“There are two types of fisherman – those who fish for sport
and those who fish for fish” – Author Unknown

This thesis is dedicated to my brother, Sergei Cheremisin, who fishes not only for sport and for fish, but also for his little sister’s research projects. To my greatest motivator, Sergei, for having endless faith in me.

University of Alberta

Zooarchaeological Study of Faunal Remains from the Ityrkhei Site on Lake Baikal, Siberia

by

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Abstract

The research proposed here examines prehistoric subsistence patterns during the Holocene (~10,000–600 BP) through the analyses of animal bones recovered from the Itrykhei site located on the shore of Lake Baikal in Siberia. The results of this examination show that Ityrkhei was a temporary camp from which a number of resources were procured, in particular littoral fishes, seal and deer. The inhabitants of Ityrkhei exploited local habitats, probably in the immediate site vicinity. It seems that hunting of seal and deer was opportunistic, and that at least from the Late Mesolithic through the Neolithic (8000–4300 BP), Itrykhei was primarily used as a base for harvesting perch, roach, dace, and pike. While the season(s) of occupation are not known with certainty, some data suggest occupation may have spanned from spring through fall.

Acknowledgments

First of all, I would like to thank my supervisor, Dr. Robert Losey, for being great and very patient with the always demanding Russian graduate student. Thank you, Rob, for coming to Siberia and spending hours, days, and weeks with me looking at almost 20,000 fish bones. Sorry for the Sarma canyon accident in 2005, it was part of a very "old" Russian initiation tradition that one must go through before working with me. Boiling fish heads for fish size reconstruction was fun (perhaps except the smelly part of it) as was our fishing trips to Lake Baikal with my brother. I never thought that I would become as crazed over fishing and fish bones as you, but here I am. Thank you, Rob, for all your support in supervising, correcting my writing, teaching me English, and for your comments and just being there to listen.

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A special thank you goes out to my brother, Sergei Cheremisin, not only for his emotional support, but also for helping to build the fish comparative collection and more importantly for allowing me to use his apartment and freshly built bania as a zooarchaeology laboratory for boiling and processing animal carcasses.

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Finally, on a personal note, I would like to thank my family Sergei Cheremisin and Galina Nomokonova for their love and support and for believing in me as a scientist. Special thanks to my friends Alena Sabirova and Uiliia Emel'ianova, for their everyday letters that I received in Canada which helped me survive. I also want to thank my friends and colleagues Andrea Hiob, Mindy Pitre, Julija Kelecevic, Tia Thomson, Kathy and Dave Gadd, Kara Zutz, Dr. G. Medvedev, Andrei Emel'ianov, Galina N. Mikhniuk, Valdimir I. Bazaliiskii, Darren Shaw, and Alexei Novikov for their friendship, support and belief in me. In closing, I want to express my special gratitude to Eric Stiwich, for making me coffee every morning, something that helped while I was working on this thesis.

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Introduction

1.1 Introduction

The Lake Baikal area is rich in archaeological mortuary and habitation sites, excavations of which produce not only large quantities of artefacts and human osteological material, but also substantial quantities of faunal remains. The earliest professional archaeological investigations in this region focused on typological designations and radiocarbon analyses of material culture and human skeletal remains (Okladnikov 1950, 1955; Weber 1995). Collections of faunal remains have been analyzed, but are generally unreported or not described in any detail. This early 'zooarchaeology' was based predominantly on the identification of the dominant animal species at some sites (Khamzina 1991; Medvedev 1971; Ovodov and Panychev 1982; Savel'ev et al. 2001). Recently, more advanced analyses of human subsistence practices in the Lake Baikal area have been undertaken. This has involved the use of stable isotope analyses to reconstruct human diet (Katzenberg and Weber 1999; Weber et al. 2002) and the study of tooth thin sections and biogeographical data to investigate seal procurement (Weber et al. 1993, 1998).

