 15.82 |
| 17/118 | 121.92 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 19.87 | 20.42 | 15.32 |
| 17/118 | 121.92 | Caudal<br>Vertebra 1     | 17 | Cd1 | 19.82 | 20.37 | 14.12 |
| 17/118 | 121.92 | Caudal<br>Vertebra 2     | 18 | Cd1 | 19.87 | 19.5  | 13.61 |
| 17/118 | 121.92 | Caudal<br>Vertebra 3     | 19 | Cd1 | 19.83 | 20.07 | 13.83 |
| 17/118 | 121.92 | Caudal<br>Vertebra 4     | 20 | Cd1 | 20.06 | 20.08 | 14.67 |
| 17/118 | 121.92 | Caudal<br>Vertebra 5     | 21 | Cd1 | 20.07 | 19.21 | 13.88 |
| 17/118 | 121.92 | Caudal<br>Vertebra 6     | 22 | Cd1 | 20.02 | 19.71 | 14.07 |
| 17/118 | 121.92 | Caudal<br>Vertebra 7     | 23 | Cd1 | 20.14 | 20.52 | 14.61 |
| 17/118 | 121.92 | Caudal<br>Vertebra 8     | 24 | Cd1 | 20.34 | 21.42 | 15.15 |
| 17/118 | 121.92 | Caudal<br>Vertebra 9     | 25 | Cd1 | 19.67 | 20.66 | 15.08 |
| 17/118 | 121.92 | Caudal<br>Vertebra 10    | 26 | Cd1 | 19.44 | 21.94 | 15.22 |
| 17/118 | 121.92 | Caudal<br>Vertebra 11    | 27 | Cd2 | 20.45 | 20.92 | 15.05 |
| 17/118 | 121.92 | Caudal<br>Vertebra 12    | 28 | Cd2 | 19.69 | 20.83 | 16.1  |
| 17/118 | 121.92 | Caudal<br>Vertebra 13    | 29 | Cd2 | 19.63 | 20.56 | 15.19 |
| 17/118 | 121.92 | Caudal<br>Vertebra 14    | 30 | Cd2 | 20.53 | 20.89 | 15    |
| 17/118 | 121.92 | Caudal<br>Vertebra 15    | 31 | Cd2 | 19.37 | 21.37 | 15.52 |
| 17/118 | 121.92 | Caudal<br>Vertebra 16    | 32 | Cd2 | 19.66 | 20.65 | 16.34 |
| 17/118 | 121.92 | Caudal<br>Vertebra 17    | 33 | Cd2 | 19.73 | 20.94 | 15.93 |
| 17/118 | 121.92 | Caudal<br>Vertebra 18    | 34 | Cd2 | 19.86 | 20.45 | 16    |
| 17/118 | 121.92 | Caudal<br>Vertebra 19    | 35 | Cd2 | 19.83 | 20.01 | 16.85 |
| 17/118 | 121.92 | Caudal<br>Vertebra 20    | 36 | Cd2 | 19.05 | 20.48 | 16.88 |
| 17/118 | 121.92 | Caudal<br>Vertebra 21    | 37 | Cd3 | 19.42 | 20.68 | 17.29 |
| 17/118 | 121.92 | Caudal<br>Vertebra 22    | 38 | Cd3 | 19.02 | 18.99 | 18.18 |
| 17/118 | 121.92 | Caudal<br>Vertebra 23    | 39 | Cd3 | 19.5  | 19.73 | 17.35 |
| 17/118 | 121.92 | Caudal<br>Vertebra 24    | 40 | Cd3 | 18.16 | 18.93 | 17.26 |
| 17/118 | 121.92 | Caudal<br>Vertebra 25    | 41 | Cd3 | 17.78 | 18.26 | 15.86 |

|        |        |                          |    |      |       |       |       |
|--------|--------|--------------------------|----|------|-------|-------|-------|
| 17/118 | 121.92 | Caudal<br>Vertebra 26    | 42 | Cd3  | 18.05 | 18.58 | 16.97 |
| 17/118 | 121.92 | Caudal<br>Vertebra 27    | 43 | Cd4  | 17.1  | 17.34 | 14.63 |
| 17/118 | 121.92 | Caudal<br>Vertebra 28    | 44 | Cd4  | 17.02 | 17.29 | 14.36 |
| 17/118 | 121.92 | Caudal<br>Vertebra 29    | 45 | Cd4  | 16.48 | 17.4  | 12.84 |
| 17/118 | 121.92 | Caudal<br>Vertebra 30    | 46 | Cd4  | 15.33 | 16.54 | 12.77 |
| 17/118 | 121.92 | Caudal<br>Vertebra 31    | 47 | Cd4  | 14.85 | 16.79 | 12.44 |
| 17/118 | 121.92 | Caudal<br>Vertebra 32    | 48 | Cd4  | 13.63 | 17.18 | 12.61 |
| 17/118 | 121.92 | Caudal<br>Vertebra 33    | 49 | Dist | 13.56 | 15.42 | 13.13 |
| 17/118 | 121.92 | Penultimate<br>Vertebrae | 50 | Dist |       |       |       |
| 17/119 | 120    | Atlas                    | 1  | Prox | 17.35 | 15.35 | 8.05  |
| 17/119 | 120    | Axis                     | 2  | Prox | 16.48 | 16.83 | 8.53  |
| 17/119 | 120    | Abdominal<br>Vertebra 3  | 3  | Ab1  | 16.05 | 17.73 | 9.52  |
| 17/119 | 120    | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.63 | 17.88 | 10.16 |
| 17/119 | 120    | Abdominal<br>Vertebra 5  | 5  | Ab1  | 16.65 | 17.3  | 10.69 |
| 17/119 | 120    | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.62 | 16.79 | 10.82 |
| 17/119 | 120    | Abdominal<br>Vertebra 7  | 7  | Ab1  | 16.63 | 17.25 | 11.36 |
| 17/119 | 120    | Abdominal<br>Vertebra 8  | 8  | Ab1  | 16.47 | 17.17 | 12.18 |
| 17/119 | 120    | Abdominal<br>Vertebra 9  | 9  | Ab1  | 17.28 | 17.22 | 13.26 |
| 17/119 | 120    | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.06 | 17.57 | 14.4  |
| 17/119 | 120    | Abdominal<br>Vertebra 11 | 11 | Ab2  | 16.9  | 16.73 | 12.62 |
| 17/119 | 120    | Abdominal<br>Vertebra 12 | 12 | Ab2  | 17.14 | 17.46 | 14.1  |
| 17/119 | 120    | Abdominal<br>Vertebra 13 | 13 | Ab2  | 18.2  | 17.93 | 14.64 |
| 17/119 | 120    | Abdominal<br>Vertebra 14 | 14 | Ab2  | 18.09 | 17.88 | 14.98 |
| 17/119 | 120    | Abdominal<br>Vertebra 15 | 15 | Ab2  | 18.27 | 17.91 | 15.32 |
| 17/119 | 120    | Abdominal<br>Vertebra 16 | 16 | Ab2  | 18.82 | 18.07 | 14.59 |
| 17/119 | 120    | Caudal<br>Vertebra 1     | 17 | Cd1  | 18.32 | 18.63 | 14.15 |
| 17/119 | 120    | Caudal<br>Vertebra 2     | 18 | Cd1  | 18.65 | 18.34 | 13.04 |
| 17/119 | 120    | Caudal<br>Vertebra 3     | 19 | Cd1  | 19.24 | 18.55 | 13.61 |

|        |     |                       |    |     |       |       |       |
|--------|-----|-----------------------|----|-----|-------|-------|-------|
| 17/119 | 120 | Caudal<br>Vertebra 4  | 20 | Cd1 | 18.88 | 18.81 | 13.96 |
| 17/119 | 120 | Caudal<br>Vertebra 5  | 21 | Cd1 | 18.67 | 18.54 | 13.31 |
| 17/119 | 120 | Caudal<br>Vertebra 6  | 22 | Cd1 | 18.96 | 18.09 | 12.76 |
| 17/119 | 120 | Caudal<br>Vertebra 7  | 23 | Cd1 | 18.71 | 18.74 | 14.02 |
| 17/119 | 120 | Caudal<br>Vertebra 8  | 24 | Cd1 | 18.57 | 18.51 | 13.64 |
| 17/119 | 120 | Caudal<br>Vertebra 9  | 25 | Cd1 | 18.81 | 18.49 | 14.08 |
| 17/119 | 120 | Caudal<br>Vertebra 10 | 26 | Cd1 | 18.47 | 19.58 | 14.85 |
| 17/119 | 120 | Caudal<br>Vertebra 11 | 27 | Cd2 | 18.93 | 18.96 | 14.72 |
| 17/119 | 120 | Caudal<br>Vertebra 12 | 28 | Cd2 | 18.27 | 18.95 | 15.68 |
| 17/119 | 120 | Caudal<br>Vertebra 13 | 29 | Cd2 | 18.48 | 18.93 | 14.8  |
| 17/119 | 120 | Caudal<br>Vertebra 14 | 30 | Cd2 | 18.62 | 19.27 | 14.75 |
| 17/119 | 120 | Caudal<br>Vertebra 15 | 31 | Cd2 | 18.32 | 18.43 | 15.79 |
| 17/119 | 120 | Caudal<br>Vertebra 16 | 32 | Cd2 | 18.17 | 19.21 | 15.81 |
| 17/119 | 120 | Caudal<br>Vertebra 17 | 33 | Cd2 | 18.66 | 19.22 | 15.67 |
| 17/119 | 120 | Caudal<br>Vertebra 18 | 34 | Cd2 | 18.46 | 17.96 | 15.95 |
| 17/119 | 120 | Caudal<br>Vertebra 19 | 35 | Cd2 | 18.06 | 18.38 | 15.99 |
| 17/119 | 120 | Caudal<br>Vertebra 20 | 36 | Cd2 | 18.34 | 17.65 | 16.45 |
| 17/119 | 120 | Caudal<br>Vertebra 21 | 37 | Cd3 | 17.82 | 18.16 | 16.41 |
| 17/119 | 120 | Caudal<br>Vertebra 22 | 38 | Cd3 | 18.41 | 18.02 | 17.24 |
| 17/119 | 120 | Caudal<br>Vertebra 23 | 39 | Cd3 | 18.01 | 18.17 | 16.92 |
| 17/119 | 120 | Caudal<br>Vertebra 24 | 40 | Cd3 | 17.63 | 17.91 | 17    |
| 17/119 | 120 | Caudal<br>Vertebra 25 | 41 | Cd3 | 16.97 | 17.47 | 16.37 |
| 17/119 | 120 | Caudal<br>Vertebra 26 | 42 | Cd3 | 16.78 | 16.33 | 16.03 |
| 17/119 | 120 | Caudal<br>Vertebra 27 | 43 | Cd4 | 16.34 | 16.17 | 14.9  |
| 17/119 | 120 | Caudal<br>Vertebra 28 | 44 | Cd4 | 15.49 | 15.71 | 13.98 |
| 17/119 | 120 | Caudal<br>Vertebra 29 | 45 | Cd4 | 14.9  | 14.73 | 13.13 |
| 17/119 | 120 | Caudal<br>Vertebra 30 | 46 | Cd4 | 15.45 | 16.2  | 13.22 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/119 | 120 | Caudal<br>Vertebra 31    | 47 | Cd4  |       |       |       |
| 17/119 | 120 | Caudal<br>Vertebra 32    | 48 | Cd4  | 13.58 | 15.17 | 12.04 |
| 17/119 | 120 | Caudal<br>Vertebra 33    | 49 | Dist | 12.76 | 14.21 | 11.49 |
| 17/119 | 120 | Penultimate<br>Vertebrae | 50 | Dist | 12.09 | 12.96 | 10.9  |
| 17/120 | 120 | Atlas                    | 1  | Prox | 18.12 | 17.47 | 9.08  |
| 17/120 | 120 | Axis                     | 2  | Prox | 17.74 | 16.85 | 8     |
| 17/120 | 120 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 17.06 | 17.74 | 9.01  |
| 17/120 | 120 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.65 | 18.34 | 9.52  |
| 17/120 | 120 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 17.39 | 18.05 | 10.1  |
| 17/120 | 120 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.92 | 18.38 | 10.47 |
| 17/120 | 120 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 17.43 | 18.19 | 10.97 |
| 17/120 | 120 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 17.84 | 18.71 | 11.81 |
| 17/120 | 120 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.19 | 18.51 | 12.84 |
| 17/120 | 120 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.89 | 19.25 | 13.26 |
| 17/120 | 120 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 18.93 | 19.61 | 13.54 |
| 17/120 | 120 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 19.28 | 19.52 | 14.73 |
| 17/120 | 120 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 19.76 | 19.73 | 14.99 |
| 17/120 | 120 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 19.63 | 20.07 | 15.07 |
| 17/120 | 120 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 20.83 | 19.66 | 15.23 |
| 17/120 | 120 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 20.57 | 20.73 | 14.92 |
| 17/120 | 120 | Caudal<br>Vertebra 1     | 17 | Cd1  | 19.66 | 20.95 | 13.75 |
| 17/120 | 120 | Caudal<br>Vertebra 2     | 18 | Cd1  | 19.99 | 21.25 | 13.68 |
| 17/120 | 120 | Caudal<br>Vertebra 3     | 19 | Cd1  | 20.25 | 20.45 | 13.53 |
| 17/120 | 120 | Caudal<br>Vertebra 4     | 20 | Cd1  | 19.99 | 21.07 | 13.76 |
| 17/120 | 120 | Caudal<br>Vertebra 5     | 21 | Cd1  | 19.82 | 21.46 | 14.11 |
| 17/120 | 120 | Caudal<br>Vertebra 6     | 22 | Cd1  | 21.14 | 22.09 | 13.51 |
| 17/120 | 120 | Caudal<br>Vertebra 7     | 23 | Cd1  | 20.65 | 21.67 | 14.23 |
| 17/120 | 120 | Caudal<br>Vertebra 8     | 24 | Cd1  | 20.63 | 22.41 | 14.8  |

|        |       |                          |    |      |       |       |       |
|--------|-------|--------------------------|----|------|-------|-------|-------|
| 17/120 | 120   | Caudal<br>Vertebra 9     | 25 | Cd1  | 20.53 | 21.46 | 14.38 |
| 17/120 | 120   | Caudal<br>Vertebra 10    | 26 | Cd1  | 19.76 | 21.49 | 14.76 |
| 17/120 | 120   | Caudal<br>Vertebra 11    | 27 | Cd2  | 20.48 | 22.1  | 14.89 |
| 17/120 | 120   | Caudal<br>Vertebra 12    | 28 | Cd2  | 20.67 | 22.23 | 15.17 |
| 17/120 | 120   | Caudal<br>Vertebra 13    | 29 | Cd2  | 20.71 | 22.36 | 15.44 |
| 17/120 | 120   | Caudal<br>Vertebra 14    | 30 | Cd2  | 20.83 | 21.86 | 15.4  |
| 17/120 | 120   | Caudal<br>Vertebra 15    | 31 | Cd2  | 21.03 | 21.94 | 15.79 |
| 17/120 | 120   | Caudal<br>Vertebra 16    | 32 | Cd2  | 20.5  | 21.77 | 16.25 |
| 17/120 | 120   | Caudal<br>Vertebra 17    | 33 | Cd2  | 21.13 | 21.49 | 16.36 |
| 17/120 | 120   | Caudal<br>Vertebra 18    | 34 | Cd2  | 21.15 | 22.62 | 15.44 |
| 17/120 | 120   | Caudal<br>Vertebra 19    | 35 | Cd2  | 21.42 | 22.69 | 15.94 |
| 17/120 | 120   | Caudal<br>Vertebra 20    | 36 | Cd2  | 20.99 | 21.59 | 17.06 |
| 17/120 | 120   | Caudal<br>Vertebra 21    | 37 | Cd3  | 21.32 | 21.52 | 16.69 |
| 17/120 | 120   | Caudal<br>Vertebra 22    | 38 | Cd3  | 21.23 | 21.88 | 16.8  |
| 17/120 | 120   | Caudal<br>Vertebra 23    | 39 | Cd3  | 20.94 | 21.58 | 16.73 |
| 17/120 | 120   | Caudal<br>Vertebra 24    | 40 | Cd3  | 20.01 | 21.35 | 16.49 |
| 17/120 | 120   | Caudal<br>Vertebra 25    | 41 | Cd3  | 20.11 | 21.27 | 16.16 |
| 17/120 | 120   | Caudal<br>Vertebra 26    | 42 | Cd3  | 18.99 | 20.87 | 16.59 |
| 17/120 | 120   | Caudal<br>Vertebra 27    | 43 | Cd4  | 18.75 | 19.69 | 14.46 |
| 17/120 | 120   | Caudal<br>Vertebra 28    | 44 | Cd4  | 18.43 | 18.71 | 13.81 |
| 17/120 | 120   | Caudal<br>Vertebra 29    | 45 | Cd4  | 17.62 | 19.25 | 13.53 |
| 17/120 | 120   | Caudal<br>Vertebra 30    | 46 | Cd4  | 17.34 | 18.4  | 11.99 |
| 17/120 | 120   | Caudal<br>Vertebra 31    | 47 | Cd4  | 16.25 | 17.79 | 12.81 |
| 17/120 | 120   | Caudal<br>Vertebra 32    | 48 | Cd4  | 15.42 | 17.65 | 12.18 |
| 17/120 | 120   | Caudal<br>Vertebra 33    | 49 | Dist | 14.72 | 16.24 | 12.38 |
| 17/120 | 120   | Penultimate<br>Vertebrae | 50 | Dist | 14.45 | 14.38 | 11.23 |
| 17/121 | 92.71 | Atlas                    | 1  | Prox | 13.81 | 11.99 | 7.26  |
| 17/121 | 92.71 | Axis                     | 2  | Prox | 13.02 | 12.71 | 7.13  |

|        |       |                          |    |     |       |       |       |
|--------|-------|--------------------------|----|-----|-------|-------|-------|
| 17/121 | 92.71 | Abdominal<br>Vertebra 3  | 3  | Ab1 | 13.12 | 13.35 | 7.6   |
| 17/121 | 92.71 | Abdominal<br>Vertebra 4  | 4  | Ab1 | 12.83 | 13.3  | 7.96  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 5  | 5  | Ab1 | 12.72 | 13.37 | 8.08  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 6  | 6  | Ab1 | 13.41 | 13.4  | 8.91  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 13.44 | 13.73 | 9.1   |
| 17/121 | 92.71 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 12.62 | 13.52 | 9.02  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 12.89 | 13.68 | 8.32  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 13.58 | 14.01 | 9.89  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 13.69 | 13.81 | 9.91  |
| 17/121 | 92.71 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 13.75 | 14.34 | 10.15 |
| 17/121 | 92.71 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 14.45 | 14.46 | 10.75 |
| 17/121 | 92.71 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 14.83 | 14.76 | 10.39 |
| 17/121 | 92.71 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 14.4  | 14.52 | 10.48 |
| 17/121 | 92.71 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 14.4  | 14.33 | 10.55 |
| 17/121 | 92.71 | Caudal<br>Vertebra 1     | 17 | Cd1 | 14.1  | 14.69 | 9.8   |
| 17/121 | 92.71 | Caudal<br>Vertebra 2     | 18 | Cd1 | 15.04 | 14.79 | 9.04  |
| 17/121 | 92.71 | Caudal<br>Vertebra 3     | 19 | Cd1 | 14.55 | 14.8  | 10.28 |
| 17/121 | 92.71 | Caudal<br>Vertebra 4     | 20 | Cd1 | 14.63 | 14.7  | 10.02 |
| 17/121 | 92.71 | Caudal<br>Vertebra 5     | 21 | Cd1 | 14.74 | 15.8  | 11.1  |
| 17/121 | 92.71 | Caudal<br>Vertebra 6     | 22 | Cd1 | 14.66 | 15.58 | 10.67 |
| 17/121 | 92.71 | Caudal<br>Vertebra 7     | 23 | Cd1 | 14.87 | 15.94 | 11.33 |
| 17/121 | 92.71 | Caudal<br>Vertebra 8     | 24 | Cd1 | 15.13 | 16.1  | 10.82 |
| 17/121 | 92.71 | Caudal<br>Vertebra 9     | 25 | Cd1 | 14.68 | 14.89 | 9.99  |
| 17/121 | 92.71 | Caudal<br>Vertebra 10    | 26 | Cd1 | 14.82 | 15.72 | 11.01 |
| 17/121 | 92.71 | Caudal<br>Vertebra 11    | 27 | Cd2 | 14.92 | 15.53 | 10.55 |
| 17/121 | 92.71 | Caudal<br>Vertebra 12    | 28 | Cd2 | 14.65 | 15.72 | 11.67 |
| 17/121 | 92.71 | Caudal<br>Vertebra 13    | 29 | Cd2 | 14.99 | 15.7  | 11.9  |

