A Chronological Analysis of Fish Ridge, San Miguel Island, Channel Islands, California

David Faith

California State University - San Bernardino

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A CHRONOLOGICAL ANALYSIS OF FISH RIDGE, SAN MIGUEL ISLAND, CHANNEL ISLANDS, CALIFORNIA

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Applied Archaeology

by
David C. Faith
June 2020
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Approved by:

Dr. Wesley Niewoehner, Committee Chair, Anthropology

Dr. Guy Hepp, Committee Member, Anthropology
ABSTRACT

In this thesis, I discuss Fish Ridge on San Miguel Island. Fish Ridge is an area located on east San Miguel Island that contains numerous archaeological sites. For my thesis, I went to San Miguel Island in the summer of 2019 to collect 18 radiocarbon samples from five sites. In this thesis, I present the results of my analysis, which include radiocarbon dating, calibration of the radiocarbon dates, and Bayesian statistical analysis. I offer an interpretation of the results, including a discussion of them and avenues for future research.

Prior to this study, a comprehensive chronological analysis of Fish Ridge had not been conducted. For this study, I established a local chronology. I analyzed five distinct shellfish middens from the area in terms of $^{14}$C dates, with a total of 18 individual shellfish from the middens studied. The shellfish I studied for this thesis were red abalone, black abalone, and California mussel shells. Results from the raw, uncalibrated $^{14}$C dates revealed that the shellfish dated to 7315–6038 BP. Refined $^{14}$C dating and Bayesian modelling additionally suggested a fairly narrow span of time for Fish Ridge’s occupation. With an overall probability considerably high at 95%, Bayesian analysis indicated that the middens were continuously utilized by Paleocoastal people during the conclusion of the Early Holocene and the beginning of the Middle Holocene, between 7600 and 6140 cal BP. From an anthropological perspective, this study emphasizes the importance of shellfish as a major subsistence for Paleocoastal people on SMI during the aforementioned period. The multiple radiocarbon dates in this
thesis help the archaeological community better understand subsistence
selection and priorities for Paleocoastal people during the aforementioned period.

My research highlights the utility of $^{14}$C dating, calibration, and Bayesian
modelling to build a reliable, local chronology. With this new information,
archaeologists will be able to have a broader understanding of the archaeological
record of both Fish Ridge and SMI. My research also encourages the
archaeological community to conduct other research on Fish Ridge, such as
dietary reconstruction studies, thorough excavations, and further Bayesian
analysis modelling. The dates provide more context regarding when and where
these coastal inhabitants harvested shellfish, as well as their specific subsistence
strategies during the last component of the Early Holocene and the first
component of the Middle Holocene. With these $^{14}$C dates, my research reinforces
the preexisting archaeological data pertaining to subsistence strategies for
Paleocoastal people on SMI. The chronology I have produced also provides the
archaeological community with a specific understanding of when Paleocoastal
people most likely made use of Fish Ridge.
ACKNOWLEDGEMENTS

I would like to dedicate this thesis to a host of people who have helped me along my journey to become an archaeologist. First, I cannot say thank you enough to my wife, Alison. You have supported me from the very beginning. Your encouragement has meant more than you know. To my children, Ezra and Soraya, you have put up with me when I’ve been up late at night writing and studying, tired and less than patient. Thank you for your willingness to sacrifice for my new career. Thank you to my parents, Gary and Sally, as you have been, all and all, steadfast pillars of encouragement and support. Thank you to my sister, Erin, for reading over many of my papers and for providing useful suggestions for improvement. Your assistance has been wonderful, stellar, unbelievable, and magnificent. And to Adam “Cholula Sauce” Bogren: All I can say is I really appreciate your help with this paper.

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Lastly, the Associated Students, Incorporated (ASI) Travel and Research Fund Committee greatly assisted me by providing funds to help partially cover the costs of my research. The financial assistance I received from ASI allowed me to pay for additional radiocarbon tests, which added validity to my research. I am grateful for their support.
DEDICATION

To my family: I love you. Thank you for supporting me.
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CHAPTER ONE:
A CHRONOLOGICAL ANALYSIS OF FISH RIDGE, SAN MIGUEL ISLAND, CHANNEL ISLANDS, CALIFORNIA

Introduction
San Miguel Island (SMI) is one of the Northern Channel Islands off the coast of southern California. With sites dating from the Terminal Pleistocene and Early Holocene up to the Historic Period (see Rick et al. 2005), SMI has a wealth of archaeological resources. As discussed by co-authors (2005), the Terminal Pleistocene and Early Holocene were from 13,000 to 7,000 years ago. The Historic Period on SMI was from the initial contact between the coastal peoples and Europeans in the sixteenth century, up to the removal of the majority of the former to continental missions in the early nineteenth century (Rick et al. 2005). The trend toward large villages on SMI began around 1500 years ago (Rick et al. 2005). In this thesis, I focus on Fish Ridge, located on the eastern aspect of the island. Originally recorded by Kritzman and Rozaire in 1965, archaeologists designated the site on Fish Ridge, CA-SMI-169, as a large village site (Jew 2019). During field work in August of 2019, I visited the island and collected marine shells for radiocarbon (\(^{14}\)C) dating. There is currently limited information related to the archaeological resources atop Fish Ridge, and the range of occupation of the area has previously been dated to the Middle Holocene. The main goal of this thesis is to develop a revised local chronology for Fish Ridge. Using the marine shells I collected on Fish Ridge: *Haliotis rufescens, Haliotis*
cracherodii, and Mytilus californianus (red abalone, black abalone, and California mussel shells, respectively), I demonstrate that $^{14}$C dating, coupled with $^{14}$C calibration and Bayesian analysis, provides the first multi-site chronology for the ridge, including a modeled chronology based on 18 $^{14}$C dates from five sites. In this paper, by demonstrating when Paleocoastal people on the island utilized the middens, I provide information that substantially adds to the archaeological record of eastern SMI. Furthermore, this thesis highlights the importance that Paleocoastal people placed on shellfish as a significant part of their dietary intake.

**Research Problem**

Prior to this research, a comprehensive assessment of Fish Ridge’s $^{14}$C sequence has not been conducted. That is, no local chronologies along Fish Ridge have been attempted before. New information about Fish Ridge’s chronology needs to be added to the island’s archaeological record. Moreover, while the archaeological community is aware, in general, of the Paleocoastal subsistence pattern along the Northern Channel Islands, an in-depth analysis of this pattern on Fish Ridge has not been undertaken.

**Research Objective.** Thus, a major objective of this paper is to fill in this substantial knowledge gap related to the prehistoric usage of the ridge. My research provides new data pertaining to these middens’ history of utilization. My research also points to the importance of shellfish harvesting as a significant subsistence pattern around the Fish Ridge area. Bayesian analysis, a tool that
has become more popular amongst archaeologists and scholars in recent years (see Bayliss and Bronk Ramsey 2004; Bronk Ramsey 2009a,b; Jew et al. 2015a; Thakar 2014), is a key component of my research. This component provides critical statistical support for the chronology of Fish Ridge. From a theoretical perspective, I rely on Bayes theorem to calculate the probability model. There is additional information on Bayes theorem in the methods section.