The places people chose to inhabit and the food items recovered from these living sites partially reflect what food items were potentially available in the local environment, what was actually procured, and how resources were exploited (Bailey and Parkington 1988). Animal remains recovered from sites in the Lake Baikal area have good potential to provide information about subsistence economies, diet, seasonality, procurement techniques, and environmental change in prehistory. Although minor zooarchaeological studies have been done in this region, methodologies for such work are not well developed, and taphonomic processes are poorly understood. When faunal remains have been analyzed, reporting is usually limited to species composition. In other words, the potential of archaeological faunal remains has yet to be fully realized, despite many decades of research. The research proposed here examines prehistoric subsistence patterns during the Holocene (~10,000–600 BP) based on the examination of animal remains recovered from the archeological site known as Itrykhei, on Lake Baikal. This thesis is the first comprehensive analysis of faunal remains from a Lake Baikal archaeological site and thus represents a first step in fully utilizing the region's rich assemblages of animal remains.

1.2 Research area

This research is focused on the Lake Baikal area, particularly the Priol'khon'e, in Siberia, Russia (Figure 1.1). The Baikal area is defined as the territory situated between 52–56° north latitude and 104–110° east longitude in the southern part of Eastern Siberia. It includes the islands and shores of Lake Baikal as well as the adjacent sections of the major rivers (Angara, Barguzin, and Selenga) draining into or out of the lake (Figure 1.2). Some of the chapters of this thesis utilize the geographic term Cis-Baikal. This term refers to the west part of the Lake Baikal region and encompasses the Angara basin down to Ust'-Ilimsk, the drainage of the upper Lena down to Kirensk, and the islands and northwestern coasts of Lake Baikal (Weber 1995).

More specifically, this research is concerned with the Priol'khon'e (Figure 1.2), which lies on the west coast of Lake Baikal from the Bol'shaia Bugul'deika River in the south, to Cape Elokhin in the north. The region also includes the lake's largest island, Ol'khon, and the Little Sea (Goriunova and Svinin 1995). The Little Sea is the portion of Lake Baikal located between Ol'khon Island and the mainland to the west (Figure 1.2).

1.3 Research objectives

The overall goal of my thesis is to gain a better understanding of hunting and fishing strategies among ancient culture groups of the Lake Baikal area during the Holocene. This is accomplished through zooarchaeological examination of animal bones from the multilayered site Ityrkhei. To this end, one primary objective in this thesis is to produce a systematic analysis of faunal remains from the site that can provide insight on subsistence change over time in the region. I draw upon various sources of information including biological and ecological data, local ethnographic records, and paleoenvironment data to understand human behavior and decision making and the ancient landscape within which this behavior took place.

The primary research questions or domains for my thesis are: (1) which animals were procured by the ancient groups at Ityrkhei during the Holocene; (2) what can these remains reveal about harvesting techniques and season(s) of site use; (3) which habitats in the region were regularly exploited; (4) were there diachronic changes in the above patterns over the ~10,000 years the site was occupied? These research questions are formulated to provide some insights beyond simple identification and quantification of faunal remains, and to speak more specifically about prehistoric human behavior in the Lake Baikal area.

1.4 Thesis organization and terminological conventions

The thesis is organized into 7 chapters. Following this Introduction, chapter 2 gives an overview of the physical and cultural contexts within which the research takes place. Chapter 3 provides background on previous research in the area focusing on zooarchaeology and prehistoric subsistence issues. In chapter 4, I present the materials and methods utilized, including discussion on taxonomic evaluation. Chapter 5 consists of a detailed examination of the Ityrkhei faunal assemblage, including a discussion of possible taphonomic biases. Following these descriptive chapters, in chapter 6, I provide an interpretation of the patterns revealed in the earlier chapters, including a discussion of diachronic patterns in faunal exploitation. Finally, chapter 7 summarizes the results of this research and presents some general comments on future research directions.