|        |       |                          |    |      |       |       |       |
|--------|-------|--------------------------|----|------|-------|-------|-------|
| 17/121 | 92.71 | Caudal<br>Vertebra 14    | 30 | Cd2  | 14.86 | 15.62 | 11.95 |
| 17/121 | 92.71 | Caudal<br>Vertebra 15    | 31 | Cd2  | 15.34 | 15.32 | 11.07 |
| 17/121 | 92.71 | Caudal<br>Vertebra 16    | 32 | Cd2  | 14.61 | 15.52 | 12.38 |
| 17/121 | 92.71 | Caudal<br>Vertebra 17    | 33 | Cd2  | 14.64 | 15.43 | 12.83 |
| 17/121 | 92.71 | Caudal<br>Vertebra 18    | 34 | Cd2  | 14.98 | 15.92 | 12.22 |
| 17/121 | 92.71 | Caudal<br>Vertebra 19    | 35 | Cd2  | 14.55 | 15.69 | 12.88 |
| 17/121 | 92.71 | Caudal<br>Vertebra 20    | 36 | Cd2  | 14.41 | 15.85 | 12.13 |
| 17/121 | 92.71 | Caudal<br>Vertebra 21    | 37 | Cd3  | 14.49 | 15.17 | 13.14 |
| 17/121 | 92.71 | Caudal<br>Vertebra 22    | 38 | Cd3  | 14.2  | 14.5  | 12.91 |
| 17/121 | 92.71 | Caudal<br>Vertebra 23    | 39 | Cd3  | 13.44 | 14.66 | 12.3  |
| 17/121 | 92.71 | Caudal<br>Vertebra 24    | 40 | Cd3  | 13.99 | 15.11 | 12.69 |
| 17/121 | 92.71 | Caudal<br>Vertebra 25    | 41 | Cd3  | 14.85 | 14.99 | 11.88 |
| 17/121 | 92.71 | Caudal<br>Vertebra 26    | 42 | Cd3  | 13.16 | 14.67 | 11.55 |
| 17/121 | 92.71 | Caudal<br>Vertebra 27    | 43 | Cd4  | 12.53 | 14.36 | 10.78 |
| 17/121 | 92.71 | Caudal<br>Vertebra 28    | 44 | Cd4  | 12.53 | 13.58 | 10.09 |
| 17/121 | 92.71 | Caudal<br>Vertebra 29    | 45 | Cd4  | 11.96 | 13.31 | 10.31 |
| 17/121 | 92.71 | Caudal<br>Vertebra 30    | 46 | Cd4  | 11.05 | 12.29 | 9.18  |
| 17/121 | 92.71 | Caudal<br>Vertebra 31    | 47 | Cd4  | 10.61 | 12.4  | 9.53  |
| 17/121 | 92.71 | Caudal<br>Vertebra 32    | 48 | Cd4  |       |       |       |
| 17/121 | 92.71 | Caudal<br>Vertebra 33    | 49 | Dist | 10.09 | 12.5  | 9.67  |
| 17/121 | 92.71 | Penultimate<br>Vertebrae | 50 | Dist | 9.43  | 11.54 | 9.3   |
| 17/122 | 130   | Atlas                    | 1  | Prox | 19.84 | 17.48 | 9.71  |
| 17/122 | 130   | Axis                     | 2  | Prox | 18.81 | 19.08 | 8.63  |
| 17/122 | 130   | Abdominal<br>Vertebra 3  | 3  | Ab1  | 18.73 | 19.56 | 10.28 |
| 17/122 | 130   | Abdominal<br>Vertebra 4  | 4  | Ab1  | 18.53 | 19.87 | 10.62 |
| 17/122 | 130   | Abdominal<br>Vertebra 5  | 5  | Ab1  | 18.1  | 19.04 | 10.92 |
| 17/122 | 130   | Abdominal<br>Vertebra 6  | 6  | Ab1  | 18.02 | 19.64 | 11.65 |
| 17/122 | 130   | Abdominal<br>Vertebra 7  | 7  | Ab1  | 17.55 | 18.9  | 13.19 |

|        |     |                          |    |     |       |       |       |
|--------|-----|--------------------------|----|-----|-------|-------|-------|
| 17/122 | 130 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 17.69 | 18.62 | 12.78 |
| 17/122 | 130 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 17.92 | 18.99 | 13.94 |
| 17/122 | 130 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 19.3  | 19.28 | 13.9  |
| 17/122 | 130 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 18.89 | 19.34 | 15    |
| 17/122 | 130 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 20.1  | 19.95 | 14.07 |
| 17/122 | 130 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 20.03 | 21.4  | 15.9  |
| 17/122 | 130 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 20.33 | 19.88 | 15.36 |
| 17/122 | 130 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 21.09 | 21.3  | 15.42 |
| 17/122 | 130 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 20.96 | 21.45 | 15.36 |
| 17/122 | 130 | Caudal<br>Vertebra 1     | 17 | Cd1 | 20.38 | 21.47 | 14.3  |
| 17/122 | 130 | Caudal<br>Vertebra 2     | 18 | Cd1 | 21.34 | 21.87 | 13.49 |
| 17/122 | 130 | Caudal<br>Vertebra 3     | 19 | Cd1 | 21.03 | 20.88 | 13.9  |
| 17/122 | 130 | Caudal<br>Vertebra 4     | 20 | Cd1 | 20.95 | 21.75 | 14.86 |
| 17/122 | 130 | Caudal<br>Vertebra 5     | 21 | Cd1 | 21.41 | 21.86 | 14.53 |
| 17/122 | 130 | Caudal<br>Vertebra 6     | 22 | Cd1 | 21.14 | 22.77 | 15.59 |
| 17/122 | 130 | Caudal<br>Vertebra 7     | 23 | Cd1 | 21.79 | 22.3  | 14.83 |
| 17/122 | 130 | Caudal<br>Vertebra 8     | 24 | Cd1 | 22.26 | 22.63 | 15.32 |
| 17/122 | 130 | Caudal<br>Vertebra 9     | 25 | Cd1 | 20.83 | 22.29 | 16.09 |
| 17/122 | 130 | Caudal<br>Vertebra 10    | 26 | Cd1 | 20.76 | 22.64 | 16.03 |
| 17/122 | 130 | Caudal<br>Vertebra 11    | 27 | Cd2 | 21.05 | 21.93 | 16.09 |
| 17/122 | 130 | Caudal<br>Vertebra 12    | 28 | Cd2 | 20.65 | 21.94 | 16.75 |
| 17/122 | 130 | Caudal<br>Vertebra 13    | 29 | Cd2 | 21.39 | 22.02 | 16.46 |
| 17/122 | 130 | Caudal<br>Vertebra 14    | 30 | Cd2 | 21.51 | 22.62 | 16.68 |
| 17/122 | 130 | Caudal<br>Vertebra 15    | 31 | Cd2 | 22.47 | 21.85 | 17.34 |
| 17/122 | 130 | Caudal<br>Vertebra 16    | 32 | Cd2 | 21.26 | 21.53 | 17.31 |
| 17/122 | 130 | Caudal<br>Vertebra 17    | 33 | Cd2 | 21.69 | 21.75 | 16.38 |
| 17/122 | 130 | Caudal<br>Vertebra 18    | 34 | Cd2 | 22.21 | 22    | 15.98 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/122 | 130 | Caudal<br>Vertebra 19    | 35 | Cd2  | 21.84 | 20.94 | 18.38 |
| 17/122 | 130 | Caudal<br>Vertebra 20    | 36 | Cd2  | 21.78 | 21.65 | 17.54 |
| 17/122 | 130 | Caudal<br>Vertebra 21    | 37 | Cd3  | 21.9  | 23.02 | 16.01 |
| 17/122 | 130 | Caudal<br>Vertebra 22    | 38 | Cd3  | 21.49 | 20.6  | 18.25 |
| 17/122 | 130 | Caudal<br>Vertebra 23    | 39 | Cd3  | 20.9  | 21.14 | 17.83 |
| 17/122 | 130 | Caudal<br>Vertebra 24    | 40 | Cd3  | 21.1  | 20.3  | 17.74 |
| 17/122 | 130 | Caudal<br>Vertebra 25    | 41 | Cd3  | 21.38 | 20.75 | 17.9  |
| 17/122 | 130 | Caudal<br>Vertebra 26    | 42 | Cd3  | 20.84 | 20.55 | 17.27 |
| 17/122 | 130 | Caudal<br>Vertebra 27    | 43 | Cd4  | 20.42 | 20.43 | 16.32 |
| 17/122 | 130 | Caudal<br>Vertebra 28    | 44 | Cd4  | 17.14 | 18.1  | 13.49 |
| 17/122 | 130 | Caudal<br>Vertebra 29    | 45 | Cd4  | 19.89 | 20.05 | 15.19 |
| 17/122 | 130 | Caudal<br>Vertebra 30    | 46 | Cd4  | 19.19 | 19.59 | 14.03 |
| 17/122 | 130 | Caudal<br>Vertebra 31    | 47 | Cd4  | 17.89 | 18.91 | 13.68 |
| 17/122 | 130 | Caudal<br>Vertebra 32    | 48 | Cd4  | 16.53 | 18.05 | 12.34 |
| 17/122 | 130 | Caudal<br>Vertebra 33    | 49 | Cd4  | 15.78 | 17.6  | 12.45 |
| 17/122 | 130 | Caudal<br>Vertebra 34    | 50 | Dist | 14.64 | 17.04 | 12.17 |
| 17/122 | 130 | Penultimate<br>Vertebrae | 51 | Dist | 14.26 | 15.15 | 11.19 |
| 17/123 | 135 | Atlas                    | 1  | Prox | 20.3  | 18.51 | 8.62  |
| 17/123 | 135 | Axis                     | 2  | Prox | 18.82 | 19.03 | 9.53  |
| 17/123 | 135 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 17.73 | 19.87 | 10.3  |
| 17/123 | 135 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 18.59 | 20.16 | 11.3  |
| 17/123 | 135 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 19.17 | 19.74 | 11.58 |
| 17/123 | 135 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 19.1  | 19.49 | 11.77 |
| 17/123 | 135 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 18.85 | 19.97 | 12.72 |
| 17/123 | 135 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 20.16 | 19.82 | 12.93 |
| 17/123 | 135 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.78 | 20.45 | 14.52 |
| 17/123 | 135 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 21.02 | 21.54 | 15.61 |
| 17/123 | 135 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 20.82 | 20.47 | 15.78 |

|        |     |                          |    |     |       |       |       |
|--------|-----|--------------------------|----|-----|-------|-------|-------|
| 17/123 | 135 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 22.05 | 21.66 | 15.99 |
| 17/123 | 135 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 22.06 | 21.9  | 15.82 |
| 17/123 | 135 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 22.44 | 21.77 | 15.44 |
| 17/123 | 135 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 22.97 | 22.27 | 16.6  |
| 17/123 | 135 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 22.26 | 22.04 | 14.84 |
| 17/123 | 135 | Caudal<br>Vertebra 1     | 17 | Cd1 | 21.57 | 22.69 | 15.33 |
| 17/123 | 135 | Caudal<br>Vertebra 2     | 18 | Cd1 | 22.11 | 22.73 | 14.48 |
| 17/123 | 135 | Caudal<br>Vertebra 3     | 19 | Cd1 | 23.12 | 22.66 | 16.09 |
| 17/123 | 135 | Caudal<br>Vertebra 4     | 20 | Cd1 | 23.38 | 23.58 | 15.68 |
| 17/123 | 135 | Caudal<br>Vertebra 5     | 21 | Cd1 | 23.68 | 22.22 | 14.51 |
| 17/123 | 135 | Caudal<br>Vertebra 6     | 22 | Cd1 | 23.83 | 23.04 | 16.25 |
| 17/123 | 135 | Caudal<br>Vertebra 7     | 23 | Cd1 | 23.45 | 23.42 | 14.78 |
| 17/123 | 135 | Caudal<br>Vertebra 8     | 24 | Cd1 | 24.34 | 23.82 | 15.74 |
| 17/123 | 135 | Caudal<br>Vertebra 9     | 25 | Cd1 | 23.71 | 23.75 | 17.57 |
| 17/123 | 135 | Caudal<br>Vertebra 10    | 26 | Cd1 | 23.6  | 22.92 | 16.75 |
| 17/123 | 135 | Caudal<br>Vertebra 11    | 27 | Cd2 | 24.31 | 23.68 | 17.5  |
| 17/123 | 135 | Caudal<br>Vertebra 12    | 28 | Cd2 | 23.47 | 23.62 | 16.3  |
| 17/123 | 135 | Caudal<br>Vertebra 13    | 29 | Cd2 | 23.8  | 23.37 | 16.5  |
| 17/123 | 135 | Caudal<br>Vertebra 14    | 30 | Cd2 | 23.72 | 23.44 | 16.19 |
| 17/123 | 135 | Caudal<br>Vertebra 15    | 31 | Cd2 | 23.33 | 21.93 | 20.07 |
| 17/123 | 135 | Caudal<br>Vertebra 16    | 32 | Cd2 | 23.37 | 22.13 | 19.2  |
| 17/123 | 135 | Caudal<br>Vertebra 17    | 33 | Cd2 | 23.29 | 23.1  | 16.44 |
| 17/123 | 135 | Caudal<br>Vertebra 18    | 34 | Cd2 | 23.12 | 22.94 | 18.3  |
| 17/123 | 135 | Caudal<br>Vertebra 19    | 35 | Cd2 | 23.46 | 22.6  | 18.49 |
| 17/123 | 135 | Caudal<br>Vertebra 20    | 36 | Cd2 | 23.49 | 21.81 | 19.7  |
| 17/123 | 135 | Caudal<br>Vertebra 21    | 37 | Cd3 | 23.24 | 22.36 | 19.65 |
| 17/123 | 135 | Caudal<br>Vertebra 22    | 38 | Cd3 | 22.68 | 21.67 | 20.66 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/123 | 135 | Caudal<br>Vertebra 23    | 39 | Cd3  | 23.63 | 21.2  | 19.87 |
| 17/123 | 135 | Caudal<br>Vertebra 24    | 40 | Cd3  | 22.14 | 21.09 | 19.85 |
| 17/123 | 135 | Caudal<br>Vertebra 25    | 41 | Cd3  | 20.7  | 19.31 | 18.23 |
| 17/123 | 135 | Caudal<br>Vertebra 26    | 42 | Cd3  | 21.62 | 21.18 | 20.1  |
| 17/123 | 135 | Caudal<br>Vertebra 27    | 43 | Cd4  | 19.62 | 18.89 | 17.43 |
| 17/123 | 135 | Caudal<br>Vertebra 28    | 44 | Cd4  | 18.99 | 17.88 | 16.35 |
| 17/123 | 135 | Caudal<br>Vertebra 29    | 45 | Cd4  | 18.77 | 19.31 | 13.89 |
| 17/123 | 135 | Caudal<br>Vertebra 30    | 46 | Cd4  | 17.45 | 18.1  | 13.9  |
| 17/123 | 135 | Caudal<br>Vertebra 31    | 47 | Cd4  | 16.62 | 18.76 | 13.24 |
| 17/123 | 135 | Caudal<br>Vertebra 32    | 48 | Dist | 15.78 | 18.54 | 13.07 |
| 17/123 | 135 | Penultimate<br>Vertebrae | 49 | Dist | 15.83 | 17.06 | 11.4  |
| 17/124 | 118 | Atlas                    | 1  | Prox | 15.49 | 15.27 | 8.1   |
| 17/124 | 118 | Axis                     | 2  | Prox | 15.9  | 15.92 | 8.27  |
| 17/124 | 118 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 15.79 | 16.52 | 9.22  |
| 17/124 | 118 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.54 | 17.57 | 9.91  |
| 17/124 | 118 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 16.28 | 16.95 | 10.22 |
| 17/124 | 118 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.88 | 15.12 | 11.16 |
| 17/124 | 118 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 16.23 | 16    | 10.69 |
| 17/124 | 118 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 16.13 | 15.7  | 12.02 |
| 17/124 | 118 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 17.34 | 16.53 | 13.31 |
| 17/124 | 118 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 16.87 | 15.79 | 12.83 |
| 17/124 | 118 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 17.45 | 17.4  | 14.28 |
| 17/124 | 118 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 17.16 | 16.45 | 13.61 |
| 17/124 | 118 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 18.21 | 17.4  | 14.73 |
| 17/124 | 118 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 18.45 | 17.24 | 15.19 |
| 17/124 | 118 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 18.6  | 17.91 | 14.76 |
| 17/124 | 118 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 18.69 | 18.24 | 14.52 |
| 17/124 | 118 | Caudal<br>Vertebra 1     | 17 | Cd1  | 18.65 | 17.3  | 13.84 |