**Research Questions:** There are three questions I aim to answer with this research. The research questions include:

1. What was the range of utilization for the abalone and mussel middens?
2. Does Bayesian analysis help refine the local chronology?
3. Archaeologists who focus on the Channel Islands generally agree that Paleocoastal people on the islands were focused on a variety of marine resource procurement, including shellfish, marine mammals, fish, and sea birds (Braje et al. 2011b). Based on the marine shells that I collected and the data produced, what can be inferred about the subsistence pattern on Fish Ridge?
CHAPTER TWO:
ENVIRONMENTAL AND CULTURAL BACKGROUND

The Northern Channel Islands, San Miguel Island, Fish Ridge, Paleocoastal People, and the Chumash

During the Late Pleistocene, the Northern Channel Islands were all connected, and it formed a single island referred to as, Santarosae (see Erlandson et al. 2004; Orr 1968; Wenner and Johnson 1980). Santarosae was quite expansive, and its shoreline measured approximately 2,250 square kilometers during the Last Glacial Maximum (Erlandson et al. 2012). To give an indication of the immense size of Santarosae, it was almost three times the size of all of the Northern Channel Islands’ combined landmasses at present (Erlandson 2013). During the transition from the Late Pleistocene to the Early Holocene, sea levels rose dramatically, separating Santarosae into four smaller islands (Erlandson et al. 2012). Some scholars have suggested that Santarosae has lost about seventy percent of its land mass since the Last Glacial Maximum (see Erlandson 2013; Kennett et al. 2008). This loss of land mass presents a significant obstacle for present-day Channel Islands archaeologists, as many of the Terminal Pleistocene archaeological sites are either underwater or have degraded due to coastal and marine erosion (Erlandson 2013). According to Erlandson (2013:107), “all the known early Paleocoastal sites (>11,000 cal BP) appear to have been located at least two kilometers from the Terminal Pleistocene coastline and several were considerably further from the shore.” It is
realistic to assume there are still many unrecorded, unexplored archaeological sites submerged where the coastline of Santarosae Island once was; the potential is high for these sites to provide archaeological data and a greater understanding of the Paleo-coastal peoples that inhabited the massive island. At the end of the Last Glacial Maximum and with substantial sea level rise, the four Northern Channel Islands established their current configuration.

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Figure 2.01: Topographic Map of the Northern Channel Islands (see Rick et al. 2005).

San Miguel Island is owned by the United States Navy (Rick et al. 2005), but the island is stewarded by the National Park Service (NPS) (National Park Service 2019). The NPS maintains a ranger station, a graded dirt airstrip for small planes, and a primitive campground with only nine sites (National Park
Service 2019). Due to the fact that the island was at one point a bombing range used by the U.S. Navy and unexploded ordinance have been recovered there, NPS employees are required to lead visitors on hikes to just a few of the more prominent places on the island (National Park Service 2019). It is also the westernmost of the Channel Islands. Due to its prominent geographical position, SMI is typically battered with strong winds and encircled by dense, cool fog (Erlandson and Braje 2004). For instance, in 1999, SMI’s Naval Weather Station recorded fierce wind gusts in excess of 100 kilometers per hour (Rick et al. 2004). As a result of the aeolian processes on SMI, the island’s landscape and surficial archaeological resources have been significantly impacted. There are sand dunes which trend in the same direction as the prevailing winds (northwest to southeast) and some of the dunes reach 30 meters in height (see Erlandson et al. 2005a; Johnson 1972, 1980; Rick 2002; Rick et al. 2004). The island’s Mediterranean climate makes the average temperature about 14°C, with cool, wet winters and mild summers. It gets approximately 356 millimeters of annual rainfall (see Johnson 1980; Rick et al. 2004; Schoenherr et al. 1999).

The island is located approximately 42 kilometers off the coast of Santa Barbara (Erlandson et al. 2004). It is about 14 kilometers in length, seven kilometers in width, and the entire land area is roughly 37 square kilometers (Erlandson et al. 2004). The island is replete with both ancient and modern sand dunes, which often obscure much of the otherwise visible bedrock geology (Erlandson et al. 2004). The exceptions to this are the areas where canyon walls,
blowouts, escarpments, and sea cliffs expose SMI’s geological features (Erlandson et al. 2004). The island’s landscape “consists of two low hills surrounded by extensive tablelands, with a series of raised marine terraces separated by steep escarpments that mark ancient shorelines and sea cliffs” (Erlandson et al. 2004:25). Fish Ridge is located on the eastern aspect of the island. From atop Fish Ridge, there is a commanding view of Santa Rosa Island and the Pacific Ocean. One can also see much of SMI from the summit of Fish Ridge.

Figure 2.02: San Miguel Island, with Fish Ridge in focus.
It is also noteworthy that the island was inhabited by Paleocoastal people since the Terminal Pleistocene. Extensive work by Jon Erlandson and other archaeologists has highlighted some important sites that these early island inhabitants utilized, such as Daisy Cave (CA-SMI-261) (see Erlandson et al. 1996; Rick 2001). The occupants of Daisy Cave were boat-using people that were also contemporaneous with people of the Folsom culture (see Erlandson et al. 1996; Rick 2001). Regarding the considerably lengthy settlement on SMI and the other Northern Channel Islands, Rick and scholars (2005:187) claimed that “early island sites have produced some of the earliest evidence for maritime voyaging, shell middens, and marine fishing in the Americas.” Furthermore, the ethnographic record has informed archaeologists about the Chumash that lived on SMI during the Historic Period and spoke the Chumashan language (Rick et al. 2005). For example, CA-SMI-163, a Late Holocene and Early Historic Period village complex located near Cuyler Harbor, is generally identified by archaeologists as the Chumash village of Tuqan (Rick 2007; Rick et al. 2013). Historical records of this Chumash village has not only placed it near the previously mentioned Cuyler Harbor, but also 34 baptisms of its inhabitants occurred during the Contact period (see Kennett 2005). Future archaeological research pertaining to the settlement of the Chumash on SMI will most likely yield new, critical information about the tribe.
Previous Archaeological Research at Fish Ridge

As mentioned earlier, SMI-169 was originally recorded by Kritzman and Rozaire in 1965. The site is situated on the northeastern portion of the island, very close to Cardwell Point. The researchers noted the site covered an area of about 375 feet east to west, 300 feet north to south, and its eastern border ran along the steep bluff to the east (Kritzman and Rozaire 1965). Additionally, the authors described SMI-169 as a village site and quarry workshop, with lithics, especially chalcedony flakes and chunks, visible at various intervals, particularly along the southeast edge of the site. The authors also observed multiple small shell middens, roughly 20 feet in circumference. The primary shells that were visible on the surface included California mussels, red and black abalone, large chiton, venus clam, owl limpet, and Tegula (a large sea snail) (Kritzman and Rozaire 1965).