I will conclude this introductory chapter by explaining some of the necessary terminological conventions that are used throughout this thesis. First, European common names are used to describe fauna in the thesis, but Latin scientific names also are always provided. For example, I refer to *Cervus elaphus* as red deer rather than elk and *Alces alces* as elk, not moose. In cases where familiar English names do not exist, common Russian terms are simply transliterated as they sound in Russian. For example, taimen' (*Hucho taimen*), lenok (*Brachymystax lenok*), and omul' (*Coregonus autumnalis migratorius*) are all widely known Russian terms for fishes that do not have commonly used English equivalents. Second, the description of skeletal element terminology is based on the *Dictionary of Evolutionary Fish Osteology* published by A.L. Rojo (1991), where all osteological terms are also presented in Russian, Latin and English. Furthermore, the translation of the Russian words and phrases into English is based on the United States Library of Congress System (without diacritical marks) and more information on different aspects of this transliteration is described by McKenzie (2006).

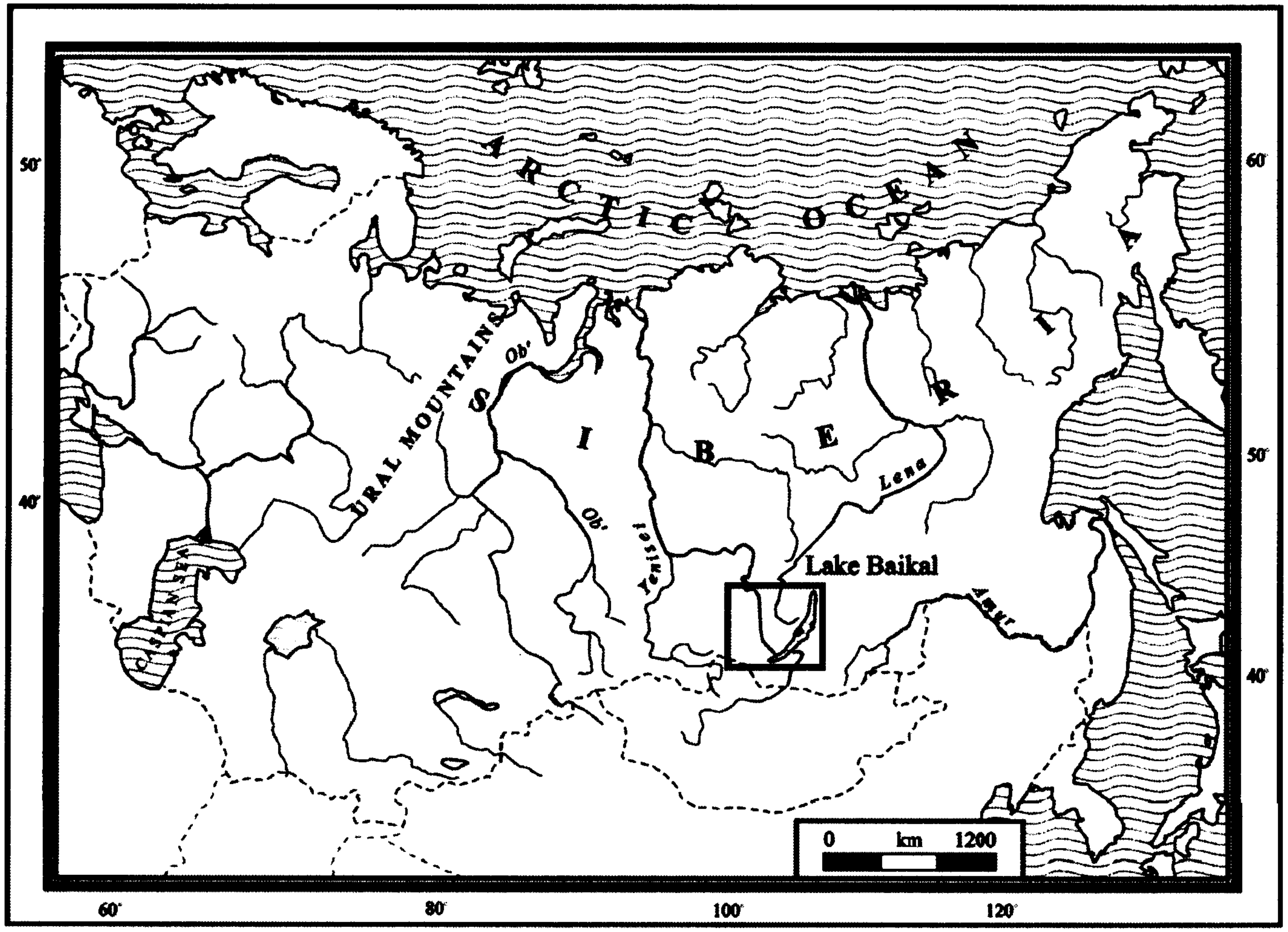


Figure 1.1: Map of Siberia indicating the location of Lake Baikal.