|        |     |                       |    |     |       |       |       |
|--------|-----|-----------------------|----|-----|-------|-------|-------|
| 17/124 | 118 | Caudal<br>Vertebra 2  | 18 | Cd1 | 19.08 | 18.11 | 12.66 |
| 17/124 | 118 | Caudal<br>Vertebra 3  | 19 | Cd1 | 19.01 | 18.8  | 13.73 |
| 17/124 | 118 | Caudal<br>Vertebra 4  | 20 | Cd1 | 19.19 | 19.31 | 14.42 |
| 17/124 | 118 | Caudal<br>Vertebra 5  | 21 | Cd1 | 19.91 | 17.43 | 13.37 |
| 17/124 | 118 | Caudal<br>Vertebra 6  | 22 | Cd1 | 18.98 | 18.36 | 13.55 |
| 17/124 | 118 | Caudal<br>Vertebra 7  | 23 | Cd1 | 18.41 | 18.65 | 14.54 |
| 17/124 | 118 | Caudal<br>Vertebra 8  | 24 | Cd1 | 19    | 18.91 | 14.71 |
| 17/124 | 118 | Caudal<br>Vertebra 9  | 25 | Cd1 | 18.88 | 18.73 | 14.41 |
| 17/124 | 118 | Caudal<br>Vertebra 10 | 26 | Cd1 | 18.71 | 19.46 | 15.58 |
| 17/124 | 118 | Caudal<br>Vertebra 11 | 27 | Cd2 | 18.64 | 18.59 | 14.99 |
| 17/124 | 118 | Caudal<br>Vertebra 12 | 28 | Cd2 | 18.55 | 19.04 | 15.16 |
| 17/124 | 118 | Caudal<br>Vertebra 13 | 29 | Cd2 |       |       | 14.04 |
| 17/124 | 118 | Caudal<br>Vertebra 14 | 30 | Cd2 | 18.77 | 18.76 | 15.25 |
| 17/124 | 118 | Caudal<br>Vertebra 15 | 31 | Cd2 | 18.78 | 18.84 | 15.66 |
| 17/124 | 118 | Caudal<br>Vertebra 16 | 32 | Cd2 | 18.55 | 18.92 | 15.9  |
| 17/124 | 118 | Caudal<br>Vertebra 17 | 33 | Cd2 | 18.85 | 18.81 | 16.39 |
| 17/124 | 118 | Caudal<br>Vertebra 18 | 34 | Cd2 | 19.37 | 18.57 | 16.05 |
| 17/124 | 118 | Caudal<br>Vertebra 19 | 35 | Cd2 | 18.93 | 18.57 | 16.67 |
| 17/124 | 118 | Caudal<br>Vertebra 20 | 36 | Cd2 | 18.73 | 18.66 | 16.55 |
| 17/124 | 118 | Caudal<br>Vertebra 21 | 37 | Cd3 | 18.94 | 18.72 | 17.4  |
| 17/124 | 118 | Caudal<br>Vertebra 22 | 38 | Cd3 | 19    | 18.14 | 17.41 |
| 17/124 | 118 | Caudal<br>Vertebra 23 | 39 | Cd3 | 18.87 | 17.61 | 17.21 |
| 17/124 | 118 | Caudal<br>Vertebra 24 | 40 | Cd3 | 18.61 | 17.66 | 16.9  |
| 17/124 | 118 | Caudal<br>Vertebra 25 | 41 | Cd3 | 17.83 | 18.25 | 17.06 |
| 17/124 | 118 | Caudal<br>Vertebra 26 | 42 | Cd3 | 17.51 | 16.7  | 16.24 |
| 17/124 | 118 | Caudal<br>Vertebra 27 | 43 | Cd4 | 16.85 | 16.31 | 15.38 |
| 17/124 | 118 | Caudal<br>Vertebra 28 | 44 | Cd4 | 16.38 | 16.03 | 14.82 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/124 | 118 | Caudal<br>Vertebra 29    | 45 | Cd4  | 15.89 | 15.06 | 13.99 |
| 17/124 | 118 | Caudal<br>Vertebra 30    | 46 | Cd4  | 14.75 | 14.86 | 13.64 |
| 17/124 | 118 | Caudal<br>Vertebra 31    | 47 | Cd4  | 14.2  | 14.79 | 13.4  |
| 17/124 | 118 | Caudal<br>Vertebra 32    | 48 | Dist | 13.58 | 15.59 | 13.75 |
| 17/124 | 118 | Penultimate<br>Vertebrae | 49 | Dist | 13.01 | 14.81 | 12.66 |
| 17/125 | 105 | Atlas                    | 1  | Prox | 14.86 | 14.27 | 8.9   |
| 17/125 | 105 | Axis                     | 2  | Prox | 14.85 | 15.66 | 7.72  |
| 17/125 | 105 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 15.11 | 15.56 | 8.45  |
| 17/125 | 105 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 15.14 | 16.19 | 9.13  |
| 17/125 | 105 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 15.4  | 15.55 | 9.36  |
| 17/125 | 105 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 15.13 | 15.87 | 9.81  |
| 17/125 | 105 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 15.34 | 15.63 | 10.81 |
| 17/125 | 105 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 15.81 | 15.86 | 11.65 |
| 17/125 | 105 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 15.88 | 15.27 | 11.46 |
| 17/125 | 105 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 15.21 | 16.13 | 10.31 |
| 17/125 | 105 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 16.1  | 16.09 | 11.99 |
| 17/125 | 105 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 16.2  | 15.82 | 12.22 |
| 17/125 | 105 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 16.15 | 15.57 | 12.94 |
| 17/125 | 105 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 16.83 | 15.54 | 12.72 |
| 17/125 | 105 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 16.79 | 15.95 | 12.68 |
| 17/125 | 105 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 16.66 | 15.83 | 12.14 |
| 17/125 | 105 | Caudal<br>Vertebra 1     | 17 | Cd1  | 16.33 | 16.15 | 11.52 |
| 17/125 | 105 | Caudal<br>Vertebra 2     | 18 | Cd1  | 16.78 | 16.55 | 10.97 |
| 17/125 | 105 | Caudal<br>Vertebra 3     | 19 | Cd1  | 16.55 | 16.69 | 11.83 |
| 17/125 | 105 | Caudal<br>Vertebra 4     | 20 | Cd1  | 17.06 | 17.22 | 12.1  |
| 17/125 | 105 | Caudal<br>Vertebra 5     | 21 | Cd1  | 17.15 | 17.48 | 12.5  |
| 17/125 | 105 | Caudal<br>Vertebra 6     | 22 | Cd1  | 17.51 | 18.06 | 13.14 |
| 17/125 | 105 | Caudal<br>Vertebra 7     | 23 | Cd1  | 16.78 | 17.13 | 12.46 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/125 | 105 | Caudal<br>Vertebra 8     | 24 | Cd1  | 17    | 17.64 | 12.96 |
| 17/125 | 105 | Caudal<br>Vertebra 9     | 25 | Cd1  | 17.04 | 18.2  | 13.63 |
| 17/125 | 105 | Caudal<br>Vertebra 10    | 26 | Cd1  | 17.64 | 17.13 | 13.24 |
| 17/125 | 105 | Caudal<br>Vertebra 11    | 27 | Cd2  | 17.62 | 18.08 | 13.44 |
| 17/125 | 105 | Caudal<br>Vertebra 12    | 28 | Cd2  | 17.07 | 18.13 | 12.7  |
| 17/125 | 105 | Caudal<br>Vertebra 13    | 29 | Cd2  | 16.63 | 16.47 | 13.09 |
| 17/125 | 105 | Caudal<br>Vertebra 14    | 30 | Cd2  | 16.74 | 17.28 | 13.47 |
| 17/125 | 105 | Caudal<br>Vertebra 15    | 31 | Cd2  | 17.08 | 17.58 | 13.22 |
| 17/125 | 105 | Caudal<br>Vertebra 16    | 32 | Cd2  | 16.65 | 17.46 | 14.79 |
| 17/125 | 105 | Caudal<br>Vertebra 17    | 33 | Cd2  | 16.99 | 16.97 | 13.92 |
| 17/125 | 105 | Caudal<br>Vertebra 18    | 34 | Cd2  | 16.67 | 17.05 | 14.04 |
| 17/125 | 105 | Caudal<br>Vertebra 19    | 35 | Cd2  | 16.93 | 16.95 | 13.5  |
| 17/125 | 105 | Caudal<br>Vertebra 20    | 36 | Cd2  | 16.78 | 16.22 | 14.74 |
| 17/125 | 105 | Caudal<br>Vertebra 21    | 37 | Cd3  | 16.77 | 17.08 | 14.64 |
| 17/125 | 105 | Caudal<br>Vertebra 22    | 38 | Cd3  | 16.78 | 16.64 | 14.92 |
| 17/125 | 105 | Caudal<br>Vertebra 23    | 39 | Cd3  | 16.53 | 16.74 | 14.79 |
| 17/125 | 105 | Caudal<br>Vertebra 24    | 40 | Cd3  | 15.94 | 16.32 | 14.74 |
| 17/125 | 105 | Caudal<br>Vertebra 25    | 41 | Cd3  | 15.41 | 16.16 | 14.39 |
| 17/125 | 105 | Caudal<br>Vertebra 26    | 42 | Cd3  | 15.15 | 15.81 | 13.71 |
| 17/125 | 105 | Caudal<br>Vertebra 27    | 43 | Cd4  | 14.21 | 15.53 | 12.71 |
| 17/125 | 105 | Caudal<br>Vertebra 28    | 44 | Cd4  | 14.18 | 14.66 | 11.67 |
| 17/125 | 105 | Caudal<br>Vertebra 29    | 45 | Cd4  | 13.67 | 14.14 | 11.26 |
| 17/125 | 105 | Caudal<br>Vertebra 30    | 46 | Cd4  | 12.52 | 13.8  | 10.74 |
| 17/125 | 105 | Caudal<br>Vertebra 31    | 47 | Cd4  | 13.29 | 13.4  | 11.08 |
| 17/125 | 105 | Caudal<br>Vertebra 32    | 48 | Cd4  | 11.85 | 13.94 | 10.66 |
| 17/125 | 105 | Caudal<br>Vertebra 33    | 49 | Dist | 11.63 | 13.53 | 10.24 |
| 17/125 | 105 | Penultimate<br>Vertebrae | 50 | Dist | 11.26 | 11.85 | 9.32  |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/126 | 114 | Atlas                    | 1  | Prox | 16.55 | 15.31 | 9.04  |
| 17/126 | 114 | Axis                     | 2  | Prox | 16.89 | 15.82 | 8.24  |
| 17/126 | 114 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 17.3  | 17.07 | 9.49  |
| 17/126 | 114 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 17.09 | 17.58 | 9.86  |
| 17/126 | 114 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 17.18 | 16.79 | 9.74  |
| 17/126 | 114 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.88 | 17.29 | 10.57 |
| 17/126 | 114 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 16.5  | 18.1  | 11.07 |
| 17/126 | 114 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 17.69 | 17.4  | 11.56 |
| 17/126 | 114 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 18.11 | 17.74 | 13.01 |
| 17/126 | 114 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 18.37 | 18.09 | 13.71 |
| 17/126 | 114 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 18.53 | 18.29 | 12.92 |
| 17/126 | 114 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 18.48 | 18.73 | 13.52 |
| 17/126 | 114 | Abdominal<br>Vertebra 13 | 13 | Ab2  | 19.28 | 18.43 | 14.69 |
| 17/126 | 114 | Abdominal<br>Vertebra 14 | 14 | Ab2  | 19.21 | 18.67 | 14.18 |
| 17/126 | 114 | Abdominal<br>Vertebra 15 | 15 | Ab2  | 19.45 | 18.7  | 13.6  |
| 17/126 | 114 | Abdominal<br>Vertebra 16 | 16 | Ab2  | 19.73 | 18.99 | 14.22 |
| 17/126 | 114 | Caudal<br>Vertebra 1     | 17 | Cd1  | 19.08 | 19.33 | 13.1  |
| 17/126 | 114 | Caudal<br>Vertebra 2     | 18 | Cd1  | 19.92 | 19.78 | 12.2  |
| 17/126 | 114 | Caudal<br>Vertebra 3     | 19 | Cd1  | 20.08 | 20.07 | 13.65 |
| 17/126 | 114 | Caudal<br>Vertebra 4     | 20 | Cd1  | 19.87 | 20.58 | 14.06 |
| 17/126 | 114 | Caudal<br>Vertebra 5     | 21 | Cd1  | 19.42 | 20.35 | 13.22 |
| 17/126 | 114 | Caudal<br>Vertebra 6     | 22 | Cd1  | 19.88 | 20.68 | 13.9  |
| 17/126 | 114 | Caudal<br>Vertebra 7     | 23 | Cd1  | 20.03 | 20.54 | 12.53 |
| 17/126 | 114 | Caudal<br>Vertebra 8     | 24 | Cd1  | 19.83 | 19.17 | 12.85 |
| 17/126 | 114 | Caudal<br>Vertebra 9     | 25 | Cd1  | 19.76 | 20.52 | 13.41 |
| 17/126 | 114 | Caudal<br>Vertebra 10    | 26 | Cd1  | 20.19 | 19.55 | 14.25 |
| 17/126 | 114 | Caudal<br>Vertebra 11    | 27 | Cd2  | 20.45 | 20.82 | 14.14 |
| 17/126 | 114 | Caudal<br>Vertebra 12    | 28 | Cd2  | 20.06 | 20.66 | 14.12 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/126 | 114 | Caudal<br>Vertebra 13    | 29 | Cd2  | 20.03 | 19.81 | 14.26 |
| 17/126 | 114 | Caudal<br>Vertebra 14    | 30 | Cd2  | 20.28 | 19.95 | 15.13 |
| 17/126 | 114 | Caudal<br>Vertebra 15    | 31 | Cd2  | 20.8  | 19.91 | 14.6  |
| 17/126 | 114 | Caudal<br>Vertebra 16    | 32 | Cd2  | 20.5  | 19.7  | 15.14 |
| 17/126 | 114 | Caudal<br>Vertebra 17    | 33 | Cd2  | 20.7  | 20.74 | 16.11 |
| 17/126 | 114 | Caudal<br>Vertebra 18    | 34 | Cd2  | 20.71 | 20.25 | 15.18 |
| 17/126 | 114 | Caudal<br>Vertebra 19    | 35 | Cd2  | 20.49 | 20.23 | 15.36 |
| 17/126 | 114 | Caudal<br>Vertebra 20    | 36 | Cd2  | 20.47 | 20.66 | 15.98 |
| 17/126 | 114 | Caudal<br>Vertebra 21    | 37 | Cd3  | 20.43 | 20.04 | 16.79 |
| 17/126 | 114 | Caudal<br>Vertebra 22    | 38 | Cd3  | 20.35 | 19.96 | 17.58 |
| 17/126 | 114 | Caudal<br>Vertebra 23    | 39 | Cd3  | 20.12 | 19.97 | 16.74 |
| 17/126 | 114 | Caudal<br>Vertebra 24    | 40 | Cd3  | 19.91 | 19.5  | 16.55 |
| 17/126 | 114 | Caudal<br>Vertebra 25    | 41 | Cd3  | 19.55 | 18.37 | 16.35 |
| 17/126 | 114 | Caudal<br>Vertebra 26    | 42 | Cd3  | 18.76 | 18.07 | 14.95 |
| 17/126 | 114 | Caudal<br>Vertebra 27    | 43 | Cd4  | 17.72 | 17.34 | 14.28 |
| 17/126 | 114 | Caudal<br>Vertebra 28    | 44 | Cd4  | 17.15 | 16.01 | 13.5  |
| 17/126 | 114 | Caudal<br>Vertebra 29    | 45 | Cd4  | 16.21 | 15.97 | 12.99 |
| 17/126 | 114 | Caudal<br>Vertebra 30    | 46 | Cd4  | 15.66 | 15.82 | 12.69 |
| 17/126 | 114 | Caudal<br>Vertebra 31    | 47 | Cd4  | 13.74 | 15.36 | 12.07 |
| 17/126 | 114 | Caudal<br>Vertebra 32    | 48 | Cd4  | 13.77 | 16.39 | 12.29 |
| 17/126 | 114 | Caudal<br>Vertebra 33    | 49 | Dist | 12.87 | 14.62 | 10.81 |
| 17/126 | 114 | Penultimate<br>Vertebrae | 50 | Dist | 11.88 | 12.92 | 9.11  |
| 17/127 | 118 | Atlas                    | 1  | Prox | 18.46 | 15.63 | 9.69  |
| 17/127 | 118 | Axis                     | 2  | Prox | 16.81 | 17.11 | 8.4   |
| 17/127 | 118 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 16.76 | 18.52 | 9.43  |
| 17/127 | 118 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.46 | 17.42 | 9.79  |
| 17/127 | 118 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 16.55 | 17.93 | 10.32 |
| 17/127 | 118 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.8  | 17.85 | 10.06 |

|        |     |                          |    |     |       |       |       |
|--------|-----|--------------------------|----|-----|-------|-------|-------|
| 17/127 | 118 | Abdominal<br>Vertebra 7  | 7  | Ab1 | 17.64 | 17.31 | 11.85 |
| 17/127 | 118 | Abdominal<br>Vertebra 8  | 8  | Ab1 | 16.83 | 17.97 | 11.78 |
| 17/127 | 118 | Abdominal<br>Vertebra 9  | 9  | Ab1 | 17.15 | 18    | 12.41 |
| 17/127 | 118 | Abdominal<br>Vertebra 10 | 10 | Ab2 | 18.26 | 18.04 | 13.27 |
| 17/127 | 118 | Abdominal<br>Vertebra 11 | 11 | Ab2 | 18.36 | 19.12 | 13.21 |
| 17/127 | 118 | Abdominal<br>Vertebra 12 | 12 | Ab2 | 18.41 | 18.69 | 13.25 |
| 17/127 | 118 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 18.97 | 19.03 | 13.83 |
| 17/127 | 118 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 18.99 | 18.7  | 14.18 |
| 17/127 | 118 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 19.22 | 19.03 | 14.16 |
| 17/127 | 118 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 19.44 | 19.24 | 13.94 |
| 17/127 | 118 | Caudal<br>Vertebra 1     | 17 | Cd1 | 19.16 | 19.56 | 13.12 |
| 17/127 | 118 | Caudal<br>Vertebra 2     | 18 | Cd1 | 18.98 | 19.94 | 12.34 |
| 17/127 | 118 | Caudal<br>Vertebra 3     | 19 | Cd1 | 20.03 | 19.96 | 12.87 |
| 17/127 | 118 | Caudal<br>Vertebra 4     | 20 | Cd1 | 19.83 | 20.83 | 13.53 |
| 17/127 | 118 | Caudal<br>Vertebra 5     | 21 | Cd1 | 19.74 | 20.29 | 12.91 |
| 17/127 | 118 | Caudal<br>Vertebra 6     | 22 | Cd1 | 19.77 | 19.88 | 12.98 |
| 17/127 | 118 | Caudal<br>Vertebra 7     | 23 | Cd1 | 20.07 | 20.81 | 13.89 |
| 17/127 | 118 | Caudal<br>Vertebra 8     | 24 | Cd1 | 19.44 | 20.77 | 14.57 |
| 17/127 | 118 | Caudal<br>Vertebra 9     | 25 | Cd1 | 20.06 | 21    | 13.78 |
| 17/127 | 118 | Caudal<br>Vertebra 10    | 26 | Cd1 | 20.11 | 19.78 | 14.02 |
| 17/127 | 118 | Caudal<br>Vertebra 11    | 27 | Cd2 | 19.17 | 20.59 | 13.86 |
| 17/127 | 118 | Caudal<br>Vertebra 12    | 28 | Cd2 | 20.13 | 20.7  | 14.77 |
| 17/127 | 118 | Caudal<br>Vertebra 13    | 29 | Cd2 | 20.01 | 20.31 | 15    |
| 17/127 | 118 | Caudal<br>Vertebra 14    | 30 | Cd2 | 19.92 | 19.97 | 15.46 |
| 17/127 | 118 | Caudal<br>Vertebra 15    | 31 | Cd2 | 19.82 | 20.39 | 14.62 |
| 17/127 | 118 | Caudal<br>Vertebra 16    | 32 | Cd2 | 20.12 | 19.1  | 17.03 |
| 17/127 | 118 | Caudal<br>Vertebra 17    | 33 | Cd2 | 19.89 | 20.46 | 15.72 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/127 | 118 | Caudal<br>Vertebra 18    | 34 | Cd2  | 19.8  | 20.22 | 16.14 |
| 17/127 | 118 | Caudal<br>Vertebra 19    | 35 | Cd2  | 20.06 | 20.52 | 14.86 |
| 17/127 | 118 | Caudal<br>Vertebra 20    | 36 | Cd2  | 20.02 | 20.06 | 15.74 |
| 17/127 | 118 | Caudal<br>Vertebra 21    | 37 | Cd3  | 19.73 | 19.93 | 17.02 |
| 17/127 | 118 | Caudal<br>Vertebra 22    | 38 | Cd3  | 19.25 | 19.88 | 16.75 |
| 17/127 | 118 | Caudal<br>Vertebra 23    | 39 | Cd3  | 19    | 19.02 | 17.22 |
| 17/127 | 118 | Caudal<br>Vertebra 24    | 40 | Cd3  | 19.75 | 19.2  | 17.1  |
| 17/127 | 118 | Caudal<br>Vertebra 25    | 41 | Cd3  | 18.79 | 18.68 | 16.69 |
| 17/127 | 118 | Caudal<br>Vertebra 26    | 42 | Cd3  | 17.93 | 18.93 | 15.08 |
| 17/127 | 118 | Caudal<br>Vertebra 27    | 43 | Cd4  | 17.01 | 17.46 | 14.54 |
| 17/127 | 118 | Caudal<br>Vertebra 28    | 44 | Cd4  | 16.89 | 16.43 | 14.05 |
| 17/127 | 118 | Caudal<br>Vertebra 29    | 45 | Cd4  | 15.43 | 16.25 | 12.78 |
| 17/127 | 118 | Caudal<br>Vertebra 30    | 46 | Cd4  | 15.34 | 16.14 | 12.11 |
| 17/127 | 118 | Caudal<br>Vertebra 31    | 47 | Cd4  | 14.47 | 16.73 | 11.88 |
| 17/127 | 118 | Caudal<br>Vertebra 32    | 48 | Dist | 13.88 | 16.33 | 12.4  |
| 17/127 | 118 | Penultimate<br>Vertebrae | 49 | Dist | 13.44 | 14.4  | 11.82 |
| 17/128 | 116 | Atlas                    | 1  | Prox | 16.53 | 15.78 | 7.96  |
| 17/128 | 116 | Axis                     | 2  | Prox | 16.54 | 17.18 | 8.24  |
| 17/128 | 116 | Abdominal<br>Vertebra 3  | 3  | Ab1  | 16.75 | 17.39 | 9.15  |
| 17/128 | 116 | Abdominal<br>Vertebra 4  | 4  | Ab1  | 16.24 | 17.61 | 9.88  |
| 17/128 | 116 | Abdominal<br>Vertebra 5  | 5  | Ab1  | 16.54 | 17.46 | 9.85  |
| 17/128 | 116 | Abdominal<br>Vertebra 6  | 6  | Ab1  | 16.26 | 17.28 | 10.34 |
| 17/128 | 116 | Abdominal<br>Vertebra 7  | 7  | Ab1  | 17.14 | 16.74 | 10.67 |
| 17/128 | 116 | Abdominal<br>Vertebra 8  | 8  | Ab1  | 16.93 | 17.37 | 11.39 |
| 17/128 | 116 | Abdominal<br>Vertebra 9  | 9  | Ab1  | 17.67 | 17.64 | 12.29 |
| 17/128 | 116 | Abdominal<br>Vertebra 10 | 10 | Ab2  | 17.99 | 17.38 | 12.54 |
| 17/128 | 116 | Abdominal<br>Vertebra 11 | 11 | Ab2  | 18.52 | 18.03 | 12.97 |
| 17/128 | 116 | Abdominal<br>Vertebra 12 | 12 | Ab2  | 18.58 | 18.31 | 13.42 |