In 2009, a number of archaeologists reassessed CA-SMI-169, and they generally agreed with the initial assessment (Erlandson et al. 2009). The researchers interpreted Fish Ridge to be a likely place of both shell processing and lithic manufacturing. Erlandson and colleagues (2009) noticed the same types of marine shells on the surface as mentioned before, and they additionally identified a number of lithic material types, including chalcedony, quartzite, Monterey, and Cico chert. More recent analysis by Jew (2013) revealed that SMI-169 was a large multi-loci shell midden and lithic quarry workshop. The site would have been an excellent area for Paleocoastal peoples to collect high
quality, knappable material. In his dissertation, Jew (2013) wrote that approximately 90% of the nearly 1900 lithic artifacts recovered at SMI-169 were Tuqan and Cico chert. A variety of chert types are commonly found on the NCI, and the former, Tuqan, is unique to SMI (Erlandson et al. 2004). While it is macroscopically comparable to Monterey chert found along the coast near Santa Barbara, Tuqan also typically contains a thin layer of white cortex, making it distinguishable from Monterey chert (Erlandson et al. 2004). Further, marine shell samples taken after the site reassessment provided more key information about the general subsistence trend. Of the roughly 150 marine shells that were recovered (10 marine shell types in sum), California mussel shells comprised nearly 75% of the first unit and 80% of the second unit (Powell 2019).
CHAPTER THREE:
MATERIALS AND METHODS

Provenience and Samples for Radiocarbon Dating

In August of 2019, I was part of a small team that conducted several days of pedestrian surveys across the entire span of Fish Ridge, working our way across SMI-169. The objectives of the surveys included recording GPS coordinates for future research, updating site records, and collecting shells from each distinct midden to conduct $^{14}$C dating and Bayesian analysis. Thirteen of the previously recorded middens were relocated, and I was able to assemble, via surface collection and probing, a combined total of approximately 140 marine shell samples from nine of the middens. The overwhelming majority of the samples were shell fragments. The surface collection was undertaken by simply identifying and collecting the most intact samples. Emulating collection methods already established by multiple scholars (see Culleton et al. 2006; Jew et al. 2015a; Nicholas Jew, personal communication 2019), I chose California mussel, and black and red abalone samples that were either oversized fragments or complete specimens. I was careful to not select bivalve fragments that may have been of the same specimen. All of the samples were relatively large and had multiple shell growth bands, so the potential for intra-shell variability was diminished. This was important for the $^{14}$C drilling procedure later in the process (Nicholas Jew, personal communication 2019). Of the nine middens where
samples were taken, I chose to conduct $^{14}$C dating and Bayesian analysis on 18 marine shells from five of the middens. Three shells were analyzed from four of the middens, and six shells were analyzed from the fifth midden. Below, I provide a cursory description for each of the five middens, along with pictures and polygons.

Figure 3.01: Close up of Fish Ridge and surveyed archaeological sites from the 2019 survey. All polygons recorded (Matheu 2019).
• Amol Point Midden:

![Image](image.jpg)

Figure 3.02: Overview of AMOL, facing north-northeast.

Located at the base of Fish Ridge, the site was named AMOL simply because an Amol projectile point was recovered at this location. This projectile point (see Appendix C for a photo) is believed by some archaeologists to date to the Terminal Pleistocene and Early Holocene (see Erlandson et al. 2012). The midden had a mixture of chert types, with Tuqan, Cico, and Monterey chert all present within its boundaries. This archaeological site is the largest of the ones I analyzed, with its length at roughly 120 meters (Matheu 2019). For the vegetation, ice plant, coreopsis, and other small shrubs covered much of the area. There were many moderate-sized patches of bare ground, where aeolian processes have taken place. Except for the barren spots, the soil is a somewhat loose, light brown, sandy loam. Additionally, AMOL had shellfish such as black
abalone, red abalone, and California mussel shells scattered on its surface, although the quantity was not as substantial as at the other middens I examined. All of the samples were recovered from the ground surface. I collected six black abalone shells, six red abalone shells, and 20, mostly fragmented, California mussel shells. From these, I selected one fragmented California mussel shell, one fragmented red abalone shell, and one nearly intact black abalone shell for drilling and $^{14}$C dating.

Figure 3.03: Polygon of AMOL (Matheu 2019).
Red Abalone Mussel Split:

At an elevation of 230 feet above mean sea level (AMSL) and with a stunning view of the Pacific Ocean, it is a midden with a mixture of primarily red abalone and California mussel shells. While the midden was not completely segregated, there appeared to be two distinct concentrations of shell types, hence the name, Red Abalone Mussel Split (RAMS). It measured about 40 meters in length, with a circumference of 88 square meters (Matheu 2019). This midden had a host of good quality red abalone shells. Many of the red abalone shells were intact, whereas the bulk of the mussel shells were fragments. I noted one small obsidian flake in situ on the surface. The vegetation consisted of ice plant, coreopsis, and other low-lying shrubs. There was good visibility on the midden, and there were numerous bare spots with somewhat loose, brown sandy loam. There were also some bird and fish bones, along with other shellfish types, such as black abalone and chiton on the surface. During my assessment of RAMS, I collected eight red abalone shells, four black abalone shells, and 15 California mussel shells that were suitable for drilling. All of the California mussel shells were fragmented samples, and most of the abalone shells were also fragmented samples. All of the samples were recovered from 0–4 cm below the surface. Most of the samples were already partially visible on the ground surface. From these, I selected a total of six samples for eventual drilling and 14C dating. I selected one intact black abalone shell, two nearly intact red abalone shells, and three fragmented California mussel shells for drilling and 14C dating.
Figure 3.04: Close-up of Red Abalone Mussel Split Midden. Note the demarcation between the large red abalone mussel shells.
Figure 3.05: Polygon of RAMS (Matheu 2019).
• Red Abalone Midden #1:

Situated on the upper aspect of Fish Ridge, Red Abalone Midden #1 (RAM1) has a total circumference of nearly 22 square meters (Matheu 2019). It is a distinct shell midden, patently separate from other marine shell middens in the nearby vicinity. There was good surface visibility at the site, and the majority of shells were surface collected, with large red abalone shells being the most noticeable. California mussel shells and a few fish bones were also apparent on the surface. The vegetation consisted of sagebrush, ice plant, and giant coreopsis.

![Overview of RAM1, facing east.](image-url)

Figure 3.06: Overview of RAM1, facing east.
The soil was primarily a moderately loose sandy loam, with the previously described flora intermixed throughout the site. There were, moreover, at least 12 expedient lithic tools and two bifaces in plain view on the surface. At RAM1, I
collected a total of nine shells; four of the shells were red abalone, and five were California mussels. The shells were recovered from 0–5 cm below the surface. From these, I selected two intact red abalone shells and one fragmented California mussel shell for eventual drilling and \(^14\)C dating.

- Mussel Midden #1:

Figure 3.08: Overview of MM1, facing north.