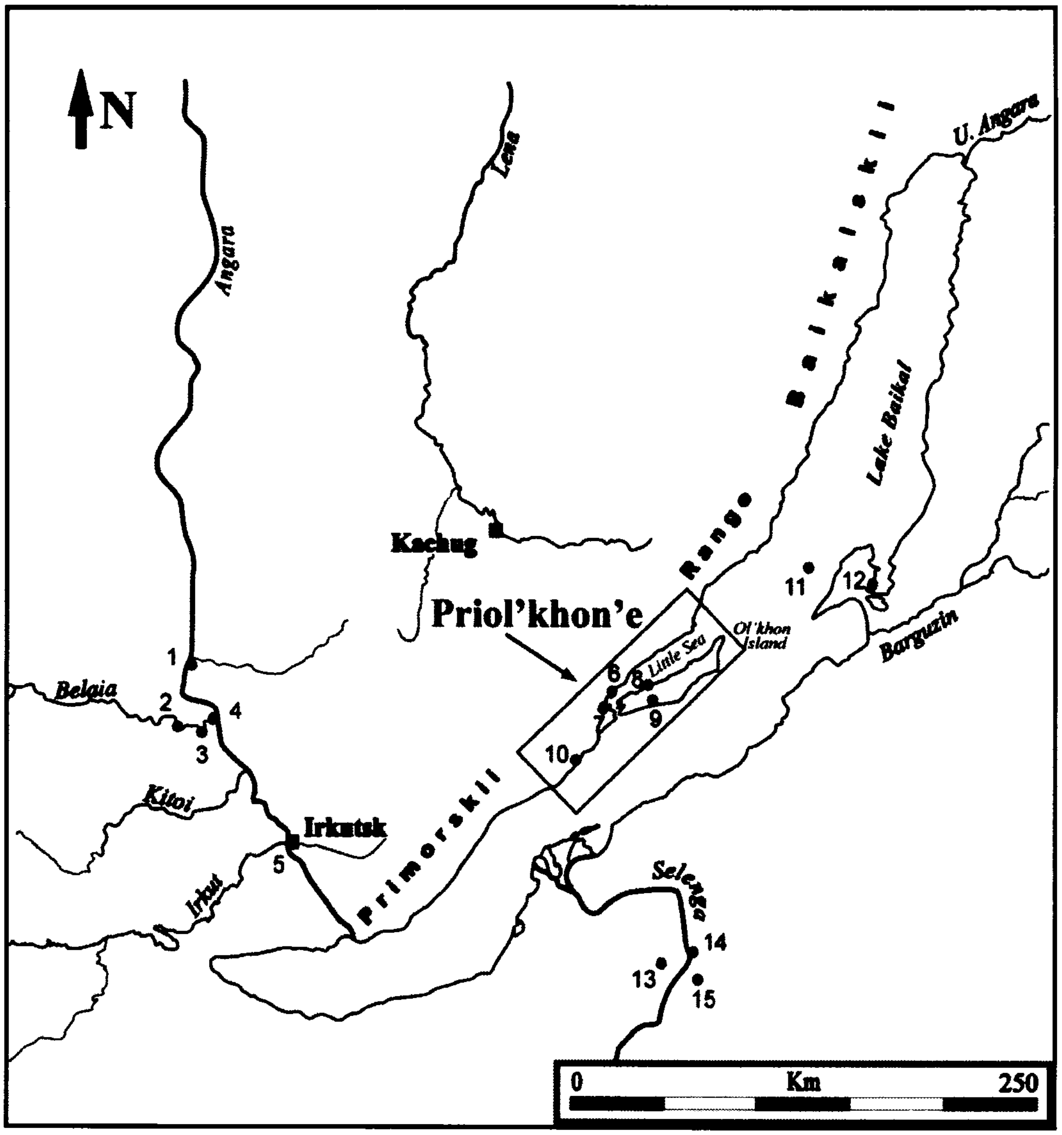


Figure 1.2: Map of the Lake Baikal area and Priol'khon'e with location of archaeological sites mentioned in text indicated: 1 – Ust'-Uda; 2 – Ust'-Khaita; 3 – Mal'ta; 4 – Ust'-Belaia; 5 – Verkholenskaia Gora; 6 – Khuzhir-Nuge XIV and XV, Sarma I; 7 – Kulara III, Sagan-Nuge, Ulan-Khada, Kurkut III, Berloga, Ityrkhei; 8 – Khuzhir; 9 – Tyshkine II and III; 10 – Sagan-Zaba II; 11 – Ushkan'i Ostrova; 12 – Katun' I, Okunevaia IV; 13 – Nizhne-Ivolginskoe; 14 – Nizhniaia Berezovka; 15 – Kamenka.

Chapter 2
Background Information

In this chapter, I outline the geography of the Lake Baikal region and describe the modern fauna, both of which are important for understanding the potential range of prehistoric subsistence strategies used by the region's foraging groups. Following this, I briefly describe the region's Holocene culture history. It should be noted that while this background focuses on faunal remains from habitation site from a particular microregion (Priol'khon'e), the descriptions provided have broader spatial and temporal application for the entire Lake Baikal area.

2.1 Geographic context

Lake Baikal is situated in southeast Siberia, Russia (Figure 1.1). It is one of the oldest lakes in the world, created ~20–30 million years ago by tectonic forces. The lake is 636 km long by 79 km wide, with a maximum depth of 1741 m. The total surface area of Lake Baikal is 31,500 km^2 (Lut 1978). The lake is located in the center of a mountainous region known as the Baikal Rift Zone that is defined by a series of ranges that border the lake shores. These include the Barguzinskii (1100–2100 m asl), Ulan-Burgazy (1100–1800 m asl), and Khamar-Daban (1100–2400 m asl) ranges along the eastern and southern coasts, and the Eastern Sayan range (1100–3400 m asl) to the west of the southern tip of Lake Baikal. In addition, the Baikal'skii range (1100–2650 m asl) descends directly into the lake on the northwest