|        |     |                          |    |     |       |       |       |
|--------|-----|--------------------------|----|-----|-------|-------|-------|
| 17/128 | 116 | Abdominal<br>Vertebra 13 | 13 | Ab2 | 18.98 | 19.27 | 13.82 |
| 17/128 | 116 | Abdominal<br>Vertebra 14 | 14 | Ab2 | 19.41 | 19.25 | 13.82 |
| 17/128 | 116 | Abdominal<br>Vertebra 15 | 15 | Ab2 | 19.35 | 19.03 | 14.18 |
| 17/128 | 116 | Abdominal<br>Vertebra 16 | 16 | Ab2 | 19.47 | 19.91 | 13.39 |
| 17/128 | 116 | Caudal<br>Vertebra 1     | 17 | Cd1 | 19.39 | 19.33 | 13.13 |
| 17/128 | 116 | Caudal<br>Vertebra 2     | 18 | Cd1 | 19.9  | 19.37 | 12.65 |
| 17/128 | 116 | Caudal<br>Vertebra 3     | 19 | Cd1 | 20.34 | 19.99 | 12.96 |
| 17/128 | 116 | Caudal<br>Vertebra 4     | 20 | Cd1 | 20.14 | 20.68 | 13.1  |
| 17/128 | 116 | Caudal<br>Vertebra 5     | 21 | Cd1 | 19.69 | 19.97 | 13.18 |
| 17/128 | 116 | Caudal<br>Vertebra 6     | 22 | Cd1 | 19.82 | 20.15 | 13.86 |
| 17/128 | 116 | Caudal<br>Vertebra 7     | 23 | Cd1 | 20.38 | 19.53 | 12.36 |
| 17/128 | 116 | Caudal<br>Vertebra 8     | 24 | Cd1 | 19.18 | 20.16 | 13.92 |
| 17/128 | 116 | Caudal<br>Vertebra 9     | 25 | Cd1 | 19.9  | 20.15 | 15.11 |
| 17/128 | 116 | Caudal<br>Vertebra 10    | 26 | Cd1 | 19.5  | 19.52 | 13.35 |
| 17/128 | 116 | Caudal<br>Vertebra 11    | 27 | Cd2 | 19.65 | 19.86 | 13.79 |
| 17/128 | 116 | Caudal<br>Vertebra 12    | 28 | Cd2 | 19.78 | 19.5  | 14.44 |
| 17/128 | 116 | Caudal<br>Vertebra 13    | 29 | Cd2 | 19.79 | 20.28 | 14.19 |
| 17/128 | 116 | Caudal<br>Vertebra 14    | 30 | Cd2 | 19.4  | 20.25 | 14.54 |
| 17/128 | 116 | Caudal<br>Vertebra 15    | 31 | Cd2 | 19.74 | 19.03 | 15.14 |
| 17/128 | 116 | Caudal<br>Vertebra 16    | 32 | Cd2 | 19.41 | 18.93 | 15.41 |
| 17/128 | 116 | Caudal<br>Vertebra 17    | 33 | Cd2 | 19.8  | 19.77 | 15.97 |
| 17/128 | 116 | Caudal<br>Vertebra 18    | 34 | Cd2 | 20    | 20    | 15.1  |
| 17/128 | 116 | Caudal<br>Vertebra 19    | 35 | Cd2 | 19.44 | 19.68 | 16.24 |
| 17/128 | 116 | Caudal<br>Vertebra 20    | 36 | Cd2 | 19.84 | 18.02 | 16.41 |
| 17/128 | 116 | Caudal<br>Vertebra 21    | 37 | Cd3 | 19.6  | 19.51 | 14.26 |
| 17/128 | 116 | Caudal<br>Vertebra 22    | 38 | Cd3 | 19.19 | 19.22 | 16.41 |
| 17/128 | 116 | Caudal<br>Vertebra 23    | 39 | Cd3 | 18.17 | 18.77 | 16.27 |

|        |     |                          |    |      |       |       |       |
|--------|-----|--------------------------|----|------|-------|-------|-------|
| 17/128 | 116 | Caudal<br>Vertebra 24    | 40 | Cd3  | 18.44 | 18.69 | 16.35 |
| 17/128 | 116 | Caudal<br>Vertebra 25    | 41 | Cd3  | 17.54 | 18.18 | 14.65 |
| 17/128 | 116 | Caudal<br>Vertebra 26    | 42 | Cd3  | 16.99 | 17.56 | 13.77 |
| 17/128 | 116 | Caudal<br>Vertebra 27    | 43 | Cd4  | 16.45 | 17.35 | 13.35 |
| 17/128 | 116 | Caudal<br>Vertebra 28    | 44 | Cd4  | 17.47 | 17.18 | 12.96 |
| 17/128 | 116 | Caudal<br>Vertebra 29    | 45 | Cd4  | 15.55 | 16.73 | 12.56 |
| 17/128 | 116 | Caudal<br>Vertebra 30    | 46 | Cd4  | 15.17 | 16.4  | 12.48 |
| 17/128 | 116 | Caudal<br>Vertebra 31    | 47 | Cd4  | 13.73 | 16.86 | 11.3  |
| 17/128 | 116 | Caudal<br>Vertebra 32    | 48 | Dist | 13.3  | 15.8  | 11.02 |
| 17/128 | 116 | Penultimate<br>Vertebrae | 49 | Dist | 12.7  | 13.96 | 10.09 |

## Appendix G: Reference Collection Measurements for Other Regression Formulae

| Specimen | Element           | Side | Measurement (mm) | Fork Length (cm) |
|----------|-------------------|------|------------------|------------------|
| 00/73    | Articular 4       | L    | 8.39             | 91               |
| 00/73    | Articular 4       | R    | 7.95             | 91               |
| 00/73    | PreMaxilla 1      | L    | 50.61            | 91               |
| 00/73    | PreMaxilla 1      | R    | 44.97            | 91               |
| 00/73    | PreMaxilla 3      | L    | 14.63            | 91               |
| 00/73    | PreMaxilla 3      | R    | 14.92            | 91               |
| 00/73    | Quadrate 3        | L    | 9.30             | 91               |
| 00/73    | Quadrate 3        | R    | 9.61             | 91               |
| 00/73    | Quadrate 4        | L    | 41.03            | 91               |
| 00/73    | Quadrate 4        | R    | 44.83            | 91               |
| 00/73    | Maxilla 2         | L    | 15.11            | 91               |
| 00/73    | Maxilla 2         | R    | 15.08            | 91               |
| 00/73    | Maxilla 3         | L    | 11.80            | 91               |
| 00/73    | Maxilla 3         | R    | 13.02            | 91               |
| 00/73    | Tail Assemblage 2 | N/A  | 8.48             | 91               |
| 00/82    | Articular 4       | L    | 9.80             | 104              |
| 00/82    | Articular 4       | R    | 9.26             | 104              |
| 00/82    | PreMaxilla 1      | L    | 53.11            | 104              |
| 00/82    | PreMaxilla 1      | R    | 48.77            | 104              |
| 00/82    | PreMaxilla 3      | L    | 16.36            | 104              |
| 00/82    | PreMaxilla 3      | R    | 16.12            | 104              |
| 00/82    | Quadrate 3        | L    | 10.99            | 104              |
| 00/82    | Quadrate 3        | R    | 10.48            | 104              |
| 00/82    | Quadrate 4        | L    | 45.44            | 104              |
| 00/82    | Quadrate 4        | R    | 50.58            | 104              |
| 00/82    | Maxilla 2         | L    | 15.31            | 104              |
| 00/82    | Maxilla 2         | R    | 14.77            | 104              |
| 00/82    | Maxilla 3         | L    | 12.26            | 104              |
| 00/82    | Maxilla 3         | R    | 13.86            | 104              |
| 00/82    | Tail Assemblage 2 | N/A  | 9.54             | 104              |
| 01/70    | Articular 4       | L    | 2.20             | 28               |
| 01/70    | Articular 4       | R    | 2.21             | 28               |
| 01/70    | PreMaxilla 1      | L    | 13.06            | 28               |
| 01/70    | PreMaxilla 1      | R    | 11.70            | 28               |
| 01/70    | PreMaxilla 3      | L    | 4.91             | 28               |
| 01/70    | PreMaxilla 3      | R    | 4.24             | 28               |
| 01/70    | Quadrate 3        | L    | 2.67             | 28               |
| 01/70    | Quadrate 3        | R    | 2.64             | 28               |
| 01/70    | Quadrate 4        | L    | 14.5             | 28               |
| 01/70    | Quadrate 4        | R    | 13.17            | 28               |
| 01/70    | Maxilla 2         | L    | 3.94             | 28               |
| 01/70    | Maxilla 2         | R    | 3.82             | 28               |
| 01/70    | Maxilla 3         | L    | 3.28             | 28               |

|       |                   |     |       |      |
|-------|-------------------|-----|-------|------|
| 01/70 | Maxilla 3         | R   | 4.01  | 28   |
| 01/70 | Tail Assemblage 2 | N/A | 2.33  | 28   |
| 01/71 | Articular 4       | L   | 2.92  | 34   |
| 01/71 | Articular 4       | R   | 2.96  | 34   |
| 01/71 | PreMaxilla 1      | L   | 15.87 | 34   |
| 01/71 | PreMaxilla 1      | R   | 14.77 | 34   |
| 01/71 | PreMaxilla 3      | L   | 5.84  | 34   |
| 01/71 | PreMaxilla 3      | R   | 5.23  | 34   |
| 01/71 | Quadrate 3        | L   | 3.35  | 34   |
| 01/71 | Quadrate 3        | R   | 3.22  | 34   |
| 01/71 | Quadrate 4        | L   | 15.08 | 34   |
| 01/71 | Quadrate 4        | R   | 16.87 | 34   |
| 01/71 | Maxilla 2         | L   | 4.80  | 34   |
| 01/71 | Maxilla 2         | R   | 4.67  | 34   |
| 01/71 | Maxilla 3         | L   | 4.01  | 34   |
| 01/71 | Maxilla 3         | R   | 4.36  | 34   |
| 01/71 | Tail Assemblage 2 | N/A | 2.97  | 34   |
| 01/72 | Articular 4       | L   | 2.73  | 32   |
| 01/72 | Articular 4       | R   | 2.57  | 32   |
| 01/72 | PreMaxilla 1      | L   | 16.30 | 32   |
| 01/72 | PreMaxilla 1      | R   | 13.89 | 32   |
| 01/72 | PreMaxilla 3      | L   | 5.61  | 32   |
| 01/72 | PreMaxilla 3      | R   |       | 32   |
| 01/72 | Quadrate 3        | L   | 3.32  | 32   |
| 01/72 | Quadrate 3        | R   | 3.23  | 31.7 |
| 01/72 | Quadrate 4        | L   | 14.8  | 31.7 |
| 01/72 | Quadrate 4        | R   | 15.78 | 31.7 |
| 01/72 | Maxilla 2         | L   | 4.60  | 31.7 |
| 01/72 | Maxilla 2         | R   | 4.49  | 31.7 |
| 01/72 | Maxilla 3         | L   | 4.03  | 31.7 |
| 01/72 | Maxilla 3         | R   | 3.89  | 31.7 |
| 01/72 | Tail Assemblage 2 | N/A | 3.03  | 31.7 |
| 04/40 | Articular 4       | L   | 16.31 | 163  |
| 04/40 | Articular 4       | R   | 16.22 | 163  |
| 04/40 | PreMaxilla 1      | L   | 95.74 | 163  |
| 04/40 | PreMaxilla 1      | R   | 89.11 | 163  |
| 04/40 | PreMaxilla 3      | L   | 25.85 | 163  |
| 04/40 | PreMaxilla 3      | R   | 25.40 | 163  |
| 04/40 | Quadrate 3        | L   | 18.75 | 163  |
| 04/40 | Quadrate 3        | R   | 17.95 | 163  |
| 04/40 | Quadrate 4        | L   | 73.22 | 163  |
| 04/40 | Quadrate 4        | R   | 78.68 | 163  |
| 04/40 | Maxilla 2         | L   | 29.27 | 163  |
| 04/40 | Maxilla 2         | R   | 28.52 | 163  |
| 04/40 | Maxilla 3         | L   | 22.60 | 163  |
| 04/40 | Maxilla 3         | R   | 24.46 | 163  |
| 04/40 | Tail Assemblage 2 | N/A |       | 163  |
| 04/41 | Articular 4       | L   | 11.44 | 125  |

|       |                   |     |       |     |
|-------|-------------------|-----|-------|-----|
| 04/41 | Articular 4       | R   | 10.36 | 125 |
| 04/41 | PreMaxilla 1      | L   | 60.18 | 125 |
| 04/41 | PreMaxilla 1      | R   | 59.32 | 125 |
| 04/41 | PreMaxilla 3      | L   | 17.17 | 125 |
| 04/41 | PreMaxilla 3      | R   | 16.30 | 125 |
| 04/41 | Quadrate 3        | L   | 12.74 | 125 |
| 04/41 | Quadrate 3        | R   | 12.62 | 125 |
| 04/41 | Quadrate 4        | L   | 52.95 | 125 |
| 04/41 | Quadrate 4        | R   | 57.61 | 125 |
| 04/41 | Maxilla 2         | L   | 18.88 | 125 |
| 04/41 | Maxilla 2         | R   | 18.46 | 125 |
| 04/41 | Maxilla 3         | L   | 15.62 | 125 |
| 04/41 | Maxilla 3         | R   | 15.90 | 125 |
| 04/41 | Tail Assemblage 2 | N/A | 12.34 | 125 |
| 04/45 | Articular 4       | L   | 11.70 | 120 |
| 04/45 | Articular 4       | R   | 11.72 | 120 |
| 04/45 | PreMaxilla 1      | L   | 62.04 | 120 |
| 04/45 | PreMaxilla 1      | R   | 54.70 | 120 |
| 04/45 | PreMaxilla 3      | L   | 17.40 | 120 |
| 04/45 | PreMaxilla 3      | R   | 17.99 | 120 |
| 04/45 | Quadrate 3        | L   | 13.60 | 120 |
| 04/45 | Quadrate 3        | R   | 13.49 | 120 |
| 04/45 | Quadrate 4        | L   | 53.00 | 120 |
| 04/45 | Quadrate 4        | R   | 57.44 | 120 |
| 04/45 | Maxilla 2         | L   | 19.21 | 120 |
| 04/45 | Maxilla 2         | R   | 18.03 | 120 |
| 04/45 | Maxilla 3         | L   | 15.40 | 120 |
| 04/45 | Maxilla 3         | R   | 16.69 | 120 |
| 04/45 | Tail Assemblage 2 | N/A | 11.65 | 120 |
| 04/53 | Articular 4       | L   | 10.45 | 97  |
| 04/53 | Articular 4       | R   | 9.38  | 97  |
| 04/53 | PreMaxilla 1      | L   |       | 97  |
| 04/53 | PreMaxilla 1      | R   | 55.63 | 97  |
| 04/53 | PreMaxilla 3      | L   | 14.78 | 97  |
| 04/53 | PreMaxilla 3      | R   | 15.89 | 97  |
| 04/53 | Quadrate 3        | L   | 12.29 | 97  |
| 04/53 | Quadrate 3        | R   | 12.24 | 97  |
| 04/53 | Quadrate 4        | L   | 46.53 | 97  |
| 04/53 | Quadrate 4        | R   | 51.08 | 97  |
| 04/53 | Maxilla 2         | L   | 17.56 | 97  |
| 04/53 | Maxilla 2         | R   | 16.60 | 97  |
| 04/53 | Maxilla 3         | L   | 14.13 | 97  |
| 04/53 | Maxilla 3         | R   | 13.58 | 97  |
| 04/53 | Tail Assemblage 2 | N/A | 9.71  | 97  |
| 04/54 | Articular 4       | L   | 8.04  | 78  |
| 04/54 | Articular 4       | R   | 7.68  | 78  |
| 04/54 | PreMaxilla 1      | L   | 47.99 | 78  |
| 04/54 | PreMaxilla 1      | R   | 43.28 | 78  |
| 04/54 | PreMaxilla 3      | L   | 12.97 | 78  |

|       |                   |     |       |     |
|-------|-------------------|-----|-------|-----|
| 04/54 | PreMaxilla 3      | R   | 11.80 | 78  |
| 04/54 | Quadrate 3        | L   | 8.58  | 78  |
| 04/54 | Quadrate 3        | R   | 9.2   | 78  |
| 04/54 | Quadrate 4        | L   | 38.80 | 78  |
| 04/54 | Quadrate 4        | R   | 41.42 | 78  |
| 04/54 | Maxilla 2         | L   | 14.49 | 78  |
| 04/54 | Maxilla 2         | R   | 14.05 | 78  |
| 04/54 | Maxilla 3         | L   | 11.84 | 78  |
| 04/54 | Maxilla 3         | R   | 12.72 | 78  |
| 04/54 | Tail Assemblage 2 | N/A |       | 78  |
| 04/55 | Articular 4       | L   | 12.59 | 122 |
| 04/55 | Articular 4       | R   | 11.58 | 122 |
| 04/55 | PreMaxilla 1      | L   | 67.83 | 122 |
| 04/55 | PreMaxilla 1      | R   | 62.43 | 122 |
| 04/55 | PreMaxilla 3      | L   | 18.35 | 122 |
| 04/55 | PreMaxilla 3      | R   | 16.97 | 122 |
| 04/55 | Quadrate 3        | L   | 14.28 | 122 |
| 04/55 | Quadrate 3        | R   | 14.5  | 122 |
| 04/55 | Quadrate 4        | L   | 59.65 | 122 |
| 04/55 | Quadrate 4        | R   | 54.38 | 122 |
| 04/55 | Maxilla 2         | L   | 20.30 | 122 |
| 04/55 | Maxilla 2         | R   | 19.64 | 122 |
| 04/55 | Maxilla 3         | L   | 17.36 | 122 |
| 04/55 | Maxilla 3         | R   | 18.18 | 122 |
| 04/55 | Tail Assemblage 2 | N/A | 12.90 | 122 |
| 04/56 | Articular 4       | L   | 8.30  | 90  |
| 04/56 | Articular 4       | R   | 7.97  | 90  |
| 04/56 | PreMaxilla 1      | L   | 49.02 | 90  |
| 04/56 | PreMaxilla 1      | R   | 45.34 | 90  |
| 04/56 | PreMaxilla 3      | L   | 12.83 | 90  |
| 04/56 | PreMaxilla 3      | R   | 13.38 | 90  |
| 04/56 | Quadrate 3        | L   |       | 90  |
| 04/56 | Quadrate 3        | R   | 9.88  | 90  |
| 04/56 | Quadrate 4        | L   | 37.70 | 90  |
| 04/56 | Quadrate 4        | R   | 42.61 | 90  |
| 04/56 | Maxilla 2         | L   | 11.40 | 90  |
| 04/56 | Maxilla 2         | R   | 14.19 | 90  |
| 04/56 | Maxilla 3         | L   | 11.30 | 90  |
| 04/56 | Maxilla 3         | R   | 13.06 | 90  |
| 04/56 | Tail Assemblage 2 | N/A | 8.36  | 90  |
| 04/57 | Articular 4       | L   | 8.35  | 90  |
| 04/57 | Articular 4       | R   | 7.75  | 90  |
| 04/57 | PreMaxilla 1      | L   | 47.15 | 90  |
| 04/57 | PreMaxilla 1      | R   | 43.43 | 90  |
| 04/57 | PreMaxilla 3      | L   | 12.88 | 90  |
| 04/57 | PreMaxilla 3      | R   | 12.19 | 90  |
| 04/57 | Quadrate 3        | L   | 10.20 | 90  |
| 04/57 | Quadrate 3        | R   | 9.14  | 90  |
| 04/57 | Quadrate 4        | L   | 40.18 | 90  |

|         |                   |     |       |     |
|---------|-------------------|-----|-------|-----|
| 04/57   | Quadrate 4        | R   | 45.34 | 90  |
| 04/57   | Maxilla 2         | L   | 14.05 | 90  |
| 04/57   | Maxilla 2         | R   | 13.67 | 90  |
| 04/57   | Maxilla 3         | L   | 11.93 | 90  |
| 04/57   | Maxilla 3         | R   | 13.37 | 90  |
| 04/57   | Tail Assemblage 2 | N/A | 8.95  | 90  |
| 2004/91 | Articular 4       | L   | 15.84 | 158 |
| 2004/91 | Articular 4       | R   | 15.68 | 158 |
| 2004/91 | PreMaxilla 1      | L   | 85.95 | 158 |
| 2004/91 | PreMaxilla 1      | R   | 80.84 | 158 |
| 2004/91 | PreMaxilla 3      | L   | 25.5  | 158 |
| 2004/91 | PreMaxilla 3      | R   | 23.5  | 158 |
| 2004/91 | Quadrate 3        | L   | 16.4  | 158 |
| 2004/91 | Quadrate 3        | R   | 15.8  | 158 |
| 2004/91 | Quadrate 4        | L   | 68.36 | 158 |
| 2004/91 | Quadrate 4        | R   | 75.26 | 158 |
| 2004/91 | Maxilla 2         | L   | 25.48 | 158 |
| 2004/91 | Maxilla 2         | R   | 25.34 | 158 |
| 2004/91 | Maxilla 3         | L   | 19.94 | 158 |
| 2004/91 | Maxilla 3         | R   | 21.67 | 158 |
| 2004/91 | Tail Assemblage 2 | N/A | 16.24 | 158 |
| 2013/5  | Articular 4       | L   | 5.9   | 62  |
| 2013/5  | Articular 4       | R   | 6.16  | 62  |
| 2013/5  | PreMaxilla 1      | L   | 37.05 | 62  |
| 2013/5  | PreMaxilla 1      | R   | 34.15 | 62  |
| 2013/5  | PreMaxilla 3      | L   | 10.88 | 62  |
| 2013/5  | PreMaxilla 3      | R   | 10.14 | 62  |
| 2013/5  | Quadrate 3        | L   | 7.1   | 62  |
| 2013/5  | Quadrate 3        | R   | 7.21  | 62  |
| 2013/5  | Quadrate 4        | L   | 29.43 | 62  |
| 2013/5  | Quadrate 4        | R   | 32.42 | 62  |
| 2013/5  | Maxilla 2         | L   | 11.01 | 62  |
| 2013/5  | Maxilla 2         | R   | 11.07 | 62  |
| 2013/5  | Maxilla 3         | L   | 8.5   | 62  |
| 2013/5  | Maxilla 3         | R   | 10.06 | 62  |
| 2013/5  | Tail Assemblage 2 | N/A | 6.25  | 62  |
| 2013/6  | Articular 4       | L   | 5.4   | 61  |
| 2013/6  | Articular 4       | R   | 6.05  | 61  |
| 2013/6  | PreMaxilla 1      | L   | 33.16 | 61  |
| 2013/6  | PreMaxilla 1      | R   | 29.7  | 61  |
| 2013/6  | PreMaxilla 3      | L   | 9.7   | 61  |
| 2013/6  | PreMaxilla 3      | R   | 9.3   | 61  |
| 2013/6  | Quadrate 3        | L   | 6.01  | 61  |
| 2013/6  | Quadrate 3        | R   | 6.11  | 61  |
| 2013/6  | Quadrate 4        | L   | 27.13 | 61  |
| 2013/6  | Quadrate 4        | R   | 29.35 | 61  |
| 2013/6  | Maxilla 2         | L   | 10.26 | 61  |
| 2013/6  | Maxilla 2         | R   | 10.33 | 61  |
| 2013/6  | Maxilla 3         | L   | 8.3   | 61  |