At an elevation of 240 feet AMSL and along Fish Ridge, Mussel Midden #1 (MM1) is a site which is chiefly composed of California mussel shells. There were, in addition, a scant amount of red abalone and Lottia shells (sea snails) visible on the ground surface. There were very few lithic artifacts noted. The primary vegetation I observed were coreopsis and sagebrush. Mussel Midden #
1 measured 37 meters in length, and its total area circumference was nearly 66 square meters (Matheu 2019). The soil was a predominantly brown, sandy loam. While at MM1 on August 3, 2019, I collected a total of 11 shells. The bulk of the samples were eight California mussel shells, but there were three red abalone shells as well. All of the shells were recovered from 1-5 cm below the surface. From the collection, I selected two intact California mussel shells and one intact red abalone shell for drilling and $^{14}$C dating.
Figure 3.09: Polygon of MM1 (Matheu 2019).
Mussel Midden #2:

Mussel Midden #2 (MM2) was a short distance away from MM1, less than 10 meters to the northwest. However, there appeared to be a distinct separation between the two middens. Similar to MM1, MM2 was primarily a California mussel midden, with a few red abalone specimens on the surface as well. There were some lithic artifacts on the midden, with several Cico chert flakes and one tested chert cobble observable within MM2’s perimeter. The midden had the same vegetation as MM1; sagebrush and coreopsis were the primary plants. The soil at MM2 was nearly identical to the soil at MM1, with sandy loam throughout. This midden was smaller than its neighbor, MM1, as it measured about 21 meters in length and had a total area circumference of approximately 24 square
meters based on surface visibility (Matheu 2019). At MM2, I probed the ground and eroded surfaces, collecting 14 marine shells. All samples were recovered in between a depth of 1-5 cm. Eleven of the 14 shellfish were California mussel, and the other three were red abalone shells. From the 14 shells, I selected one fragmented red abalone shell and two fragmented California mussel shells for drilling and $^{14}$C dating.
Figure 3.11: Polygon of MM2 (Matheu 2019).
Radiocarbon Dating Procedure, Calibration, and Bayesian Modelling

For each of the above five middens described, I chose three of the most intact samples per site for radiocarbon dating. I followed the methods of other archaeologists by examining each to select the ones with an intact carbonate layer void of possible contaminants for drilling. Using an established laboratory method (see Culleton et al. 2006; Erlandson et al. 2019; Jew et al. 2015a; Nicholas Jew, personal communication 2019), prior to drilling, I gently washed and scrubbed each shell. I etched the exterior of each shell in dilute hydrochloric acid (10% solution) to remove potential surface contaminants, and then allowed the shells to dry overnight. The drying process eliminated the chance of the shells retaining moisture. I then drilled various, small quantities of powder from each shell’s exterior to send for $^{14}$C dating. The minimum amount of powder I was required to drill for each shell for $^{14}$C dating was 20 milligrams (mg). The shells I drilled yielded weights from 26 mg to 304 mg (see Appendix B for each samples’ exact weights). The company I chose to do the $^{14}$C dating was Direct AMS laboratory, located in Bothell, Washington. Other archaeologists have used this reputable company in their archaeological investigations (see Fitzpatrick and Jew 2018; Jew et al. 2015a). Extensive details of the procedures used by Direct AMS are available on the company’s website (Direct 2019).
Figure 3.12: Etching a few of the shells with 10% hydrochloric acid.

To develop the chronology of human occupation atop Fish Ridge, I used the OxCal 4.3 online program to calibrate the dates that were provided by Direct AMS. I used OxCal’s most up-to-date calibration curve to perform the calibration. Bronk Ramsey (1995:430) described OxCal as a computer program that “allows the user to perform many different kinds of analyses on $^{14}$C dates, from simple calibration to analysis of entire archaeological sites including information from stratigraphy to other dating methods. Complex chronological models can be built and imposed on the dating evidence to provide a coherent picture.” Furthermore, the computer program gives researchers the ability to produce graphical output, basically making the results visible and relatively easy to interpret (Bronk
Ramsey 1995). After receiving the uncalibrated $^{14}$C dates, the information was inserted into this program. Calibration of the dates was paramount because the $^{14}$C dates are essentially raw data that must be corrected to account for a host of variables. Reimer and colleagues (2013b:1924) described the importance of calibrating $^{14}$C dates. The authors wrote that a $^{14}$C date “does not provide a calendrical age directly but must be corrected for variations in the $^{14}$C/$^{12}$C ratio of the atmosphere, ocean, or other reservoir where the sample grew or was formed. This is done by comparison (i.e., calibration), with curves derived from $^{14}$C ages of samples that have been calendrically dated by alternative and independent means.” All 18 shell samples were successfully calibrated using the Marine 13 calibration curve (Reimer et al. 2013a). All of the samples were further adjusted using a ΔR of 261 ± 21, as a number of archaeologists have used these values to adjust $^{14}$C dates of shells (see Jazwa et al. 2012; Jew et al. 2015a; Kennett et al. 1997; Thakar 2014). The next step was to implement Bayesian analysis on the calibrated $^{14}$C dates.

Scholars have recently relied more heavily on Bayesian analysis to understand at times rather complicated series of $^{14}$C dates. This method has been increasingly used by many archaeologists, as this form of analysis has provided statistical support for the accuracy of modeled site chronologies (see Bayliss and Bronk Ramsey 2004; Bronk Ramsey 2009a, b; Fitzpatrick and Jew 2018; Jew et al. 2015a). Utilizing the OxCal 4.3 program, Bayesian analysis was conducted to produce a modelled chronology for all of the samples. I created
several models including one for all of the dates and then for each site. Each model was run as a phase with boundaries set for the entire model. While all of the samples were recovered either on the surface or within five centimeters below surface level, it should be noted that Bayesian analysis has become a major device for archaeologists who are working at sites that are deeply stratified, including shell middens (see Culleton et al. 2012; Jazwa et al. 2013; Jew et al. 2015a; Kennett et al. 2011, 2014). For instance, Jew and colleagues (2015a) utilized this method to interpret a host of dates from the Prisoners Harbor Site on Santa Cruz Island. Moreover, it is important to point out that when Bayesian analysis is applied for $^{14}$C sequences, the three types of probabilities are prior, likelihood, and posterior (Jew et al. 2015a). Importantly, another positive contribution of this approach is that Bayesian analysis will pinpoint questionable dates with poor agreement indices, which is considered to be below the index threshold of 60% (see Bronk Ramsey 2000; Jew et al. 2015a). In my analysis, all of the agreement indices were well above the 60% minimum. In fact, my analysis produced an overall agreement index of 98.9%.

Other researchers have also utilized Bayesian analysis as an effective approach at interpreting archaeological sites. For example, Sanchez and colleagues (2018), were able to refine the chronology for the Par-Tee site on the northern Oregon coast. The results of their reassessment via Bayesian analysis indicated that the first analysis of the site was significantly incorrect, as it suggested that the occupation occurred between approximately 2300 to 800 cal
However, Bayesian analysis revealed the site was more likely occupied from roughly 1850 to 1150 cal BP (Sanchez et al. 2018).