coast, while the Primorskii range (1100–1700 m asl) stretches along the its southwest portion. The Primorskii range forms the western geographic border of the Priol'khon'e. The coastal plain is almost absent here due to the position of this range close to the shore, and small rivers and seasonal channels divide its slopes into narrow V-shaped valleys (Lut 1978; Galazii and Molozhanikov 1982).

The climate in the Lake Baikal region is distinctly continental, and affected by a number of different factors including geographical location, specific atmospheric circulation, topography, and the influence of lake itself. These interactions create a variety of local microclimates: dry steppe in the southern part of the Selenginsk Dauriia, coastal climate on the Baikal shores, and cold alpine conditions at high altitudes. The high mountains surrounding Lake Baikal create a relatively mild continental climate in its valleys. Winters are cold and last approximately five months, while summers, approximately two months in length, are warm and dry. Temperatures during summer may reach 33–35°C, but in winter may drop as low as – 40°C. In general, the climate is drier and more variable on the western coast, and wetter and colder on the east (Galazii and Molozhnikov 1982). The Baikal region experiences very little precipitation, averaging 300 mm per year or less.

The Priol'khon'e has a unique microclimate due to its proximity to the Primorskii range to the west and Baikal waters to the east. The thermal influence of the lake on the coastline differs depending on the season. The lake has a warming effect on the Priol'khon'e in autumn and winter and cooling effect in spring and summer. In addition, the Primorskii range protects the area from strong winds, which results in less frequent cloud cover and less precipitation than seen in surrounding areas. As such, Ol'khon Island is extremely arid, receiving only 169 mm of precipitation annually (Berg 1950).