|          |                   |     |       |       |
|----------|-------------------|-----|-------|-------|
| 2013/6   | Maxilla 3         | R   | 9.33  | 61    |
| 2013/6   | Tail Assemblage 2 | N/A | 5.99  | 61    |
| 2015/21  | Articular 4       | L   | 1.73  | 19.5  |
| 2015/21  | Articular 4       | R   | 1.95  | 19.5  |
| 2015/21  | PreMaxilla 1      | L   |       | 19.5  |
| 2015/21  | PreMaxilla 1      | R   | 11.02 | 19.5  |
| 2015/21  | PreMaxilla 3      | L   | 3.86  | 19.5  |
| 2015/21  | PreMaxilla 3      | R   | 3.24  | 19.5  |
| 2015/21  | Quadrate 3        | L   | 2.34  | 19.5  |
| 2015/21  | Quadrate 3        | R   | 2.31  | 19.5  |
| 2015/21  | Quadrate 4        | L   | 10.35 | 19.5  |
| 2015/21  | Quadrate 4        | R   | 12.02 | 19.5  |
| 2015/21  | Maxilla 2         | L   | 3.55  | 19.5  |
| 2015/21  | Maxilla 2         | R   | 3.59  | 19.5  |
| 2015/21  | Maxilla 3         | L   | 2.92  | 19.5  |
| 2015/21  | Maxilla 3         | R   | 3.24  | 19.5  |
| 2015/21  | Tail Assemblage 2 | N/A | 2.02  | 19.5  |
| 2017/117 | Articular 4       | L   | 9.93  | 99    |
| 2017/117 | Articular 4       | R   | 9.65  | 99    |
| 2017/117 | PreMaxilla 1      | L   | 54.18 | 99    |
| 2017/117 | PreMaxilla 1      | R   | 48.06 | 99    |
| 2017/117 | PreMaxilla 3      | L   | 16.08 | 99    |
| 2017/117 | PreMaxilla 3      | R   | 15.68 | 99    |
| 2017/117 | Quadrate 3        | L   | 10.32 | 99    |
| 2017/117 | Quadrate 3        | R   | 9.92  | 99    |
| 2017/117 | Quadrate 4        | L   | 43.41 | 99    |
| 2017/117 | Quadrate 4        | R   | 49.9  | 99    |
| 2017/117 | Maxilla 2         | L   | 14.89 | 99    |
| 2017/117 | Maxilla 2         | R   | 15.93 | 99    |
| 2017/117 | Maxilla 3         | L   | 13.29 | 99    |
| 2017/117 | Maxilla 3         | R   | 13.54 | 99    |
| 2017/117 | Tail Assemblage 2 | N/A | 8.27  | 99    |
| 2017/118 | Articular 4       | L   | 12.8  | 121.9 |
| 2017/118 | Articular 4       | R   | 12.09 | 121.9 |
| 2017/118 | PreMaxilla 1      | L   | 71.2  | 121.9 |
| 2017/118 | PreMaxilla 1      | R   | 67.54 | 121.9 |
| 2017/118 | PreMaxilla 3      | L   | 19.23 | 121.9 |
| 2017/118 | PreMaxilla 3      | R   | 16.8  | 121.9 |
| 2017/118 | Quadrate 3        | L   | 14.72 | 121.9 |
| 2017/118 | Quadrate 3        | R   | 13.57 | 121.9 |
| 2017/118 | Quadrate 4        | L   | 57.18 | 121.9 |
| 2017/118 | Quadrate 4        | R   | 60.14 | 121.9 |
| 2017/118 | Maxilla 2         | L   | 21.05 | 121.9 |
| 2017/118 | Maxilla 2         | R   | 20.05 | 121.9 |
| 2017/118 | Maxilla 3         | L   | 16.98 | 121.9 |
| 2017/118 | Maxilla 3         | R   | 18.55 | 121.9 |
| 2017/118 | Tail Assemblage 2 | N/A | 11.51 | 121.9 |
| 2017/119 | Articular 4       | L   | 11.59 | 120   |
| 2017/119 | Articular 4       | R   | 11.31 | 120   |

|          |                   |     |       |       |
|----------|-------------------|-----|-------|-------|
| 2017/119 | PreMaxilla 1      | L   | 66.59 | 120   |
| 2017/119 | PreMaxilla 1      | R   | 61.69 | 120   |
| 2017/119 | PreMaxilla 3      | L   | 18.33 | 120   |
| 2017/119 | PreMaxilla 3      | R   | 15.45 | 120   |
| 2017/119 | Quadrate 3        | L   | 13.53 | 120   |
| 2017/119 | Quadrate 3        | R   | 12.08 | 120   |
| 2017/119 | Quadrate 4        | L   | 49.1  | 120   |
| 2017/119 | Quadrate 4        | R   | 54.53 | 120   |
| 2017/119 | Maxilla 2         | L   | 17.38 | 120   |
| 2017/119 | Maxilla 2         | R   | 17.88 | 120   |
| 2017/119 | Maxilla 3         | L   | 15.02 | 120   |
| 2017/119 | Maxilla 3         | R   | 16.28 | 120   |
| 2017/119 | Tail Assemblage 2 | N/A | 9.61  | 120   |
| 2017/120 | Articular 4       | L   | 11.74 | 120   |
| 2017/120 | Articular 4       | R   | 11.39 | 120   |
| 2017/120 | PreMaxilla 1      | L   | 63.16 | 120   |
| 2017/120 | PreMaxilla 1      | R   | 59.52 | 120   |
| 2017/120 | PreMaxilla 3      | L   | 18.52 | 120   |
| 2017/120 | PreMaxilla 3      | R   | 16.77 | 120   |
| 2017/120 | Quadrate 3        | L   | 14.01 | 120   |
| 2017/120 | Quadrate 3        | R   | 12.9  | 120   |
| 2017/120 | Quadrate 4        | L   | 51.23 | 120   |
| 2017/120 | Quadrate 4        | R   | 53.87 | 120   |
| 2017/120 | Maxilla 2         | L   | 17.94 | 120   |
| 2017/120 | Maxilla 2         | R   | 18.94 | 120   |
| 2017/120 | Maxilla 3         | L   | 16.13 | 120   |
| 2017/120 | Maxilla 3         | R   | 16.16 | 120   |
| 2017/120 | Tail Assemblage 2 | N/A | 11.8  | 120   |
| 2017/121 | Articular 4       | L   | 8.86  | 92.71 |
| 2017/121 | Articular 4       | R   | 8.18  | 92.71 |
| 2017/121 | PreMaxilla 1      | L   | 52.13 | 92.71 |
| 2017/121 | PreMaxilla 1      | R   | 44.7  | 92.71 |
| 2017/121 | PreMaxilla 3      | L   | 13.57 | 92.71 |
| 2017/121 | PreMaxilla 3      | R   | 11.54 | 92.71 |
| 2017/121 | Quadrate 3        | L   | 10.31 | 92.71 |
| 2017/121 | Quadrate 3        | R   | 9.86  | 92.71 |
| 2017/121 | Quadrate 4        | L   | 37.95 | 92.71 |
| 2017/121 | Quadrate 4        | R   | 42.11 | 92.71 |
| 2017/121 | Maxilla 2         | L   | 13.25 | 92.71 |
| 2017/121 | Maxilla 2         | R   | 13.97 | 92.71 |
| 2017/121 | Maxilla 3         | L   | 11.18 | 92.71 |
| 2017/121 | Maxilla 3         | R   | 11.89 | 92.71 |
| 2017/121 | Tail Assemblage 2 | N/A | 9.02  | 92.71 |
| 2017/122 | Articular 4       | L   | 13.44 | 130   |
| 2017/122 | Articular 4       | R   | 13.25 | 130   |
| 2017/122 | PreMaxilla 1      | L   | 71.07 | 130   |
| 2017/122 | PreMaxilla 1      | R   | 62.76 | 130   |
| 2017/122 | PreMaxilla 3      | L   | 20.24 | 130   |
| 2017/122 | PreMaxilla 3      | R   | 19.68 | 130   |

|          |                   |     |       |     |
|----------|-------------------|-----|-------|-----|
| 2017/122 | Quadrate 3        | L   | 14.49 | 130 |
| 2017/122 | Quadrate 3        | R   | 13.95 | 130 |
| 2017/122 | Quadrate 4        | L   | 50.35 | 130 |
| 2017/122 | Quadrate 4        | R   | 61.88 | 130 |
| 2017/122 | Maxilla 2         | L   | 21.3  | 130 |
| 2017/122 | Maxilla 2         | R   | 19.68 | 130 |
| 2017/122 | Maxilla 3         | I   | 17.76 | 130 |
| 2017/122 | Maxilla 3         | R   | 18.28 | 130 |
| 2017/122 | Tail Assemblage 2 | N/A | 11.41 | 130 |
| 2017/123 | Articular 4       | L   | 13.88 | 135 |
| 2017/123 | Articular 4       | R   | 13.68 | 135 |
| 2017/123 | PreMaxilla 1      | L   | 70.45 | 135 |
| 2017/123 | PreMaxilla 1      | R   | 78.98 | 135 |
| 2017/123 | PreMaxilla 3      | L   | 20.68 | 135 |
| 2017/123 | PreMaxilla 3      | R   | 21.11 | 135 |
| 2017/123 | Quadrate 3        | L   | 16.25 | 135 |
| 2017/123 | Quadrate 3        | R   | 14.11 | 135 |
| 2017/123 | Quadrate 4        | L   | 58.88 | 135 |
| 2017/123 | Quadrate 4        | R   | 65.91 | 135 |
| 2017/123 | Maxilla 2         | L   | 19.32 | 135 |
| 2017/123 | Maxilla 2         | R   | 20.66 | 135 |
| 2017/123 | Maxilla 3         | L   | 18.75 | 135 |
| 2017/123 | Maxilla 3         | R   | 19.35 | 135 |
| 2017/123 | Tail Assemblage 2 | N/A | 11.67 | 135 |
| 2017/124 | Articular 4       | L   | 11.59 | 118 |
| 2017/124 | Articular 4       | R   | 10.53 | 118 |
| 2017/124 | PreMaxilla 1      | L   | 62.16 | 118 |
| 2017/124 | PreMaxilla 1      | R   | 55.66 | 118 |
| 2017/124 | PreMaxilla 3      | L   | 17.05 | 118 |
| 2017/124 | PreMaxilla 3      | R   | 15.74 | 118 |
| 2017/124 | Quadrate 3        | L   | 13.92 | 188 |
| 2017/124 | Quadrate 3        | R   | 12.84 | 118 |
| 2017/124 | Quadrate 4        | L   | 48.92 | 118 |
| 2017/124 | Quadrate 4        | R   | 55.63 | 118 |
| 2017/124 | Maxilla 2         | L   | 17.7  | 118 |
| 2017/124 | Maxilla 2         | R   | 17.37 | 118 |
| 2017/124 | Maxilla 3         | L   | 14.75 | 118 |
| 2017/124 | Maxilla 3         | R   | 16.24 | 118 |
| 2017/124 | Tail Assemblage 2 | N/A | 12.39 | 118 |
| 2017/125 | Articular 4       | L   | 10.31 | 105 |
| 2017/125 | Articular 4       | R   | 10.68 | 105 |
| 2017/125 | PreMaxilla 1      | L   | 63.23 | 105 |
| 2017/125 | PreMaxilla 1      | R   | 58.83 | 105 |
| 2017/125 | PreMaxilla 3      | L   | 16.76 | 105 |
| 2017/125 | PreMaxilla 3      | R   | 17.4  | 105 |
| 2017/125 | Quadrate 3        | L   | 12.13 | 105 |
| 2017/125 | Quadrate 3        | R   | 12.12 | 105 |
| 2017/125 | Quadrate 4        | L   | 51.62 | 105 |
| 2017/125 | Quadrate 4        | R   | 45.42 | 105 |

|          |                   |     |       |     |
|----------|-------------------|-----|-------|-----|
| 2017/125 | Maxilla 2         | L   | 16.85 | 105 |
| 2017/125 | Maxilla 2         | R   | 16.63 | 105 |
| 2017/125 | Maxilla 3         | L   | 14.75 | 105 |
| 2017/125 | Maxilla 3         | R   | 15.35 | 105 |
| 2017/125 | Tail Assemblage 2 | N/A | 9.4   | 105 |
| 2017/126 | Articular 4       | L   | 11.06 | 114 |
| 2017/126 | Articular 4       | R   | 10.96 | 114 |
| 2017/126 | PreMaxilla 1      | L   | 61.32 | 114 |
| 2017/126 | PreMaxilla 1      | R   | 45.82 | 114 |
| 2017/126 | PreMaxilla 3      | L   | 19.41 | 114 |
| 2017/126 | PreMaxilla 3      | R   | 14.26 | 114 |
| 2017/126 | Quadrate 3        | L   | 12.64 | 114 |
| 2017/126 | Quadrate 3        | R   | 12.09 | 114 |
| 2017/126 | Quadrate 4        | L   | 48.67 | 114 |
| 2017/126 | Quadrate 4        | R   | 54.22 | 114 |
| 2017/126 | Maxilla 2         | L   | 18.26 | 114 |
| 2017/126 | Maxilla 2         | R   | 17.88 | 114 |
| 2017/126 | Maxilla 3         | L   | 15.71 | 114 |
| 2017/126 | Maxilla 3         | R   | 16.21 | 114 |
| 2017/126 | Tail Assemblage 2 | N/A | 11.13 | 114 |
| 2017/127 | Articular 4       | L   | 11.94 | 118 |
| 2017/127 | Articular 4       | R   |       | 118 |
| 2017/127 | PreMaxilla 1      | L   | 58.38 | 118 |
| 2017/127 | PreMaxilla 1      | R   | 62.33 | 118 |
| 2017/127 | PreMaxilla 3      | L   | 16.86 | 118 |
| 2017/127 | PreMaxilla 3      | R   | 17.04 | 118 |
| 2017/127 | Quadrate 3        | L   | 12.93 | 118 |
| 2017/127 | Quadrate 3        | R   | 13.97 | 118 |
| 2017/127 | Quadrate 4        | L   | 48.94 | 118 |
| 2017/127 | Quadrate 4        | R   | 49.74 | 118 |
| 2017/127 | Maxilla 2         | L   | 16.33 | 118 |
| 2017/127 | Maxilla 2         | R   | 17.16 | 118 |
| 2017/127 | Maxilla 3         | L   | 15.33 | 118 |
| 2017/127 | Maxilla 3         | R   | 15.75 | 118 |
| 2017/127 | Tail Assemblage 2 | N/A | 10.42 | 118 |
| 2017/128 | Articular 4       | L   | 10.33 | 116 |
| 2017/128 | Articular 4       | R   | 10.15 | 116 |
| 2017/128 | PreMaxilla 1      | L   | 58.54 | 116 |
| 2017/128 | PreMaxilla 1      | R   | 53.98 | 116 |
| 2017/128 | PreMaxilla 3      | L   | 16.64 | 116 |
| 2017/128 | PreMaxilla 3      | R   | 14.73 | 116 |
| 2017/128 | Quadrate 3        | L   | 13.16 | 116 |
| 2017/128 | Quadrate 3        | R   | 11.87 | 116 |
| 2017/128 | Quadrate 4        | L   | 48.03 | 116 |
| 2017/128 | Quadrate 4        | R   | 51.58 | 116 |
| 2017/128 | Maxilla 2         | L   | 17.46 | 116 |
| 2017/128 | Maxilla 2         | R   | 17.28 | 116 |
| 2017/128 | Maxilla 3         | L   | 15.34 | 116 |
| 2017/128 | Maxilla 3         | R   | 15.13 | 116 |

|             |                   |     |       |      |
|-------------|-------------------|-----|-------|------|
| 2017/128    | Tail Assemblage 2 | N/A | 10.86 | 116  |
| 90/01       | Articular 4       | L   | 14.99 | 149  |
| 90/01       | Articular 4       | R   | 14.25 | 149  |
| 90/01       | PreMaxilla 1      | L   | 81.07 | 149  |
| 90/01       | PreMaxilla 1      | R   | 76.47 | 149  |
| 90/01       | PreMaxilla 3      | L   | 23.84 | 149  |
| 90/01       | PreMaxilla 3      | R   | 22.16 | 149  |
| 90/01       | Quadrate 3        | L   | 16.94 | 149  |
| 90/01       | Quadrate 3        | R   | 15.4  | 149  |
| 90/01       | Quadrate 4        | L   | 63.53 | 149  |
| 90/01       | Quadrate 4        | R   | 69.80 | 149  |
| 90/01       | Maxilla 2         | L   | 24.24 | 149  |
| 90/01       | Maxilla 2         | R   | 23.12 | 149  |
| 90/01       | Maxilla 3         | L   | 18.55 | 149  |
| 90/01       | Maxilla 3         | R   | 19.19 | 149  |
| 90/01       | Tail Assemblage 2 | N/A | 13.84 | 149  |
| 92/16       | Articular 4       | L   | 10.52 | 94   |
| 92/16       | Articular 4       | R   | 9.23  | 94   |
| 92/16       | PreMaxilla 1      | L   | 61.16 | 94   |
| 92/16       | PreMaxilla 1      | R   | 54.65 | 94   |
| 92/16       | PreMaxilla 3      | L   | 19.55 | 94   |
| 92/16       | PreMaxilla 3      | R   | 18.85 | 94   |
| 92/16       | Quadrate 3        | L   | 12.38 | 94   |
| 92/16       | Quadrate 3        | R   | 11.64 | 94   |
| 92/16       | Quadrate 4        | L   | 49.52 | 94   |
| 92/16       | Quadrate 4        | R   | 55.96 | 94   |
| 92/16       | Maxilla 2         | L   | 17.69 | 94   |
| 92/16       | Maxilla 2         | R   | 17.24 | 94   |
| 92/16       | Maxilla 3         | L   | 14.13 | 94   |
| 92/16       | Maxilla 3         | R   | 15.89 | 94   |
| 92/16       | Tail Assemblage 2 | N/A | 10.89 | 94   |
| NMML 0052bn | Articular 4       | L   | 1.45  | 16.7 |
| NMML 0052bn | Articular 4       | R   | 1.62  | 16.7 |
| NMML 0052bn | PreMaxilla 1      | L   | 9.84  | 16.7 |
| NMML 0052bn | PreMaxilla 1      | R   | 8.52  | 16.7 |
| NMML 0052bn | PreMaxilla 3      | L   | 3.54  | 16.7 |
| NMML 0052bn | PreMaxilla 3      | R   | 3.15  | 16.7 |
| NMML 0052bn | Quadrate 3        | L   | 1.92  | 16.7 |
| NMML 0052bn | Quadrate 3        | R   | 1.77  | 16.7 |
| NMML 0052bn | Quadrate 4        | L   | 8.84  | 16.7 |
| NMML 0052bn | Quadrate 4        | R   | 10.15 | 16.7 |
| NMML 0052bn | Maxilla 2         | L   | 3.1   | 16.7 |
| NMML 0052bn | Maxilla 2         | R   | 3.33  | 16.7 |
| NMML 0052bn | Maxilla 3         | R   | 3.01  | 16.7 |
| NMML 0052bn | Tail Assemblage 2 | N/A | 1.64  | 16.7 |
| NMML 043bn  | Articular 4       | L   | 2.82  | 31.3 |
| NMML 043bn  | Articular 4       | R   | 2.67  | 31.3 |
| NMML 043bn  | PreMaxilla 1      | L   | 16.34 | 31.3 |
| NMML 043bn  | PreMaxilla 1      | R   | 15.56 | 31.3 |