Table 3.01: All $^{14}$C dates on Fish Ridge

<table>
<thead>
<tr>
<th>Site</th>
<th>Lab ID</th>
<th>Species</th>
<th>Depth</th>
<th>Uncal $^{14}$C Date</th>
<th>Error ±</th>
<th>From 1 Sigma</th>
<th>To 1 Sigma</th>
<th>From 2 Sigma</th>
<th>To 2 Sigma</th>
</tr>
</thead>
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<tr>
<td>RAMS</td>
<td>D-AMS 035925</td>
<td>Haliotis rufescens</td>
<td>Probe, 1-4 cmbs</td>
<td>6548</td>
<td>31</td>
<td>6850</td>
<td>6640</td>
<td>6910</td>
<td>6600</td>
</tr>
<tr>
<td>RAMS</td>
<td>D-AMS 035926</td>
<td>Haliotis cracherodii</td>
<td>Surface</td>
<td>6665</td>
<td>33</td>
<td>7000</td>
<td>6760</td>
<td>7080</td>
<td>6710</td>
</tr>
<tr>
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<td>H. rufescens</td>
<td>Probe, 1-4 cmbs</td>
<td>6685</td>
<td>28</td>
<td>7010</td>
<td>6790</td>
<td>7100</td>
<td>6740</td>
</tr>
<tr>
<td>RAMS</td>
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<td>Mytilus californianus</td>
<td>Surface</td>
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<td>29</td>
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<td>6680</td>
<td>6940</td>
<td>6640</td>
</tr>
<tr>
<td>RAMS</td>
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<td>M. californianus</td>
<td>Surface</td>
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<td>28</td>
<td>7000</td>
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<td>7080</td>
<td>6730</td>
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<td>M. californianus</td>
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<td>H. rufescens</td>
<td>Probe, 1-5 cmbs</td>
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<td>31</td>
<td>6280</td>
<td>6100</td>
<td>6310</td>
<td>6010</td>
</tr>
<tr>
<td>MM1</td>
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<td>M. californianus</td>
<td>Probe, 1-5 cmbs</td>
<td>6679</td>
<td>39</td>
<td>7030</td>
<td>6760</td>
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<tr>
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<td>M. californianus</td>
<td>Probe, 1-5 cmbs</td>
<td>6654</td>
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<td>H. rufescens</td>
<td>Probe, 1-5 cmbs</td>
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<td>7600</td>
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<td>7640</td>
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<td>M. californianus</td>
<td>Probe, 1-5 cmbs</td>
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<td>6440</td>
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</table>
In this research, I rely on the known information (the uncalibrated and calibrated $^{14}$C dates) in combination with Bayes theorem to produce modelled dates for the middens. With Bayes theorem, the basic idea is that one takes into consideration a few different factors and uses this information to produce modelled dates. These factors include the researcher's prior beliefs about the chronometric information before it is obtained, the probability of the researcher obtaining his or her observations if the dates were known, and the researcher's posterior beliefs, which is comprised of both the data and prior beliefs (Millard 2006). Steel (2001:155) wrote that “Bayesianism is founded on the claim that (ideally) rational people have degrees of belief that can be represented as probabilities, and that scientific inference is a matter of changing these degrees of belief in accordance with Bayes theorem as new information is received.” This perspective is applicable in my research because it produced modelled dates that are reliable and likely accurate. However, it is important to highlight that this
sort of analysis often works best when examining stratigraphically complex sites (see Jew et al. 2015a), and while the middens I focus on may indeed contain complex stratigraphy, I only collected marine shells from the surface.
CHAPTER FOUR: RESULTS

The results of the $^{14}$C dates and Bayesian analysis of the archaeological sites atop Fish Ridge provides new information to previously undated resources in the area. Direct AMS provided the first set of data. All of the 18 marine shells dated to the latter component of the Early Holocene and the beginning of the Middle Holocene. In a timespan that is relatively narrow in terms of the archaeological record, there is a variance of only about 1,280 years between the youngest and oldest shells’ uncalibrated $^{14}$C dates. The range of reported uncalibrated $^{14}$C dates for all of the samples is 7315–6040 cal BP (see Table 3.01).

Along with the uncalibrated dates provided by Direct AMS, 1 and 2-Sigma calibration of the reported $^{14}$C dates illuminated more important information about the middens in question. For instance, 2-Sigma calibration indicated the youngest marine shell yielded calibrated $^{14}$C dates to 6310–6010 cal BP. Again, with 2-Sigma calibration, the oldest shell’s $^{14}$C dates are from 7650 to 7420 cal BP (see Table 3.01). When 2-Sigma calibration is employed, the time gap between these aforementioned shells is only 1,630 years. Bayesian analysis has revealed even more telling information about when the middens were most likely exploited. The combined results indicated there is a 95% probability the five middens on Fish Ridge were used between 7600 and 6140 cal BP, a span of
Bayesian modelling also produced agreement indices of $A_m = 116.2\%$ and $A_o = 98.9\%$, both of which are well above the minimum threshold of 60% (see Jew et al. 2015a).

Radiocarbon dating and Bayesian analysis demonstrated that these distinct middens were utilized by groups of people over a relatively close timespan. My overall analysis suggests the entire length of time is from approximately 7600 to 6140 cal BP, thus making the timeframes only about 1,460 years across the five middens. Bayesian analysis of the marine shells has emphasized the point that these middens were likely used during the latter part of the Early Holocene and the beginning of the Middle Holocene. The above dates comport with other Middle Holocene sites, as Vellanoweth and colleagues (2006) indicated that red abalone middens were commonplace during this timeframe.

There have been quite a few red abalone middens which have been $^{14}$C dated from 7500 to 3500 cal BP (Vellanoweth et al. 2006). Erlandson and scholars (2005b:15) claimed that “between about 7,300 and 3,000 years ago large red abalone shells are abundant in many San Miguel middens. These red abalone middens, which vary in size and setting, have been found around the entire perimeter of the island.” At the Otter Point midden (CA-SMI-481) on SMI, for example, at least ten discrete shell midden deposits were recorded, and more than 20 $^{14}$C dates of marine shells strongly suggested human occupation began at it roughly around 7300 cal BP (Vellanoweth et al. 2006).

Yet the midden deposits at Otter Point are not the sole indicators of the
utilization of California mussels and abalone shells during the late Early Holocene and the start of the Middle Holocene. Along SMI there are many archaeological sites which provide more evidence for such usage, similar to the middens in focus on Fish Ridge. Braje and scholars (2005) detailed how two sites on SMI’s south coast yielded California mussels with $^{14}$C dates near the latter part of the Early Holocene. In addition, at SMI-350, researchers (see Rick et al. 2005) have determined that red abalone from a midden were harvested from 7440–7360 cal BP, or roughly contemporaneous with the red abalone sample from MM2. Also, at the Cave of the Chimneys site (CA-SMI-603) located on SMI’s northeast coast, multiple shellfish were excavated from different strata, and many of the shells yielded $^{14}$C dates which corresponded with the Middle Holocene (Ainis et al. 2011). The most plentiful shellfish by weight at this site included California mussels, sea urchin, red abalone, and black abalone. When the researchers examined the remains at the site by counting the minimum number of individuals, California mussel shells, at about 31%, were the most abundant of the shellfish (Ainis et al. 2011).