The Lake Baikal region is characterized by a high degree of differentiation in vegetation, especially between the plains and mountainous areas (Galazii and Molozhnikov 1982). Vegetation complexes include steppe, forest-steppe, taiga and alpine-tundra environments (Berg 1950). Common steppe and forest-steppe zone vegetation includes fescue, koeleria, feather grass, and steppe sedge. In some locales, such as southeast part of Ol'khon Island, the landscape is solely a steppe zone, with little tree cover being present, except for the occasional larch (*Larix sibirica* and *Larix dahurica*) (Kas'ianova 1993). The taiga vegetation complex is the most widespread in the region, and includes mainly pine (*Pinus sylvestris*), larch, Siberian pine (*Pinus sibirica*), spruce (*Picea obovata*), and fir (*Abies sibirica*), with an admixture of poplar (*Populus suaveolens*) and aspen (*Populus tremula*). There are also a number of shrubs, berry bushes, and forest grasses present. Alpine areas are characterized by a diversity of mosses, lichens, grasses, and willows, with meadows being common. Overall, the Lake Baikal region has a large variety of plant communities that depends on specific configurations of ecological variables, including geographic position, exposure of the range and plateau slopes, elevation and latitudinal position, as well as precipitation (Bezrukova 1999; Kozhova and Izmest'eva 1998; Weber 2003).

The description of Lake Baikal and the Little Sea presented below follows Kozhova and Izmest'eva (1998) and Sorokin and Sorokina (1998). The Lake Baikal basin consists of three troughs: the southern trough with maximum depth of 1473 m (located south of the Selenga delta), the central trough with depth of 1741 m (bounded by Selenga shallows in the south and Akademicheskii range in the north), which stretches across Baikal from Ol'khon Island to the Ushkan'i Islands, and the northern trough, with a depth of 1620 m (northern part of Lake Baikal).

Lake Baikal contains 30 sizable islands, the largest of which is Ol'khon. This island is 71.7 km long and has an average width about 12 km, for a total area of 730 km^2. The lake also holds three large 'gulfs' or 'seas', namely the Barguzinskii, Chivyrkuiskii and Little Sea. The Barguzinskii and Chivyrkuiskii are situated in the central part of Lake Baikal on its east coast, while the Little Sea lies between Ol'khon Island and the lake's western shore. The Little Sea stretches ~70 km and reaches a maximum width of 18 km, with total area of 800 km^2. It connects with Lake Baikal through the narrow (7 km long, 2 km wide, and 30–40 m deep) Ol'khon Gates at its southern end, and an much wider unnamed passage at the north end of Ol'khon Island. The depth of the southern part of Little Sea generally does not exceed 5 m, whereas its northern end reaches ~200–300 m in depth.

There are around 365 rivers flowing into the lake and only one, the Angara River, flowing from it. The largest rivers, the Selenga, Upper Angara, Kichera, Barguzin, and Turka all drain areas to the east and north of Lake Baikal. The rivers and streams on the west coast have much smaller watersheds, and have flow volumes that vary seasonally. Lake Baikal is also a turbulent lake; winds create powerful horizontal currents and vertical water circulation, especially during the autumn when stormy days outnumber calm days.

The average water temperature of Lake Baikal is 4° C, but varies depending on location, season, and depth. In August, for example, the surface temperature can reach 16° C along the coastline. In winter the lake gradually freezes, beginning in the shallow bays at the end of October and encompassing the entire lake during the first few months of the winter. Open water first appears along the northwestern coast of the lake at the end of April.

Water in the southern and central portions of the Little Sea cools faster than in open Lake Baikal. The Little Sea is usually completely ice covered by the third or fourth week of December, and even earlier in the shallow bays. Mukhor Bay, for example, typically freezes in late October. If autumn is atypically warm, however, the formation of ice in the Little Sea does not occur until the end of December or even early January. The melting process begins approximately during the third week of May or later if there is a cold spring. While the thermal regime of the northern portion of the Little Sea has similar characteristics to the open water in the center of Lake Baikal, the shallow areas in the south are much warmer. The water temperature in Mukhor Bay in summer can reach 18–20° C, in comparison to the 4–5° C average in open Lake Baikal.