|             |                   |     |       |       |
|-------------|-------------------|-----|-------|-------|
| NMML 043bn  | PreMaxilla 3      | L   | 5.63  | 31.3  |
| NMML 043bn  | PreMaxilla 3      | R   | 5.48  | 31.3  |
| NMML 043bn  | Quadrate 3        | L   | 3.52  | 31.3  |
| NMML 043bn  | Quadrate 3        | R   | 3.29  | 31.3  |
| NMML 043bn  | Quadrate 4        | L   | 14.82 | 31.3  |
| NMML 043bn  | Quadrate 4        | R   | 16.68 | 31.3  |
| NMML 043bn  | Maxilla 2         | L   | 5.54  | 31.3  |
| NMML 043bn  | Maxilla 2         | R   | 5.4   | 31.3  |
| NMML 043bn  | Maxilla 3         | L   | 4.39  | 31.3  |
| NMML 043bn  | Maxilla 3         | R   | 5     | 31.3  |
| NMML 043bn  | Tail Assemblage 2 | N/A | 3.12  | 31.3  |
| NMML 0557bn | Articular 4       | L   | 4.12  | 45.93 |
| NMML 0557bn | Articular 4       | R   | 4.31  | 45.93 |
| NMML 0557bn | PreMaxilla 1      | L   | 25.3  | 45.93 |
| NMML 0557bn | PreMaxilla 1      | R   | 24.45 | 45.93 |
| NMML 0557bn | PreMaxilla 3      | L   | 7.99  | 45.93 |
| NMML 0557bn | PreMaxilla 3      | R   | 8.29  | 45.93 |
| NMML 0557bn | Quadrate 3        | L   | 4.83  | 45.93 |
| NMML 0557bn | Quadrate 3        | R   | 5.01  | 45.93 |
| NMML 0557bn | Quadrate 4        | L   | 21.42 | 45.93 |
| NMML 0557bn | Quadrate 4        | R   | 24.41 | 45.93 |
| NMML 0557bn | Maxilla 2         | L   | 8.17  | 45.93 |
| NMML 0557bn | Maxilla 2         | R   | 8.39  | 45.93 |
| NMML 0557bn | Maxilla 3         | L   | 6.72  | 45.93 |
| NMML 0557bn | Maxilla 3         | R   | 7.3   | 45.93 |
| NMML 0557bn | Tail Assemblage 2 | N/A | 4.58  | 45.93 |
| NMML 0558bn | Articular 4       | L   | 3.2   | 35.5  |
| NMML 0558bn | Articular 4       | R   | 3.16  | 35.5  |
| NMML 0558bn | PreMaxilla 1      | L   | 20.73 | 35.5  |
| NMML 0558bn | PreMaxilla 1      | R   | 17.48 | 35.5  |
| NMML 0558bn | PreMaxilla 3      | L   | 6.71  | 35.5  |
| NMML 0558bn | PreMaxilla 3      | R   | 6.09  | 35.5  |
| NMML 0558bn | Quadrate 3        | L   |       | 35.5  |
| NMML 0558bn | Quadrate 3        | R   | 3.76  | 35.5  |
| NMML 0558bn | Quadrate 4        | L   |       | 35.5  |
| NMML 0558bn | Quadrate 4        | R   | 18.78 | 35.5  |
| NMML 0558bn | Maxilla 2         | L   | 6.52  | 35.5  |
| NMML 0558bn | Maxilla 2         | R   | 6.57  | 35.5  |
| NMML 0558bn | Maxilla 3         | L   | 5.22  | 35.5  |
| NMML 0558bn | Maxilla 3         | R   | 6.2   | 35.5  |
| NMML 0558bn | Tail Assemblage 2 | N/A |       | 35.5  |
| NMML 0631bn | Articular 4       | L   | 2.54  | 28.09 |
| NMML 0631bn | Articular 4       | R   | 2.68  | 28.09 |
| NMML 0631bn | PreMaxilla 1      | L   | 17.6  | 28.09 |
| NMML 0631bn | PreMaxilla 1      | R   | 15.63 | 28.09 |
| NMML 0631bn | PreMaxilla 3      | L   | 6.38  | 28.09 |
| NMML 0631bn | PreMaxilla 3      | R   | 5.35  | 28.09 |
| NMML 0631bn | Quadrate 3        | L   | 3.11  | 28.09 |
| NMML 0631bn | Quadrate 3        | R   | 3.06  | 28.09 |

|             |                   |     |       |       |
|-------------|-------------------|-----|-------|-------|
| NMML 0631bn | Quadrate 4        | L   | 15.2  | 28.09 |
| NMML 0631bn | Quadrate 4        | R   | 17.38 | 28.09 |
| NMML 0631bn | Maxilla 2         | L   | 5.23  | 28.09 |
| NMML 0631bn | Maxilla 2         | R   | 5.62  | 28.09 |
| NMML 0631bn | Maxilla 3         | L   | 2.22  | 16.7  |
| NMML 0631bn | Maxilla 3         | L   | 4.13  | 28.09 |
| NMML 0631bn | Maxilla 3         | R   | 4.96  | 28.09 |
| NMML 0631bn | Tail Assemblage 2 | N/A | 3.07  | 28.09 |
| NMML 0632bn | Articular 4       | L   | 2.73  | 33    |
| NMML 0632bn | Articular 4       | R   | 2.73  | 33    |
| NMML 0632bn | PreMaxilla 1      | L   | 19.33 | 33    |
| NMML 0632bn | PreMaxilla 1      | R   | 17.19 | 33    |
| NMML 0632bn | PreMaxilla 3      | L   | 6.19  | 33    |
| NMML 0632bn | PreMaxilla 3      | R   | 5.78  | 33    |
| NMML 0632bn | Quadrate 3        | L   | 3.32  | 33    |
| NMML 0632bn | Quadrate 3        | R   | 3.36  | 33    |
| NMML 0632bn | Quadrate 4        | L   | 16.84 | 33    |
| NMML 0632bn | Quadrate 4        | R   | 19.1  | 33    |
| NMML 0632bn | Maxilla 2         | L   | 5.81  | 33    |
| NMML 0632bn | Maxilla 2         | R   | 5.85  | 33    |
| NMML 0632bn | Maxilla 3         | L   | 5.92  | 33    |
| NMML 0632bn | Maxilla 3         | R   | 5.56  | 33    |
| NMML 0632bn | Tail Assemblage 2 | N/A | 3.38  | 33    |
| NMML 208bn  | Articular 4       | L   | 1.57  | 19.44 |
| NMML 208bn  | Articular 4       | R   | 1.82  | 19.44 |
| NMML 208bn  | PreMaxilla 1      | L   | 11.08 | 19.44 |
| NMML 208bn  | PreMaxilla 1      | R   | 10.4  | 19.44 |
| NMML 208bn  | PreMaxilla 3      | L   | 4.03  | 19.44 |
| NMML 208bn  | PreMaxilla 3      | R   | 3.93  | 19.44 |
| NMML 208bn  | Quadrate 3        | L   | 2.02  | 19.44 |
| NMML 208bn  | Quadrate 3        | R   | 2.01  | 19.44 |
| NMML 208bn  | Quadrate 4        | L   | 9.76  | 19.44 |
| NMML 208bn  | Quadrate 4        | R   | 11.23 | 19.44 |
| NMML 208bn  | Maxilla 2         | L   | 3.53  | 19.44 |
| NMML 208bn  | Maxilla 2         | R   | 3.59  | 19.44 |
| NMML 208bn  | Maxilla 3         | L   | 2.82  | 19.44 |
| NMML 208bn  | Maxilla 3         | R   | 3.42  | 19.44 |
| NMML 208bn  | Tail Assemblage 2 | N/A | 1.86  | 19.44 |

## Appendix H: Archaeological Size Estimations

| Site   | Estimated Fork Length (cm) |
|--------|----------------------------|
| EjTa-4 | 94.37                      |
| EjTa-4 | 109.97                     |
| EjTa-4 | 117.39                     |
| EjTa-4 | 74.49                      |
| EjTa-4 | 106.96                     |
| EjTa-4 | 75.12                      |
| EjTa-4 | 159.04                     |
| EjTa-4 | 159.15                     |
| EjTa-4 | 71.02                      |
| EjTa-4 | 76.53                      |
| EjTa-4 | 147.98                     |
| EjTa-4 | 77.20                      |
| EjTa-4 | 58.12                      |
| EjTa-1 | 108.57                     |
| EjTa-1 | 116.13                     |
| EjTa-1 | 95.45                      |
| EjTa-1 | 104.28                     |
| EjTa-1 | 113.39                     |
| EjTa-1 | 112.02                     |
| EjTa-1 | 95.91                      |
| EjTa-1 | 108.10                     |
| EjTa-1 | 84.00                      |
| EjTa-1 | 79.86                      |
| EjTa-1 | 97.97                      |
| EjTa-1 | 92.59                      |
| EjTa-1 | 91.32                      |
| EjTa-1 | 89.93                      |
| EjTa-1 | 113.84                     |
| EjTa-1 | 103.56                     |
| EjTa-1 | 92.42                      |
| EjTa-1 | 84.94                      |
| EjTa-1 | 104.74                     |
| EjTa-1 | 90.59                      |
| EjTa-1 | 84.58                      |
| EjTa-1 | 91.50                      |
| EjTa-1 | 76.83                      |
| EjTa-1 | 91.73                      |
| EjTa-1 | 72.11                      |

|                              |        |
|------------------------------|--------|
| EjTa-1                       | 92.04  |
| EjTa-1                       | 85.56  |
| EjTa-1                       | 87.64  |
| EjTa-1                       | 90.92  |
| EjTa-1                       | 107.54 |
| EjTa-1                       | 97.68  |
| EjTa-1                       | 97.93  |
| EjTa-1                       | 85.64  |
| EjTa-1                       | 94.51  |
| EjTa-1                       | 88.55  |
| EjTa-1                       | 152.64 |
| EjTa-1                       | 110.04 |
| EjTa-1                       | 64.25  |
| EjTa-1                       | 135.61 |
| EjTa-1                       | 123.91 |
| EjTa-1                       | 112.06 |
| EjTa-1                       | 85.09  |
| EjTa-1                       | 92.78  |
| EjTa-1                       | 118.16 |
| EjTa-1                       | 107.88 |
| EjTa-1                       | 108.37 |
| EjTa-1                       | 108.90 |
| EjTa-1                       | 112.26 |
| EjTa-1                       | 111.03 |
| EjTa-1                       | 131.41 |
| EjTa-1                       | 98.69  |
| EjTa-1                       | 123.58 |
| EjTa-1                       | 87.86  |
| 45CA21 "Hoko<br>Rockshelter" | 92.15  |
| 45CA21 "Hoko<br>Rockshelter" | 100.51 |
| 45CA21 "Hoko<br>Rockshelter" | 95.15  |
| 45CA21 "Hoko<br>Rockshelter" | 103.81 |
| 45CA21 "Hoko<br>Rockshelter" | 81.59  |
| 45CA21 "Hoko<br>Rockshelter" | 79.58  |
| 45CA21 "Hoko<br>Rockshelter" | 127.67 |
| 45CA21 "Hoko<br>Rockshelter" | 148.30 |
| 45CA21 "Hoko<br>Rockshelter" | 78.57  |

|                           |        |
|---------------------------|--------|
| 45CA21 "Hoko Rockshelter" | 79.00  |
| 45CA21 "Hoko Rockshelter" | 64.42  |
| 45CA21 "Hoko Rockshelter" | 90.12  |
| 45CA21 "Hoko Rockshelter" | 139.59 |
| 45CA21 "Hoko Rockshelter" | 69.44  |
| 45CA21 "Hoko Rockshelter" | 124.79 |
| 45CA21 "Hoko Rockshelter" | 51.05  |
| 45CA21 "Hoko Rockshelter" | 88.00  |
| 45CA21 "Hoko Rockshelter" | 97.70  |
| 45CA21 "Hoko Rockshelter" | 84.29  |
| 45CA21 "Hoko Rockshelter" | 87.49  |
| 45CA21 "Hoko Rockshelter" | 90.95  |
| 45CA21 "Hoko Rockshelter" | 85.40  |
| 45CA21 "Hoko Rockshelter" | 148.50 |
| 45CA21 "Hoko Rockshelter" | 59.08  |
| 45CA213 "Hoko Wet/Dry"    | 44.00  |
| 45CA213 "Hoko Wet/Dry"    | 35.24  |
| 45CA213 "Hoko Wet/Dry"    | 36.15  |
| 45CA213 "Hoko Wet/Dry"    | 50.12  |
| 45CA213 "Hoko Wet/Dry"    | 43.86  |
| 45CA213 "Hoko Wet/Dry"    | 62.95  |
| 45CA213 "Hoko Wet/Dry"    | 58.73  |
| 45CA213 "Hoko Wet/Dry"    | 53.31  |
| 45CA213 "Hoko Wet/Dry"    | 38.69  |
| 45CA213 "Hoko Wet/Dry"    | 58.32  |
| 45CA213 "Hoko Wet/Dry"    | 51.91  |
| 45CA213 "Hoko Wet/Dry"    | 55.03  |

|                            |        |
|----------------------------|--------|
| 45CA213 "Hoko<br>Wet/Dry"  | 48.97  |
| 45CA213 "Hoko<br>Wet/Dry"  | 42.43  |
| 45CA213 "Hoko<br>Wet/Dry"  | 61.10  |
| 45CA213 "Hoko<br>Wet/Dry"  | 78.80  |
| 45CA213 "Hoko<br>Wet/Dry"  | 77.33  |
| 45CA213 "Hoko<br>Wet/Dry"  | 105.55 |
| 45CA213 "Hoko<br>Wet/Dry"  | 41.64  |
| 45CA213 "Hoko<br>Wet/Dry"  | 49.27  |
| 45CA213 "Hoko<br>Wet/Dry"  | 44.02  |
| 45CA213 "Hoko<br>Wet/Dry"  | 47.16  |
| 45CA213 "Hoko<br>Wet/Dry"  | 57.39  |
| 45CA213 "Hoko<br>Wet/Dry"  | 44.85  |
| 45CA213 "Hoko<br>Wet/Dry"  | 44.41  |
| 45CA213 "Hoko<br>Wet/Dry"  | 45.35  |
| 45CA213 "Hoko<br>Wet/Dry"  | 40.07  |
| 45CA213 "Hoko<br>Wet/Dry"  | 33.22  |
| 45CA213 "Hoko<br>Wet/Dry"  | 44.08  |
| 45CA213 "Hoko<br>Wet/Dry"  | 42.66  |
| 45CA213 "Hoko<br>Wet/Dry"  | 56.13  |
| 45CA213 "Hoko<br>Wet/Dry"  | 58.57  |
| 45CA213 "Hoko<br>Wet/Dry"  | 52.20  |
| 45CA213 "Hoko<br>Wet/Dry"  | 47.87  |
| 45CA213 "Hoko<br>Wet/Dry"  | 43.21  |
| 45CA213 "Hoko<br>Wet Site" | 33.28  |
| 45CA213 "Hoko<br>Wet Site" | 39.35  |
| 45CA213 "Hoko<br>Wet Site" | 39.35  |
| 45CA213 "Hoko<br>Wet Site" | 39.35  |

|                         |       |
|-------------------------|-------|
| 45CA213 "Hoko Wet Site" | 39.35 |
| 45CA213 "Hoko Wet Site" | 39.35 |
| 45CA213 "Hoko Wet Site" | 39.35 |
| 45CA213 "Hoko Wet Site" | 39.35 |
| 45CA213 "Hoko Wet Site" | 39.35 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 45.41 |
| 45CA213 "Hoko Wet Site" | 51.48 |
| 45CA213 "Hoko Wet Site" | 51.48 |
| 45CA213 "Hoko Wet Site" | 51.48 |
| 45CA213 "Hoko Wet Site" | 51.48 |
| 45CA213 "Hoko Wet Site" | 51.48 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 57.55 |
| 45CA213 "Hoko Wet Site" | 63.62 |
| 45CA213 "Hoko Wet Site" | 63.62 |
| 45CA213 "Hoko Wet Site" | 63.62 |

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|----------------------------|--------|
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 63.62  |
| 45CA213 "Hoko<br>Wet Site" | 69.69  |
| 45CA213 "Hoko<br>Wet Site" | 69.69  |
| 45CA213 "Hoko<br>Wet Site" | 69.69  |
| 45CA213 "Hoko<br>Wet Site" | 69.69  |
| 45CA213 "Hoko<br>Wet Site" | 106.10 |
| 45CA213 "Hoko<br>Wet Site" | 112.17 |
| 45CA24 "Ozette"<br>House 1 | 61.19  |
| 45CA24 "Ozette"<br>House 1 | 72.57  |
| 45CA24 "Ozette"<br>House 1 | 49.81  |
| 45CA24 "Ozette"<br>House 1 | 58.92  |
| 45CA24 "Ozette"<br>House 1 | 59.68  |
| 45CA24 "Ozette"<br>House 1 | 63.47  |
| 45CA24 "Ozette"<br>House 1 | 69.54  |
| 45CA24 "Ozette"<br>House 1 | 74.09  |
| 45CA24 "Ozette"<br>House 1 | 81.68  |
| 45CA24 "Ozette"<br>House 1 | 66.15  |
| 45CA24 "Ozette"<br>House 1 | 78.09  |
| 45CA24 "Ozette"<br>House 1 | 81.85  |
| 45CA24 "Ozette"<br>House 1 | 83.11  |
| 45CA24 "Ozette"<br>House 1 | 180.49 |

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|----------------------------|--------|
| 45CA24 "Ozette"<br>House 1 | 61.48  |
| 45CA24 "Ozette"<br>House 1 | 68.62  |
| 45CA24 "Ozette"<br>House 1 | 68.62  |
| 45CA24 "Ozette"<br>House 1 | 69.21  |
| 45CA24 "Ozette"<br>House 1 | 69.81  |
| 45CA24 "Ozette"<br>House 1 | 69.81  |
| 45CA24 "Ozette"<br>House 1 | 69.81  |
| 45CA24 "Ozette"<br>House 1 | 70.40  |
| 45CA24 "Ozette"<br>House 1 | 71.00  |
| 45CA24 "Ozette"<br>House 1 | 71.59  |
| 45CA24 "Ozette"<br>House 1 | 76.95  |
| 45CA24 "Ozette"<br>House 1 | 78.14  |
| 45CA24 "Ozette"<br>House 1 | 80.52  |
| 45CA24 "Ozette"<br>House 1 | 81.71  |
| 45CA24 "Ozette"<br>House 1 | 84.09  |
| 45CA24 "Ozette"<br>House 1 | 85.88  |
| 45CA24 "Ozette"<br>House 1 | 93.02  |
| 45CA24 "Ozette"<br>House 1 | 93.61  |
| 45CA24 "Ozette"<br>House 1 | 103.73 |
| 45CA24 "Ozette"<br>House 1 | 105.52 |
| 45CA24 "Ozette"<br>House 1 | 114.44 |
| 45CA24 "Ozette"<br>House 1 | 123.96 |
| 45CA24 "Ozette"<br>House 1 | 144.79 |
| 45CA24 "Ozette"<br>House 1 | 59.55  |
| 45CA24 "Ozette"<br>House 1 | 59.55  |
| 45CA24 "Ozette"<br>House 1 | 67.56  |
| 45CA24 "Ozette"<br>House 1 | 69.85  |

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|----------------------------|--------|
| 45CA24 "Ozette"<br>House 1 | 69.85  |
| 45CA24 "Ozette"<br>House 1 | 72.14  |
| 45CA24 "Ozette"<br>House 1 | 72.71  |
| 45CA24 "Ozette"<br>House 1 | 73.28  |
| 45CA24 "Ozette"<br>House 1 | 73.85  |
| 45CA24 "Ozette"<br>House 1 | 73.85  |
| 45CA24 "Ozette"<br>House 1 | 76.71  |
| 45CA24 "Ozette"<br>House 1 | 79.57  |
| 45CA24 "Ozette"<br>House 1 | 83.58  |
| 45CA24 "Ozette"<br>House 1 | 89.30  |
| 45CA24 "Ozette"<br>House 1 | 92.73  |
| 45CA24 "Ozette"<br>House 1 | 92.73  |
| 45CA24 "Ozette"<br>House 1 | 93.30  |
| 45CA24 "Ozette"<br>House 1 | 93.30  |
| 45CA24 "Ozette"<br>House 1 | 93.88  |
| 45CA24 "Ozette"<br>House 1 | 99.02  |
| 45CA24 "Ozette"<br>House 1 | 99.02  |
| 45CA24 "Ozette"<br>House 1 | 100.74 |
| 45CA24 "Ozette"<br>House 1 | 101.31 |
| 45CA24 "Ozette"<br>House 1 | 102.46 |
| 45CA24 "Ozette"<br>House 1 | 105.32 |
| 45CA24 "Ozette"<br>House 1 | 120.76 |
| 45CA24 "Ozette"<br>House 1 | 122.48 |
| 45CA24 "Ozette"<br>House 1 | 123.62 |
| 45CA24 "Ozette"<br>House 1 | 60.04  |
| 45CA24 "Ozette"<br>House 1 | 60.64  |
| 45CA24 "Ozette"<br>House 1 | 60.64  |