Moreover, Bayesian modelling suggests there is a high likelihood of a continuous occupation near the middens between 7600 and 6140 cal BP. With a probability of 95%, there is a very strong likelihood that the middens were utilized during the above timespan. The middens were most likely used extensively during the latter part of the Early Holocene and during the beginning of the Middle Holocene. Erlandson and authors (2005b) stated that the Terminal
The Pleistocene and Early Holocene were from approximately 12000 to 6700 cal BP, whereas the Middle Holocene was from 6700 to 3400 cal BP. Bayesian modelling strongly suggests there was a relatively short period of use for the five middens, and they were used during the latter Early Holocene and the initial stage of the Middle Holocene.

Importantly, the quantity of samples only lends credence to the study. Other researchers have used considerably smaller quantities in their chronological analyses. For example, in an attempt to understand when occupation occurred at a coastal site in Oregon, Hall and scholars (2005) relied on one piece of charcoal to contend that the site was occupied during the Early Holocene. The authors also received scrutiny (see Moss et al. 2005) for making broad chronological assumptions predicated on a single $^{14}$C date. However, similar to the study conducted by Jew and colleagues (2015a), my thesis does not simply rely on a minimal number of $^{14}$C dates for analysis and chronological sequencing. I use a considerable number of samples to build the chronology on Fish Ridge, thereby increasing the validity of the results.
Figure 4.01: Bayesian modelling of Fish Ridge.
CHAPTER FIVE:  
DISCUSSION

The fact that the middens were utilized over a fairly brief period may suggest a number of key points and help answer my first research question: What was the range of utilization for the abalone and mussel middens? According to 2-Sigma calibration, the entire range of utilization was from 7650 to 6010 cal BP, or 1,640 years (see Table 3.01). Bayesian analysis narrowed this range to a greater degree (see Figure 4.01). The evidence suggests that maritime people on SMI used the middens during the latter component of Early Holocene and beginning stage of the Middle Holocene. For my second research question, I asked: Does Bayesian analysis help refine the local chronology of Fish Ridge? Bayesian analysis undoubtedly refines the $^{14}$C dates produced by 2-Sigma calibration. As mentioned, 2-Sigma calibration yielded an entire range of 1,640 years, a relatively narrow timespan. However, Bayesian analysis shortened this already narrow chronology from 7600 to 6140 cal BP, or 1,460 years. In other words, Bayesian analysis produced a chronology that was, in total, 180 years less than the results from 2-Sigma calibration. Importantly, the nearly continuous use of the middens also suggests that resources along the eastern aspect of SMI during the latter part of Early Holocene and beginning of the Middle Holocene were most likely bountiful enough to sustain maritime
people. Paleocoastal people during this time span were likely finding many nutritional resources from the sea, and on Fish Ridge, shellfish were especially abundant. The shellfish harvested off the coast of Fish Ridge would have most likely been a substantial part of the diet for Paleocoastal people living in the site’s vicinity. While the focus of this thesis on Fish Ridge, other shellfish middens on the island, particularly red abalone middens, seem to suggest that this nutritional pattern was probably prevalent along much of SMI. Moreover, the aforementioned tight chronology likely suggests one of two options: (1) There were multiple groups that occupied Fish Ridge (and used the middens in this study) over the dates previously mentioned; or (2) This was a large village group which utilized the entire area for nearly 1,500 years. Below, I provide a discussion for each site.

For the AMOL site, I tested one red abalone, one black abalone, and one California mussel shell. The two types of abalone shells yielded $^{14}$C dates from 2-Sigma calibration that were considerably close in age (see Table 3.01). Similarly, Bayesian analysis reinforced the results of 2-Sigma calibration (see Figure 5.01), as the analysis suggested that the abalone shells tested on AMOL were consumed during remarkably close points. Two-Sigma calibration of the red abalone shell produced $^{14}$C dates from 6440 to 6190 cal BP (see Table 3.01), whereas the modelled dates of the same shell from Bayesian analysis were from 6410 to 6240 cal BP (see Appendix D). The black abalone shell also produced similar dates, with 2-Sigma calibrated $^{14}$C dates of 6550 to 6270 cal BP (see
Table 3.01), while Bayesian analysis produced modelled dates from 6490 to 6300 cal BP (see Appendix D). These dates suggest that the abalone shells were relatively close in terms of their $^{14}$C dates, as there is some overlap between them. In fact, because of this overlap it is feasible the site was occupied during a short span of time, possibly by the same group of people. However, the one California mussel shell I tested from AMOL returned a $^{14}$C date that was significantly older than the two abalone shells, with a 2-Sigma calibrated age range of 7650 to 7420 cal BP. The modelled dates of the mussel shell produced dates from 7610 to 7450 cal BP. The dates do not overlap with the abalone shells at the midden. Therefore, it was most likely consumed well before the red and black abalone shells. This may indicate that the site was utilized more than once. The consumption of California mussel shells is also consistent with the subsistence pattern on the Channel Islands during the Early Holocene, as discussed by Rick and scholars (2005). In the authors’ (2005) review of multiple Early Holocene sites along most of the Channel Islands, California mussels were a significant resource at nearly all of the sites.
For the RAMS site, I tested two red abalone shells, one black abalone shell, and three California mussel shells. Not unlike the abalone shells from AMOL, the two types of abalone shells from RAMS produced fairly close results. Two-Sigma calibration of the two red abalone shells yielded $^{14}$C dates from 6910 to 6600 cal BP and 7100 to 6740 cal BP, and 2-Sigma calibration of the black abalone shell produced $^{14}$C dates from 7080 to 6710 cal BP (see Table 3.01). Bayesian analysis (see Figure 5.02) of the two red abalone shells generated modelled dates from 6880 to 6680 cal BP and 6970 to 6780 cal BP, respectively. Bayesian analysis of the black abalone shell produced modelled dates from 6960 to 6760 cal BP (see Appendix E). All three of these abalone shells produced dates which overlapped, both with 2-Sigma calibration and Bayesian analysis. The results, comparable to the two abalone shells I tested from AMOL,
suggested that the three abalone shells I tested from RAMS could have consumed by the same group of people, or they were consumed during a relatively short span of time. The results of the abalone shells also indicated that there was probably continuous use of the RAMS midden.

The three California mussel shells I tested from RAMS produced nearly equivalent \(^{14}\)C dates. For example, 2-Sigma calibration of the three shells yielded \(^{14}\)C dates from 6940 to 6640 cal BP, 7080 to 6730 cal BP, and 6920 to 6610 cal BP (see Table 3.01). Bayesian analysis produced very similar results, with modelled dates from 6900 to 6710 cal BP, 6970 to 6770 cal BP, and 6880 to 6690 cal BP, respectively (see Figure 5.02 and Appendix E). All three of the California mussel shells produced \(^{14}\)C dates that overlapped each other, therefore making it probable that the shells were consumed over a short span of time during the Middle Holocene, possibly by the same group of people. In fact, there is overlap between all six of the marine shells I tested from RAMS. These results may highlight the point that RAMS was utilized for a continuous period of time. Bayesian analysis produced dates without a noteworthy disparity between the oldest and youngest shells’ age ranges. The difference in age range between the oldest shell and the youngest shell is only 90 years, therefore possibly
pointing to the continuous usage of RAMS.