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|----------------------------|--------|
| 45CA24 "Ozette"<br>House 1 | 63.05  |
| 45CA24 "Ozette"<br>House 1 | 64.85  |
| 45CA24 "Ozette"<br>House 1 | 66.06  |
| 45CA24 "Ozette"<br>House 1 | 66.66  |
| 45CA24 "Ozette"<br>House 1 | 67.26  |
| 45CA24 "Ozette"<br>House 1 | 67.26  |
| 45CA24 "Ozette"<br>House 1 | 68.47  |
| 45CA24 "Ozette"<br>House 1 | 69.67  |
| 45CA24 "Ozette"<br>House 1 | 69.67  |
| 45CA24 "Ozette"<br>House 1 | 70.27  |
| 45CA24 "Ozette"<br>House 1 | 70.87  |
| 45CA24 "Ozette"<br>House 1 | 72.08  |
| 45CA24 "Ozette"<br>House 1 | 72.08  |
| 45CA24 "Ozette"<br>House 1 | 73.88  |
| 45CA24 "Ozette"<br>House 1 | 75.09  |
| 45CA24 "Ozette"<br>House 1 | 75.69  |
| 45CA24 "Ozette"<br>House 1 | 76.29  |
| 45CA24 "Ozette"<br>House 1 | 77.50  |
| 45CA24 "Ozette"<br>House 1 | 79.30  |
| 45CA24 "Ozette"<br>House 1 | 84.12  |
| 45CA24 "Ozette"<br>House 1 | 84.12  |
| 45CA24 "Ozette"<br>House 1 | 87.73  |
| 45CA24 "Ozette"<br>House 1 | 90.14  |
| 45CA24 "Ozette"<br>House 1 | 95.56  |
| 45CA24 "Ozette"<br>House 1 | 96.16  |
| 45CA24 "Ozette"<br>House 1 | 100.37 |
| 45CA24 "Ozette"<br>House 1 | 100.37 |

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|----------------------------|--------|
| 45CA24 "Ozette"<br>House 1 | 102.18 |
| 45CA24 "Ozette"<br>House 1 | 69.67  |
| 45CA24 "Ozette"<br>House 1 | 74.22  |
| 45CA24 "Ozette"<br>House 1 | 79.91  |
| 45CA24 "Ozette"<br>House 1 | 79.91  |
| 45CA24 "Ozette"<br>House 1 | 93.56  |
| 45CA24 "Ozette"<br>House 1 | 97.54  |
| 45CA24 "Ozette"<br>House 1 | 103.79 |
| 45CA24 "Ozette"<br>House 2 | 72.74  |
| 45CA24 "Ozette"<br>House 2 | 74.75  |
| 45CA24 "Ozette"<br>House 2 | 83.44  |
| 45CA24 "Ozette"<br>House 2 | 126.23 |
| 45CA24 "Ozette"<br>House 2 | 58.92  |
| 45CA24 "Ozette"<br>House 2 | 61.95  |
| 45CA24 "Ozette"<br>House 2 | 68.02  |
| 45CA24 "Ozette"<br>House 2 | 68.02  |
| 45CA24 "Ozette"<br>House 2 | 68.78  |
| 45CA24 "Ozette"<br>House 2 | 69.54  |
| 45CA24 "Ozette"<br>House 2 | 71.81  |
| 45CA24 "Ozette"<br>House 2 | 51.70  |
| 45CA24 "Ozette"<br>House 2 | 62.38  |
| 45CA24 "Ozette"<br>House 2 | 68.03  |
| 45CA24 "Ozette"<br>House 2 | 69.92  |
| 45CA24 "Ozette"<br>House 2 | 70.55  |
| 45CA24 "Ozette"<br>House 2 | 71.80  |
| 45CA24 "Ozette"<br>House 2 | 72.43  |
| 45CA24 "Ozette"<br>House 2 | 72.43  |

|                            |        |
|----------------------------|--------|
| 45CA24 "Ozette"<br>House 2 | 73.06  |
| 45CA24 "Ozette"<br>House 2 | 76.20  |
| 45CA24 "Ozette"<br>House 2 | 78.71  |
| 45CA24 "Ozette"<br>House 2 | 81.23  |
| 45CA24 "Ozette"<br>House 2 | 81.85  |
| 45CA24 "Ozette"<br>House 2 | 94.42  |
| 45CA24 "Ozette"<br>House 2 | 101.96 |
| 45CA24 "Ozette"<br>House 2 | 48.38  |
| 45CA24 "Ozette"<br>House 2 | 48.38  |
| 45CA24 "Ozette"<br>House 2 | 48.38  |
| 45CA24 "Ozette"<br>House 2 | 48.38  |
| 45CA24 "Ozette"<br>House 2 | 51.95  |
| 45CA24 "Ozette"<br>House 2 | 51.95  |
| 45CA24 "Ozette"<br>House 2 | 57.90  |
| 45CA24 "Ozette"<br>House 2 | 64.45  |
| 45CA24 "Ozette"<br>House 2 | 66.83  |
| 45CA24 "Ozette"<br>House 2 | 67.43  |
| 45CA24 "Ozette"<br>House 2 | 67.43  |
| 45CA24 "Ozette"<br>House 2 | 67.43  |
| 45CA24 "Ozette"<br>House 2 | 68.02  |
| 45CA24 "Ozette"<br>House 2 | 68.62  |
| 45CA24 "Ozette"<br>House 2 | 71.59  |
| 45CA24 "Ozette"<br>House 2 | 71.59  |
| 45CA24 "Ozette"<br>House 2 | 77.54  |
| 45CA24 "Ozette"<br>House 2 | 77.54  |
| 45CA24 "Ozette"<br>House 2 | 78.73  |
| 45CA24 "Ozette"<br>House 2 | 81.11  |

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| 45CA24 "Ozette"<br>House 2 | 81.71  |
| 45CA24 "Ozette"<br>House 2 | 82.31  |
| 45CA24 "Ozette"<br>House 2 | 84.09  |
| 45CA24 "Ozette"<br>House 2 | 93.02  |
| 45CA24 "Ozette"<br>House 2 | 94.80  |
| 45CA24 "Ozette"<br>House 2 | 98.37  |
| 45CA24 "Ozette"<br>House 2 | 99.56  |
| 45CA24 "Ozette"<br>House 2 | 104.33 |
| 45CA24 "Ozette"<br>House 2 | 109.68 |
| 45CA24 "Ozette"<br>House 2 | 113.85 |
| 45CA24 "Ozette"<br>House 2 | 56.69  |
| 45CA24 "Ozette"<br>House 2 | 68.13  |
| 45CA24 "Ozette"<br>House 2 | 69.85  |
| 45CA24 "Ozette"<br>House 2 | 73.85  |
| 45CA24 "Ozette"<br>House 2 | 76.14  |
| 45CA24 "Ozette"<br>House 2 | 77.86  |
| 45CA24 "Ozette"<br>House 2 | 85.87  |
| 45CA24 "Ozette"<br>House 2 | 90.44  |
| 45CA24 "Ozette"<br>House 2 | 92.73  |
| 45CA24 "Ozette"<br>House 2 | 93.88  |
| 45CA24 "Ozette"<br>House 2 | 94.45  |
| 45CA24 "Ozette"<br>House 2 | 95.02  |
| 45CA24 "Ozette"<br>House 2 | 95.02  |
| 45CA24 "Ozette"<br>House 2 | 100.74 |
| 45CA24 "Ozette"<br>House 2 | 101.31 |
| 45CA24 "Ozette"<br>House 2 | 109.32 |
| 45CA24 "Ozette"<br>House 2 | 113.90 |



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| 45CA24 "Ozette"<br>House 2 | 69.67 |
| 45CA24 "Ozette"<br>House 2 | 70.87 |
| 45CA24 "Ozette"<br>House 2 | 71.48 |
| 45CA24 "Ozette"<br>House 2 | 71.48 |
| 45CA24 "Ozette"<br>House 2 | 72.08 |
| 45CA24 "Ozette"<br>House 2 | 72.68 |
| 45CA24 "Ozette"<br>House 2 | 73.28 |
| 45CA24 "Ozette"<br>House 2 | 74.49 |
| 45CA24 "Ozette"<br>House 2 | 75.09 |
| 45CA24 "Ozette"<br>House 2 | 75.09 |
| 45CA24 "Ozette"<br>House 2 | 75.09 |
| 45CA24 "Ozette"<br>House 2 | 75.69 |
| 45CA24 "Ozette"<br>House 2 | 76.29 |
| 45CA24 "Ozette"<br>House 2 | 76.89 |
| 45CA24 "Ozette"<br>House 2 | 76.89 |
| 45CA24 "Ozette"<br>House 2 | 76.89 |
| 45CA24 "Ozette"<br>House 2 | 76.89 |
| 45CA24 "Ozette"<br>House 2 | 76.89 |
| 45CA24 "Ozette"<br>House 2 | 78.10 |
| 45CA24 "Ozette"<br>House 2 | 78.10 |
| 45CA24 "Ozette"<br>House 2 | 78.10 |
| 45CA24 "Ozette"<br>House 2 | 79.90 |
| 45CA24 "Ozette"<br>House 2 | 79.90 |
| 45CA24 "Ozette"<br>House 2 | 80.51 |
| 45CA24 "Ozette"<br>House 2 | 80.51 |
| 45CA24 "Ozette"<br>House 2 | 81.11 |
| 45CA24 "Ozette"<br>House 2 | 81.71 |

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| 45CA24 "Ozette"<br>House 2 | 82.91 |
| 45CA24 "Ozette"<br>House 2 | 83.52 |
| 45CA24 "Ozette"<br>House 2 | 87.13 |
| 45CA24 "Ozette"<br>House 2 | 88.33 |
| 45CA24 "Ozette"<br>House 2 | 88.33 |
| 45CA24 "Ozette"<br>House 2 | 88.33 |
| 45CA24 "Ozette"<br>House 2 | 88.33 |
| 45CA24 "Ozette"<br>House 2 | 88.33 |
| 45CA24 "Ozette"<br>House 2 | 89.54 |
| 45CA24 "Ozette"<br>House 2 | 89.54 |
| 45CA24 "Ozette"<br>House 2 | 89.54 |
| 45CA24 "Ozette"<br>House 2 | 93.15 |
| 45CA24 "Ozette"<br>House 2 | 93.15 |
| 45CA24 "Ozette"<br>House 2 | 93.15 |
| 45CA24 "Ozette"<br>House 2 | 93.75 |
| 45CA24 "Ozette"<br>House 2 | 94.35 |
| 45CA24 "Ozette"<br>House 2 | 94.35 |
| 45CA24 "Ozette"<br>House 2 | 95.56 |
| 45CA24 "Ozette"<br>House 2 | 96.16 |
| 45CA24 "Ozette"<br>House 2 | 96.16 |
| 45CA24 "Ozette"<br>House 2 | 96.16 |
| 45CA24 "Ozette"<br>House 2 | 97.36 |
| 45CA24 "Ozette"<br>House 2 | 97.96 |
| 45CA24 "Ozette"<br>House 2 | 97.96 |
| 45CA24 "Ozette"<br>House 2 | 97.96 |
| 45CA24 "Ozette"<br>House 2 | 99.17 |
| 45CA24 "Ozette"<br>House 2 | 99.17 |

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| 45CA24 "Ozette"<br>House 2 | 99.77  |
| 45CA24 "Ozette"<br>House 2 | 99.77  |
| 45CA24 "Ozette"<br>House 2 | 102.18 |
| 45CA24 "Ozette"<br>House 2 | 103.38 |
| 45CA24 "Ozette"<br>House 2 | 105.79 |
| 45CA24 "Ozette"<br>House 2 | 106.99 |
| 45CA24 "Ozette"<br>House 2 | 111.21 |
| 45CA24 "Ozette"<br>House 2 | 112.41 |
| 45CA24 "Ozette"<br>House 2 | 114.82 |
| 45CA24 "Ozette"<br>House 2 | 114.82 |
| 45CA24 "Ozette"<br>House 2 | 123.25 |
| 45CA24 "Ozette"<br>House 5 | 57.40  |
| 45CA24 "Ozette"<br>House 5 | 58.92  |
| 45CA24 "Ozette"<br>House 5 | 64.99  |
| 45CA24 "Ozette"<br>House 5 | 69.54  |
| 45CA24 "Ozette"<br>House 5 | 74.94  |
| 45CA24 "Ozette"<br>House 5 | 74.94  |
| 45CA24 "Ozette"<br>House 5 | 74.94  |
| 45CA24 "Ozette"<br>House 5 | 77.46  |
| 45CA24 "Ozette"<br>House 5 | 93.16  |
| 45CA24 "Ozette"<br>House 5 | 97.56  |
| 45CA24 "Ozette"<br>House 5 | 101.33 |
| 45CA24 "Ozette"<br>House 5 | 101.96 |
| 45CA24 "Ozette"<br>House 5 | 110.13 |
| 45CA24 "Ozette"<br>House 5 | 59.69  |
| 45CA24 "Ozette"<br>House 5 | 60.29  |
| 45CA24 "Ozette"<br>House 5 | 62.07  |

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| 45CA24 "Ozette"<br>House 5 | 62.67  |
| 45CA24 "Ozette"<br>House 5 | 72.19  |
| 45CA24 "Ozette"<br>House 5 | 72.19  |
| 45CA24 "Ozette"<br>House 5 | 72.19  |
| 45CA24 "Ozette"<br>House 5 | 72.19  |
| 45CA24 "Ozette"<br>House 5 | 72.78  |
| 45CA24 "Ozette"<br>House 5 | 72.78  |
| 45CA24 "Ozette"<br>House 5 | 75.76  |
| 45CA24 "Ozette"<br>House 5 | 78.14  |
| 45CA24 "Ozette"<br>House 5 | 79.92  |
| 45CA24 "Ozette"<br>House 5 | 88.85  |
| 45CA24 "Ozette"<br>House 5 | 91.23  |
| 45CA24 "Ozette"<br>House 5 | 93.61  |
| 45CA24 "Ozette"<br>House 5 | 93.61  |
| 45CA24 "Ozette"<br>House 5 | 94.21  |
| 45CA24 "Ozette"<br>House 5 | 94.80  |
| 45CA24 "Ozette"<br>House 5 | 94.80  |
| 45CA24 "Ozette"<br>House 5 | 95.40  |
| 45CA24 "Ozette"<br>House 5 | 95.40  |
| 45CA24 "Ozette"<br>House 5 | 95.40  |
| 45CA24 "Ozette"<br>House 5 | 95.40  |
| 45CA24 "Ozette"<br>House 5 | 95.99  |
| 45CA24 "Ozette"<br>House 5 | 97.18  |
| 45CA24 "Ozette"<br>House 5 | 101.94 |
| 45CA24 "Ozette"<br>House 5 | 101.94 |
| 45CA24 "Ozette"<br>House 5 | 105.52 |
| 45CA24 "Ozette"<br>House 5 | 72.71  |

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| 45CA24 "Ozette"<br>House 5 | 73.28  |
| 45CA24 "Ozette"<br>House 5 | 74.43  |
| 45CA24 "Ozette"<br>House 5 | 74.43  |
| 45CA24 "Ozette"<br>House 5 | 74.43  |
| 45CA24 "Ozette"<br>House 5 | 76.14  |
| 45CA24 "Ozette"<br>House 5 | 76.14  |
| 45CA24 "Ozette"<br>House 5 | 76.14  |
| 45CA24 "Ozette"<br>House 5 | 77.29  |
| 45CA24 "Ozette"<br>House 5 | 77.29  |
| 45CA24 "Ozette"<br>House 5 | 77.29  |
| 45CA24 "Ozette"<br>House 5 | 79.00  |
| 45CA24 "Ozette"<br>House 5 | 80.15  |
| 45CA24 "Ozette"<br>House 5 | 80.72  |
| 45CA24 "Ozette"<br>House 5 | 83.58  |
| 45CA24 "Ozette"<br>House 5 | 85.87  |
| 45CA24 "Ozette"<br>House 5 | 88.16  |
| 45CA24 "Ozette"<br>House 5 | 88.73  |
| 45CA24 "Ozette"<br>House 5 | 98.45  |
| 45CA24 "Ozette"<br>House 5 | 121.34 |
| 45CA24 "Ozette"<br>House 5 | 122.48 |
| 45CA24 "Ozette"<br>House 5 | 125.34 |
| 45CA24 "Ozette"<br>House 5 | 127.06 |
| 45CA24 "Ozette"<br>House 5 | 127.63 |
| 45CA24 "Ozette"<br>House 5 | 127.63 |
| 45CA24 "Ozette"<br>House 5 | 127.63 |
| 45CA24 "Ozette"<br>House 5 | 130.49 |
| 45CA24 "Ozette"<br>House 5 | 133.92 |

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| 45CA24 "Ozette"<br>House 5 | 66.06 |
| 45CA24 "Ozette"<br>House 5 | 70.27 |
| 45CA24 "Ozette"<br>House 5 | 70.87 |
| 45CA24 "Ozette"<br>House 5 | 71.48 |
| 45CA24 "Ozette"<br>House 5 | 71.48 |
| 45CA24 "Ozette"<br>House 5 | 71.48 |
| 45CA24 "Ozette"<br>House 5 | 71.48 |
| 45CA24 "Ozette"<br>House 5 | 72.68 |
| 45CA24 "Ozette"<br>House 5 | 72.68 |
| 45CA24 "Ozette"<br>House 5 | 72.68 |
| 45CA24 "Ozette"<br>House 5 | 73.88 |
| 45CA24 "Ozette"<br>House 5 | 76.29 |
| 45CA24 "Ozette"<br>House 5 | 76.89 |
| 45CA24 "Ozette"<br>House 5 | 76.89 |
| 45CA24 "Ozette"<br>House 5 | 79.90 |
| 45CA24 "Ozette"<br>House 5 | 84.12 |
| 45CA24 "Ozette"<br>House 5 | 85.32 |
| 45CA24 "Ozette"<br>House 5 | 87.13 |
| 45CA24 "Ozette"<br>House 5 | 88.33 |
| 45CA24 "Ozette"<br>House 5 | 88.33 |
| 45CA24 "Ozette"<br>House 5 | 88.93 |
| 45CA24 "Ozette"<br>House 5 | 88.93 |
| 45CA24 "Ozette"<br>House 5 | 88.93 |
| 45CA24 "Ozette"<br>House 5 | 89.54 |
| 45CA24 "Ozette"<br>House 5 | 90.14 |
| 45CA24 "Ozette"<br>House 5 | 90.14 |
| 45CA24 "Ozette"<br>House 5 | 90.14 |

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| 45CA24 "Ozette"<br>House 5 | 90.74  |
| 45CA24 "Ozette"<br>House 5 | 96.76  |
| 45CA24 "Ozette"<br>House 5 | 96.76  |
| 45CA24 "Ozette"<br>House 5 | 96.76  |
| 45CA24 "Ozette"<br>House 5 | 96.76  |
| 45CA24 "Ozette"<br>House 5 | 96.76  |
| 45CA24 "Ozette"<br>House 5 | 97.36  |
| 45CA24 "Ozette"<br>House 5 | 97.36  |
| 45CA24 "Ozette"<br>House 5 | 97.36  |
| 45CA24 "Ozette"<br>House 5 | 97.96  |
| 45CA24 "Ozette"<br>House 5 | 99.17  |
| 45CA24 "Ozette"<br>House 5 | 99.17  |
| 45CA24 "Ozette"<br>House 5 | 99.17  |
| 45CA24 "Ozette"<br>House 5 | 99.77  |
| 45CA24 "Ozette"<br>House 5 | 99.77  |
| 45CA24 "Ozette"<br>House 5 | 99.77  |
| 45CA24 "Ozette"<br>House 5 | 99.77  |
| 45CA24 "Ozette"<br>House 5 | 100.37 |
| 45CA24 "Ozette"<br>House 5 | 100.37 |
| 45CA24 "Ozette"<br>House 5 | 100.37 |
| 45CA24 "Ozette"<br>House 5 | 101.58 |
| 45CA24 "Ozette"<br>House 5 | 102.78 |
| 45CA24 "Ozette"<br>House 5 | 105.19 |
| 45CA201 "Sand<br>Point"    | 63.62  |
| 45CA201 "Sand<br>Point"    | 63.62  |
| 45CA201 "Sand<br>Point"    | 63.62  |
| 45CA201 "Sand<br>Point"    | 63.62  |









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| 45CA201 "Sand Point" | 106.10 |
| 45CA201 "Sand Point" | 106.10 |
| 45CA201 "Sand Point" | 106.10 |
| 45CA201 "Sand Point" | 106.10 |
| 45CA201 "Sand Point" | 106.10 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 112.17 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 118.24 |
| 45CA201 "Sand Point" | 124.31 |
| 45CA201 "Sand Point" | 124.31 |
| 45CA201 "Sand Point" | 124.31 |

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| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 130.38 |
| 45CA201 "Sand Point" | 136.45 |
| 45CA201 "Sand Point" | 136.45 |
| 45CA201 "Sand Point" | 136.45 |
| 45CA201 "Sand Point" | 142.51 |
| 45CA201 "Sand Point" | 142.51 |
| 45CA201 "Sand Point" | 142.51 |
| 45CA201 "Sand Point" | 142.51 |
| 45CA201 "Sand Point" | 142.51 |
| 45CA201 "Sand Point" | 148.58 |
| 45CA201 "Sand Point" | 148.58 |
| 45CA201 "Sand Point" | 154.65 |
| 45CA201 "Sand Point" | 166.79 |
| 45CA201 "Sand Point" | 166.79 |
| 45CA201 "Sand Point" | 172.86 |
| 45CA201 "Sand Point" | 178.93 |
| 45CA201 "Sand Point" | 209.27 |
| 45CA1 "Waatch"       | 78.48  |
| 45CA1 "Waatch"       | 62.33  |
| 45CA1 "Waatch"       | 90.75  |
| 45CA1 "Waatch"       | 84.90  |
| 45CA1 "Waatch"       | 84.34  |

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| 45CA1 "Waatch" | 50.25  |
| 45CA1 "Waatch" | 84.47  |
| 45CA1 "Waatch" | 53.64  |
| 45CA1 "Waatch" | 101.00 |
| 45CA1 "Waatch" | 67.57  |
| 45CA1 "Waatch" | 69.96  |
| 45CA25 "Sooes" | 87.80  |
| 45CA25 "Sooes" | 118.00 |
| 45CA25 "Sooes" | 87.09  |
| 45CA25 "Sooes" | 100.58 |
| 45CA25 "Sooes" | 99.81  |
| 45CA25 "Sooes" | 82.77  |
| 45CA25 "Sooes" | 79.96  |
| 45CA25 "Sooes" | 79.66  |
| 45CA25 "Sooes" | 84.83  |
| 45CA25 "Sooes" | 80.50  |
| 45CA25 "Sooes" | 76.74  |
| 45CA25 "Sooes" | 74.14  |
| 45CA25 "Sooes" | 98.80  |
| 45CA25 "Sooes" | 89.03  |
| 45CA25 "Sooes" | 88.61  |
| 45CA25 "Sooes" | 132.69 |
| 45CA25 "Sooes" | 125.80 |
| 45CA25 "Sooes" | 78.31  |
| 45CA25 "Sooes" | 69.79  |
| 45CA25 "Sooes" | 86.22  |
| 45CA25 "Sooes" | 77.75  |
| 45CA25 "Sooes" | 92.11  |
| 45CA25 "Sooes" | 90.10  |
| 45CA25 "Sooes" | 77.13  |
| 45CA25 "Sooes" | 126.56 |
| 45CA25 "Sooes" | 72.73  |
| 45CA25 "Sooes" | 93.59  |
| 45CA25 "Sooes" | 122.89 |
| 45CA25 "Sooes" | 105.55 |
| 45CA25 "Sooes" | 89.00  |
| 45CA25 "Sooes" | 84.87  |
| 45CA25 "Sooes" | 80.00  |
| 45CA25 "Sooes" | 69.04  |
| 45CA25 "Sooes" | 104.45 |
| 45CA25 "Sooes" | 102.02 |
| 45CA25 "Sooes" | 75.09  |
| 45CA25 "Sooes" | 81.61  |

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| 45CA25 "Sooes" | 95.24  |
| 45CA25 "Sooes" | 119.37 |
| 45CA25 "Sooes" | 111.99 |
| 45CA25 "Sooes" | 115.75 |
| 45CA25 "Sooes" | 90.89  |
| 45CA25 "Sooes" | 103.19 |
| 45CA25 "Sooes" | 94.51  |
| 45CA25 "Sooes" | 96.64  |
| 45CA25 "Sooes" | 78.66  |
| 45CA25 "Sooes" | 86.39  |
| 45CA25 "Sooes" | 95.12  |
| 45CA25 "Sooes" | 88.56  |
| 45CA25 "Sooes" | 64.08  |
| 45CA25 "Sooes" | 64.44  |
| 45CA25 "Sooes" | 95.90  |
| 45CA25 "Sooes" | 80.87  |
| 45CA25 "Sooes" | 75.05  |
| 45CA25 "Sooes" | 78.86  |
| 45CA25 "Sooes" | 92.67  |
| 45CA25 "Sooes" | 82.76  |
| 45CA25 "Sooes" | 87.96  |
| 45CA25 "Sooes" | 84.23  |
| 45CA25 "Sooes" | 72.92  |
| 45CA25 "Sooes" | 76.21  |
| 45CA25 "Sooes" | 88.21  |
| 45CA25 "Sooes" | 60.93  |
| 45CA25 "Sooes" | 61.02  |
| 45CA25 "Sooes" | 99.15  |
| 45CA25 "Sooes" | 83.71  |
| 45CA25 "Sooes" | 99.17  |
| 45CA25 "Sooes" | 120.74 |
| 45CA25 "Sooes" | 120.18 |
| 45CA25 "Sooes" | 89.75  |
| 45CA25 "Sooes" | 121.41 |
| 45CA25 "Sooes" | 98.94  |
| 45CA25 "Sooes" | 96.54  |
| 45CA25 "Sooes" | 125.22 |
| 45CA25 "Sooes" | 114.25 |
| 45CA25 "Sooes" | 96.09  |
| 45CA25 "Sooes" | 104.75 |
| 45CA25 "Sooes" | 100.62 |
| 45CA25 "Sooes" | 116.32 |
| 45CA25 "Sooes" | 116.93 |

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| 45CA25 "Sooes" | 121.39 |
| 45CA25 "Sooes" | 117.46 |
| 45CA25 "Sooes" | 100.32 |
| 45CA25 "Sooes" | 82.87  |
| 45CA25 "Sooes" | 111.91 |
| 45CA25 "Sooes" | 78.32  |
| 45CA25 "Sooes" | 109.79 |
| 45CA25 "Sooes" | 111.14 |
| 45CA25 "Sooes" | 81.46  |
| 45CA25 "Sooes" | 78.84  |
| 45CA25 "Sooes" | 104.82 |
| 45CA25 "Sooes" | 103.58 |
| 45CA25 "Sooes" | 86.61  |
| 45CA25 "Sooes" | 72.76  |
| 45CA25 "Sooes" | 66.02  |
| 45CA25 "Sooes" | 80.10  |
| 45CA25 "Sooes" | 92.86  |
| 45CA25 "Sooes" | 81.45  |
| 45CA25 "Sooes" | 90.39  |
| 45CA25 "Sooes" | 75.58  |
| 45CA25 "Sooes" | 76.74  |
| 45CA25 "Sooes" | 66.26  |
| 45CA25 "Sooes" | 75.77  |
| 45CA25 "Sooes" | 72.85  |
| 45CA25 "Sooes" | 47.59  |
| 45CA25 "Sooes" | 79.07  |
| 45CA25 "Sooes" | 71.41  |
| 45CA25 "Sooes" | 148.05 |
| 45CA25 "Sooes" | 119.54 |
| 45CA25 "Sooes" | 124.29 |
| 45CA25 "Sooes" | 63.01  |
| 45CA25 "Sooes" | 95.56  |
| 45CA25 "Sooes" | 106.06 |
| 45CA25 "Sooes" | 130.67 |
| 45CA25 "Sooes" | 141.90 |
| 45CA25 "Sooes" | 132.33 |
| 45CA25 "Sooes" | 76.20  |
| 45CA25 "Sooes" | 85.26  |
| 45CA25 "Sooes" | 95.10  |
| 45CA25 "Sooes" | 96.03  |
| 45CA25 "Sooes" | 85.12  |
| 45CA25 "Sooes" | 85.54  |
| 45CA25 "Sooes" | 86.19  |

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| 45CA25 "Sooes" | 67.79  |
| 45CA25 "Sooes" | 55.95  |
| 45CA25 "Sooes" | 82.05  |
| 45CA25 "Sooes" | 95.20  |
| 45CA25 "Sooes" | 110.02 |
| 45CA25 "Sooes" | 98.52  |
| 45CA25 "Sooes" | 106.69 |
| 45CA25 "Sooes" | 103.80 |
| 45CA25 "Sooes" | 79.63  |
| 45CA25 "Sooes" | 102.99 |
| 45CA25 "Sooes" | 99.59  |
| 45CA25 "Sooes" | 90.89  |
| 45CA25 "Sooes" | 65.01  |
| 45CA25 "Sooes" | 81.77  |
| 45CA25 "Sooes" | 100.99 |
| 45CA25 "Sooes" | 110.89 |
| 45CA25 "Sooes" | 96.17  |
| 45CA25 "Sooes" | 132.94 |
| 45CA25 "Sooes" | 116.40 |
| 45CA25 "Sooes" | 94.74  |
| 45CA25 "Sooes" | 87.90  |
| 45CA25 "Sooes" | 98.16  |
| 45CA25 "Sooes" | 69.73  |
| 45CA25 "Sooes" | 75.05  |
| 45CA25 "Sooes" | 72.16  |
| 45CA25 "Sooes" | 114.38 |
| 45CA25 "Sooes" | 94.68  |
| 45CA25 "Sooes" | 107.26 |
| 45CA25 "Sooes" | 90.10  |
| 45CA25 "Sooes" | 115.84 |
| 45CA25 "Sooes" | 83.12  |
| 45CA25 "Sooes" | 77.16  |
| 45CA25 "Sooes" | 79.70  |
| 45CA25 "Sooes" | 77.63  |
| 45CA25 "Sooes" | 111.24 |
| 45CA25 "Sooes" | 107.17 |
| 45CA25 "Sooes" | 75.13  |
| 45CA25 "Sooes" | 77.94  |
| 45CA25 "Sooes" | 74.75  |
| 45CA25 "Sooes" | 69.90  |
| 45CA25 "Sooes" | 123.75 |
| 45CA25 "Sooes" | 83.27  |
| 45CA25 "Sooes" | 76.51  |

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| 45CA25 "Sooes" | 56.88  |
| 45CA25 "Sooes" | 138.82 |
| 45CA25 "Sooes" | 105.08 |
| 45CA25 "Sooes" | 76.20  |
| 45CA25 "Sooes" | 106.23 |
| 45CA25 "Sooes" | 84.40  |
| 45CA25 "Sooes" | 64.51  |
| 45CA25 "Sooes" | 90.04  |
| 45CA25 "Sooes" | 71.73  |
| 45CA25 "Sooes" | 100.32 |
| 45CA25 "Sooes" | 97.36  |
| 45CA25 "Sooes" | 61.09  |
| 45CA25 "Sooes" | 97.34  |
| 45CA25 "Sooes" | 72.14  |
| 45CA25 "Sooes" | 74.21  |
| 45CA25 "Sooes" | 112.30 |
| 45CA25 "Sooes" | 88.37  |
| 45CA25 "Sooes" | 64.23  |
| 45CA25 "Sooes" | 120.41 |
| 45CA25 "Sooes" | 122.69 |
| 45CA25 "Sooes" | 93.89  |
| 45CA25 "Sooes" | 110.21 |
| 45CA25 "Sooes" | 89.53  |
| 45CA25 "Sooes" | 80.98  |
| 45CA25 "Sooes" | 89.54  |
| 45CA25 "Sooes" | 61.09  |
| 45CA25 "Sooes" | 68.86  |
| 45CA25 "Sooes" | 62.66  |
| 45CA25 "Sooes" | 75.17  |
| 45CA25 "Sooes" | 64.58  |
| 45CA25 "Sooes" | 69.26  |
| 45CA25 "Sooes" | 50.99  |
| 45CA25 "Sooes" | 63.30  |
| 45CA25 "Sooes" | 74.63  |
| 45CA25 "Sooes" | 82.87  |
| 45CA25 "Sooes" | 80.56  |
| 45CA25 "Sooes" | 81.72  |
| 45CA25 "Sooes" | 126.13 |
| 45CA25 "Sooes" | 113.52 |
| 45CA25 "Sooes" | 76.87  |
| 45CA25 "Sooes" | 119.25 |
| 45CA25 "Sooes" | 73.92  |
| 45CA25 "Sooes" | 120.76 |

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| 45CA25 "Sooes" | 120.10 |
| 45CA25 "Sooes" | 75.29  |
| 45CA25 "Sooes" | 69.07  |
| 45CA25 "Sooes" | 61.16  |
| 45CA25 "Sooes" | 115.28 |
| 45CA25 "Sooes" | 98.99  |
| 45CA25 "Sooes" | 79.46  |
| 45CA25 "Sooes" | 60.55  |
| 45CA25 "Sooes" | 82.71  |
| 45CA25 "Sooes" | 135.19 |
| 45CA25 "Sooes" | 147.74 |
| 45CA25 "Sooes" | 111.53 |
| 45CA25 "Sooes" | 108.31 |
| 45CA25 "Sooes" | 81.23  |
| 45CA25 "Sooes" | 131.79 |
| 45CA25 "Sooes" | 136.59 |
| 45CA25 "Sooes" | 139.33 |
| 45CA25 "Sooes" | 67.45  |
| 45CA25 "Sooes" | 73.74  |
| 45CA25 "Sooes" | 138.16 |
| 45CA25 "Sooes" | 144.52 |
| 45CA25 "Sooes" | 115.51 |
| 45CA25 "Sooes" | 66.44  |
| 45CA25 "Sooes" | 93.17  |
| 45CA25 "Sooes" | 104.38 |
| 45CA25 "Sooes" | 119.41 |
| 45CA25 "Sooes" | 115.42 |
| 45CA25 "Sooes" | 103.81 |
| 45CA25 "Sooes" | 121.72 |
| 45CA25 "Sooes" | 99.23  |
| 45CA25 "Sooes" | 100.32 |
| 45CA25 "Sooes" | 98.39  |
| 45CA25 "Sooes" | 87.83  |
| 45CA25 "Sooes" | 120.04 |
| 45CA25 "Sooes" | 99.23  |
| 45CA25 "Sooes" | 114.55 |
| 45CA25 "Sooes" | 95.19  |
| 45CA25 "Sooes" | 98.56  |
| 45CA25 "Sooes" | 96.45  |
| 45CA25 "Sooes" | 93.58  |
| 45CA25 "Sooes" | 92.86  |
| 45CA25 "Sooes" | 96.57  |
| 45CA25 "Sooes" | 102.44 |

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| 45CA25 "Sooes" | 93.24  |
| 45CA25 "Sooes" | 104.84 |
| 45CA25 "Sooes" | 105.69 |
| 45CA25 "Sooes" | 91.31  |
| 45CA25 "Sooes" | 75.72  |
| 45CA25 "Sooes" | 68.89  |
| 45CA25 "Sooes" | 67.96  |
| 45CA25 "Sooes" | 69.60  |
| 45CA25 "Sooes" | 76.85  |
| 45CA25 "Sooes" | 80.36  |
| 45CA25 "Sooes" | 92.00  |
| 45CA25 "Sooes" | 79.44  |
| 45CA25 "Sooes" | 50.12  |
| 45CA25 "Sooes" | 47.59  |
| 45CA25 "Sooes" | 82.11  |
| 45CA25 "Sooes" | 89.49  |
| 45CA25 "Sooes" | 82.83  |
| 45CA25 "Sooes" | 105.81 |
| 45CA25 "Sooes" | 105.00 |
| 45CA25 "Sooes" | 96.79  |
| 45CA25 "Sooes" | 85.42  |
| 45CA25 "Sooes" | 69.82  |
| 45CA25 "Sooes" | 79.15  |
| 45CA25 "Sooes" | 67.09  |
| 45CA25 "Sooes" | 68.30  |
| 45CA25 "Sooes" | 70.43  |
| 45CA25 "Sooes" | 80.18  |
| 45CA25 "Sooes" | 75.99  |
| 45CA25 "Sooes" | 68.51  |
| 45CA25 "Sooes" | 89.16  |
| 45CA25 "Sooes" | 77.40  |
| 45CA25 "Sooes" | 64.72  |
| 45CA25 "Sooes" | 76.68  |
| 45CA25 "Sooes" | 71.60  |
| 45CA25 "Sooes" | 71.80  |
| 45CA25 "Sooes" | 74.27  |
| 45CA25 "Sooes" | 80.36  |
| 45CA25 "Sooes" | 75.99  |
| 45CA25 "Sooes" | 53.08  |
| 45CA25 "Sooes" | 60.39  |
| 45CA25 "Sooes" | 54.81  |
| 45CA25 "Sooes" | 74.71  |
| 45CA25 "Sooes" | 83.55  |

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| 45CA25 "Sooes"         | 70.71  |
| 45CA25 "Sooes"         | 89.34  |
| 45CA25 "Sooes"         | 85.07  |
| 45CA25 "Sooes"         | 89.79  |
| 45CA25 "Sooes"         | 60.38  |
| 45CA25 "Sooes"         | 62.48  |
| 45CA25 "Sooes"         | 96.21  |
| 45CA25 "Sooes"         | 58.36  |
| 45CA25 "Sooes"         | 66.36  |
| 45CA25 "Sooes"         | 86.06  |
| 45CA25 "Sooes"         | 45.54  |
| 45CA25 "Sooes"         | 63.41  |
| 45CA25 "Sooes"         | 41.56  |
| 45CA25 "Sooes"         | 65.40  |
| 45CA25 "Sooes"         | 68.79  |
| 45CA25 "Sooes"         | 109.53 |
| 45CA25 "Sooes"         | 77.91  |
| 45CA25 "Sooes"         | 33.92  |
| 45CA25 "Sooes"         | 57.97  |
| 45CA25 "Sooes"         | 75.80  |
| 45CA25 "Sooes"         | 71.50  |
| 45CA25 "Sooes"         | 94.52  |
| 45CA25 "Sooes"         | 76.74  |
| 45CA25 "Sooes"         | 63.09  |
| 45CA25 "Sooes"         | 76.21  |
| 45CA204<br>"Warmhouse" | 108.84 |
| 45CA204<br>"Warmhouse" | 108.28 |
| 45CA204<br>"Warmhouse" | 39.14  |
| 45CA204<br>"Warmhouse" | 86.76  |
| 45CA204<br>"Warmhouse" | 82.10  |
| 45CA204<br>"Warmhouse" | 93.33  |
| 45CA204<br>"Warmhouse" | 78.02  |
| 45CA204<br>"Warmhouse" | 88.54  |
| 45CA204<br>"Warmhouse" | 86.97  |
| 45CA204<br>"Warmhouse" | 80.72  |
| 45CA204<br>"Warmhouse" | 86.26  |

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| 45CA204<br>"Warmhouse" | 65.58  |
| 45CA204<br>"Warmhouse" | 58.14  |
| 45CA204<br>"Warmhouse" | 54.84  |
| 45CA204<br>"Warmhouse" | 54.89  |
| 45CA204<br>"Warmhouse" | 78.84  |
| 45CA204<br>"Warmhouse" | 68.75  |
| 45CA204<br>"Warmhouse" | 71.74  |
| 45CA204<br>"Warmhouse" | 76.22  |
| 45CA204<br>"Warmhouse" | 90.55  |
| 45CA204<br>"Warmhouse" | 79.05  |
| 45CA204<br>"Warmhouse" | 69.40  |
| 45CA204<br>"Warmhouse" | 79.49  |
| 45CA204<br>"Warmhouse" | 113.81 |
| 45CA204<br>"Warmhouse" | 124.56 |
| 45CA204<br>"Warmhouse" | 112.08 |
| 45CA204<br>"Warmhouse" | 100.19 |
| 45CA204<br>"Warmhouse" | 94.86  |
| 45CA204<br>"Warmhouse" | 106.62 |
| 45CA204<br>"Warmhouse" | 87.04  |
| 45CA204<br>"Warmhouse" | 107.45 |
| 45CA204<br>"Warmhouse" | 84.02  |
| 45CA204<br>"Warmhouse" | 97.34  |
| 45CA204<br>"Warmhouse" | 112.35 |
| 45CA204<br>"Warmhouse" | 95.84  |
| 45CA204<br>"Warmhouse" | 87.34  |
| 45CA204<br>"Warmhouse" | 112.27 |
| 45CA204<br>"Warmhouse" | 84.90  |

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| 45CA204<br>"Warmhouse" | 103.79 |
| 45CA204<br>"Warmhouse" | 105.39 |
| 45CA204<br>"Warmhouse" | 105.14 |
| 45CA204<br>"Warmhouse" | 105.14 |
| 45CA204<br>"Warmhouse" | 130.51 |
| 45CA204<br>"Warmhouse" | 123.68 |
| 45CA204<br>"Warmhouse" | 116.12 |
| 45CA204<br>"Warmhouse" | 69.14  |
| 45CA204<br>"Warmhouse" | 106.60 |
| 45CA204<br>"Warmhouse" | 93.25  |
| 45CA204<br>"Warmhouse" | 64.44  |