Figure 5.02: Bayesian modelling of RAMS.

I tested a total of three samples from RAM1; there were two red abalone shells and one California mussel shell. The two red abalone shells produced a 2-Sigma calibrated age range of 6970 to 6660 cal BP and 7150 to 6790 cal BP (see Table 3.01). The California mussel shell had a 2-Sigma calibrated age range of 6880 to 6560 cal BP (see Table 3.01). Bayesian analysis of the above marine shells yielded similar results, with modelled dates (see Figure 5.03 and Appendix F) of the red abalone shells from 6930 to 6720 cal BP and 7070 to 6800 cal BP; the California mussel shell's modelled dates were from 6850 to
6630 cal BP. Similar to the RAMS site, there are overlapping age ranges in between the three shells on RAM1, and a relatively narrow age gap between the oldest and youngest shell. Bayesian analysis of the three shells produced modelled dates with a difference of only 220 years between the oldest and youngest shell.

I tested one red abalone shell and two California mussel shells from MM1. There was a significant disparity in age ranges between the two species. For instance, 2-Sigma calibration of the red abalone shell yielded $^{14}$C dates from 6310 to 6010 cal BP (see Table 3.01), while Bayesian analysis produced modelled dates from 6280 to 6110 cal BP (see Figure 5.04 and Appendix G) for the same sample. However, for the two California mussel shells, 2-Sigma
calibration resulted in age ranges from 7130 to 6720 cal BP and 7040 to 6700 cal BP (see Table 3.01). The modelled dates for the same two samples were from 7010 to 6760 cal BP and 6970 to 6750 cal BP, respectively (see Figure 5.04 and Appendix G). While there is some overlap between the two California mussel shells on MM1, there is no overlap between the red abalone shell and the California mussel shells. The red abalone shell was harvested and consumed during a period appreciably younger than the California mussels. There is a significant overlap amongst the two California mussel shells, with a difference of only 40 years between their modelled dates. The collection of California mussel shells was, as mentioned with the subsistence strategy on AMOL, a prominent pattern during the Early Holocene. This same trend appeared to occur on MM1, where the $^{14}$C dates and analysis seem to suggest that the subsistence pattern of harvesting mussel shells was more prominent during the Early Holocene.

Another point to consider is the notion of when MM1 was exploited. The large gap in age between the two species seems to suggest that although it is possible MM1 was continuously used by a large group, it may be more likely that multiple groups exploited the site over varying intervals.
Figure 5.04: Bayesian modelling of MM1.

For MM2, I tested two California mussel shells and one red abalone shell. The shells all yielded $^{14}$C dates from the concluding segment of the Early Holocene. Further, there was overlap between the two California mussel shells, with a 2-Sigma age range of 7410 to 7150 cal BP, and 7280 to 6970 cal BP (see Table 3.01). Bayesian modelling of the same two mussel shells produced date ranges from 7370 to 7170 cal BP and 7260 to 7050 cal BP, respectively (see Figure 5.05 and Appendix H). The single red abalone shell from MM2 produced a 2-Sigma age range of 7460 to 7420 cal BP (see Table 3.01). Bayesian analysis of the red abalone shell manufactured modelled dates from 7590 to 7440 cal BP (see Figure 5.05 and Appendix H). Using the modelled dates, the age difference between the two California mussel shells is 110 years. Similar to some of the
shells at the other sites, these two shells had age ranges which overlapped. Interestingly, the red abalone shell yielded both modelled and 2-Sigma date ranges that were older than either of the California mussel shells previously mentioned, and the modelled dates did not overlap with the California mussel shells. In fact, the red abalone shell from MM2 was the oldest of the species I collected, and the second oldest of the 18 marine shells I analyzed. This unique component of MM2 may indicate that variation between subsistence selection was a phenomenon during the Early Holocene. In Glassow’s (2005) analysis of five sites on Santa Cruz Island, for example, all of the red abalone samples, except for one anomaly, produced $^{14}$C dates from the Middle Holocene. The one outlier yielded a 1-Sigma calibrated age range from 7537 to 7319 cal BP (Glassow 2005), which was not significantly different from the red abalone shell on MM2 that I have described.
With regard to the above five middens I have discussed, RAMS has the narrowest time interval, with only 90 years of variation between the oldest and youngest shells’ modelled dates. The site with the longest interval was AMOL, with 1200 years between the oldest and youngest shells’ modelled dates. Additionally, all five sites contain marine shells with some overlapping date ranges, although not every shell from each site overlapped. For instance, there were outliers at AMOL, MM1, and MM2. On RAMS and RAM1, the coastal people who most likely lived near these sites were consuming red abalone, black abalone, and California mussels within a considerably short span of time, possibly simultaneously. However, the people who exploited the resources at
MM1, MM2, and AMOL were probably consuming California mussels and abalone shells during distinctly separate periods.

While this comes as no surprise, there additionally appears to be a patent subsistence pattern during the time in which the middens were exploited. This pattern answers my third research question: Based on the marine shells that I collected, and the data produced, what can be inferred about the subsistence pattern on Fish Ridge? An important inference from this research is that the marine shells species I studied clearly provided a significant portion of the diet for maritime peoples during the Early and Middle Holocene. Moreover, not only were California mussel and abalone shells a staple part of the diet, but this must also indicate that these marine shells were fairly abundant resources. While other shellfish were most likely consumed during the dates in which the middens were taken advantage of, California mussels and abalone shells were by far the most plentiful resource on the surface. The information from the middens may suggest that certain marine resources, in particular red abalone and California mussels, were both abundant and relatively easy to acquire. Glassow (1987) suggested that prehistoric people may have descended into the fairly shallow subtidal waters to retrieve red abalone, not unlike present day abalone fisherman. Also, red abalone may have simply been considered more palatable than some other shellfish (Glassow 1987). Concerning subsistence strategies, perhaps the Chumash on Fish Ridge chose to gather marine shells because it was easier than other forms of subsistence, such as hunting large sea mammals. Possibly
hunting certain large mammals, like pinnipeds, was not a predominant trend on the Channel Islands during the Early and Middle Holocene, thus necessitating other forms of subsistence. Rick and colleagues (2005) claimed that at certain Late Holocene sites such as CA-SMI-232, SMI-481, and SMI-528, the densities of pinniped faunal remains increased. Writing about CA-SMI-602 and SMI-528, both near the western end of the island, Walker and scholars (2000) argued evidence from these two sites suggests that pinniped hunting increased dramatically on SMI during the Late Holocene. A number of scholars (see Braje et al. 2011a; Jew et al. 2015b) put forth the argument that ancient groups of pinnipeds may have been limited to offshore islands and rocks. Perhaps during the period in which the middens on Fish Ridge were occupied, a considerable time disparity from the Late Holocene sites previously mentioned, pinniped hunting was not the dominant subsistence strategy.

The significant presence of red abalone shells on Fish Ridge may also suggest a unique pattern. For example, on RAMS and RAM1, red abalone comprised approximately 36% and 44% of the collected assemblage, respectively. However, in their study of CA-SRI-666, Erlandson and colleagues (2019) wrote that this Early Holocene site on Santa Rosa Island was dominated by the presence of California mussel, while red abalone were significantly less abundant. The assemblage consisted of 83% California mussel and just 2% red abalone. This disparity may be due to geographic and temporal variability, as discussed by Braje (2007). In his analysis of three Middle Holocene red abalone
middles on SMI, there was considerable variability in the dry shell weights, ranging from nearly 90% to 11% (Braje 2007). Moreover, the significant presence of red abalone along Fish Ridge may be partially connected to the occurrence of cooler sea-surface temperatures during the Middle Holocene, as suggested by Glassow (2015).

Additionally, the data from this study seems to suggest that although Rozaire did tremendous work on the island (and on the Channel Islands in general), he was incorrect in his assessment of SMI’s occupational history. In the 1965 report of his fieldwork, the author stated that “a predominantly late prehistoric occupation is indicated by the emphasis on food resources from the sea as evidenced by the extensive refuse in the midden of a wide variety of shellfish” (Rozaire 1965:31). Yet, the present information strongly suggests human occupation much earlier than the late prehistoric phase.

Limitations

Subsurface excavations were not conducted for this research. It would indeed add to the study if there were some marine shells retrieved from different depths, including the deepest parts of the middens in question. Exploring the middens’ depths and contents would likely provide key additional information. As mentioned, Bayesian analysis tends to be effective in the analysis of sites which are deeply stratified (see Culleton et al. 2012; Jazwa et al. 2013; Jew et al. 2015a; Kennett et al. 2011, 2014). In addition, although the sample size was
ample for the purposes of this research, not every midden we recorded was analyzed.

Another limitation is the fact that I focused on three types of shellfish, as opposed to the entire array of shellfish species on Fish Ridge. While red abalone, black abalone, and California mussels were by far the most prominent marine shells on the surface of Fish Ridge, there were other shellfish types visible, such as Lottia and chiton. The former three were indeed a major part of these maritime peoples' diets during the span of time previously mentioned, but I did not include other types of shellfish in my analysis. The monetary cost of conducting analysis on more than three types of shellfish was a prohibitive factor. A more expansive analysis would study all of the marine shells on the surface of Fish Ridge.

Future Research

Fish Ridge is replete with cultural materials and artifacts, and the area requires further analysis. One of the more obvious tasks for future research is to conduct subsurface testing along some of the middens. With the marine shells' $^{14}$C dates all within the latter part of the Early Holocene and the beginning component of the Middle Holocene and all found on the surface (or within a few centimeters of it), targeted excavations may reveal the middens contain cultural material that date to the Terminal Pleistocene. Considering the documented antiquity of SMI, the data potential for these middens is presumably great, and the probability of them informing the archaeological record is also likely high.
Other potential future research avenues include an in-depth dietary reconstruction for all of Fish Ridge, and stable isotope studies of the collected marine shells. A thorough dietary reconstruction for all of Fish Ridge would provide information pertaining to the subsistence patterns of on the island for thousands of years. Similarly, stable isotope studies would provide even more context to the dietary reconstruction, by pointing to when certain shellfish were harvested. Such investigations would probably add important information to SMI’s archaeological record.

Additionally, if excavations are conducted and cultural materials are recovered, then Bayesian analysis (see Jew et al. 2015a; Thakar 2014) of the materials will likely provide useful chronological information. Other scholars have utilized this approach to better understand shell middens, which tend to be stratigraphically complex (see Jew et al. 2015a; Stein et al. 2003; Thakar 2014).

With multiple avenues for possible future research, Fish Ridge will likely remain an area of great interest for the archaeological community.
CHAPTER SIX:
CONCLUSION

This research has undoubtedly added critical information to the archaeological record of SMI. Prior to this study, a comprehensive chronological analysis of Fish Ridge had not been conducted. In this study, a local chronology has been established. The first set of raw, uncalibrated \( ^{14} \text{C} \) dates revealed that the marine shells all yielded dates from the Early and Middle Holocene. Furthermore, refined \( ^{14} \text{C} \) dating and Bayesian modelling suggest there was a fairly narrow span of time for Fish Ridge’s occupation. Bayesian analysis indicates that the area was occupied during the conclusion of the Early Holocene and the beginning of the Middle Holocene, between 7600 and 6140 cal BP. Further refining of the Bayesian modelling suggests that the five midden sites I analyzed had distinct patterns of utilization. From an anthropological perspective, this study has revealed not only the most likely timeframes in which Paleocoastal people used these middens, but also their heavy reliance on shellfish during the aforementioned periods. The evidence I have detailed seems to suggest that Paleocoastal people were quite reliant on shellfish as a form of subsistence, particularly during the transition from the Early to Middle Holocene. More research may also follow the theme of this thesis by examining the nutritional content of the shellfish utilized by Paleocoastal people. For example, did Paleocoastal people rely more heavily on black abalone as opposed to red abalone either during the Early Holocene or on other parts of SMI?
Additionally, my research points to the importance of relying upon the combination of ¹⁴C dating and Bayesian modelling to build a reliable, local chronology. With this new information, archaeologists will be able to have a broader understanding of the archaeological record of both Fish Ridge and SMI. Moreover, SMI, as mentioned, has numerous archaeological sites, and some of them are from the Late Pleistocene and Early Holocene. The potential for more research on Fish Ridge is high, with in-depth excavations, dietary reconstruction, and more Bayesian analysis being just a few options. My thesis has also opened the door for important future research questions, such as questions pertaining to Paleocoastal peoples’ reliance on the natural resources around Fish Ridge during the latter part of the Early Holocene and the beginning segment of the Middle Holocene. Other research questions concerning how the Chumash survived on the island, and the relative importance of shellfish middens on eastern SMI compared to other sections of SMI, may be further avenues of research.

My thesis, in addition to elucidating information related to when the middens were used and the corresponding likely times for when Fish Ridge was occupied, may point to new research frontiers associated with the island. Perhaps a larger number of ¹⁴C dates from many more shellfish middens in the vicinity of Fish Ridge will be useful, informative future research. More ¹⁴C dates will enable archaeologists to expound on this study by encouraging the implementation of additional Bayesian analyses to understand the archaeological
record of SMI. Do similar midden patterns appear on other parts of the island? Were there key resources other than shellfish that drew these Paleo-coastal people to Fish Ridge? My thesis has opened up a considerable number of interesting questions and issues related to the archaeology of SMI.
APPENDIX A:

BAYESIAN ANALYSIS OUTPUT CHART
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AMOL PROJECTILE POINT
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