2.2 Fauna

The Lake Baikal region is characterized by considerable biodiversity and a vast richness in natural resources. The basins surrounding Lake Baikal contain common Siberian fauna as well as species unique to the Baikal subregion. This variety of species is the result of the lake's location, which overlaps the Central Asian, European-Siberian and Eastern-Asian faunal complexes. This biodiversity is also the result of intermixture of vegetation complexes (Berg 1950).

Mammals

The mammals of the Lake Baikal region include 67 indigenous species associated with five different ecological zones: mountain-tundra, taiga, steppe, meadow-marsh-shrub and aquatic (Liamkin 2002). Fauna that were likely important for prehistoric food procurement in this area include various Cervidae (musk deer, red deer, roe deer, elk and reindeer), Siberian snow sheep (*Ovis nivicola*), wild boar (*Sus scrofa*), and fur-bearers such as hare (*Lepus timidus*), Eurasian red squirrel (*Sciurus vulgaris*), Canidae (gray wolf and red fox), brown bear (*Ursus arctos*), lynx (*Felis lynx*), and Mustelidae (sable, wolverine, ermine, weasel, badger) (Table 2.1).

With regard to habitat preferences, red deer (*Cervus elaphus*), roe deer (*Capreolus pygargus*) and elk (*Alces alces*) are inhabitants of the forest steppe, taiga and mountain taiga in the region (Lavov 1974; Geptner and Naumov 1961). Roe deer prefer the open landscapes of the forest steppe, while elk favor wet taiga valleys. The highland and mountain taiga is the home of musk deer (*Moschus moschiferus*), while reindeer (*Rangifer tarandus*) occupy the mountain tundra regions. Boar inhabit the steppe area of the forests and flood plains, and snow sheep live in the high mountain landscapes (Shvetsov et al. 1980). Among other species, bear, sable (*Martes zibellina*), lynx (*Felis lynx*), and squirrel can be found in the taiga zone. Ermine (*Mustela erminea*) and Siberian weasel (*Mustela sibirica*) inhabit meadow-mursh shrub. Other animals, such as fox (*Vulpes vulpes*), wolf (*Canis lupis*), and hare prefer steppe and forest steppe areas of the Lake Baikal region.

Aquatic mammals in this region are represented by the Lake Baikal seal (*Phoca sibirica*), and the otter (*Lutra lutra*). The latter mainly inhabits rivers (Stroganov 1962). Another aquatic mammal, the beaver (*Castor fiber),* used to be present in this region, but it was extirpated more than 100 years ago (Nekipelov et al. 1965). The Baikal seal (*Phoca sibirica*) is known locally as *nerpa* (Kozhov 1972). The range of the seal is limited mainly to open Lake Baikal; however, seals are sometimes found wandering up the rivers connected to the lake and occasionally in the Little Sea. Their ecological and biological behavior is reflected in their seasonal distributions throughout the lake (Pastukhov 1993). This pelagic animal keeps far from the coasts for most of the year. Beginning mid-October/November they begin to move to the northern parts of the lake where ice-cover develops. When ice cover is complete, seals disperse southward to the deep waters. During the winter period (beginning of January to first half of May) mature females occupy the central-eastern part of the lake, while others concentrate mainly in the central-western regions. Adults dominate in the northern part of Lake Baikal, and sexually immature seals remain in the southern parts. When the lake becomes free from ice (during the second half of May to June) seals begin their mating period. During this time, nearly all seals move to the northern portion of the lake where they form large congregations on remnant patches of ice or on shore (Pastukhov 1993).

Birds

Environments surrounding Lake Baikal are utilized by at least 417 avian species (Fefelov 2001). The mountain taiga ecozone is home to birds such as woodpeckers (Picidae), wood-grouse (*Tetrao* spp.) and partridge (*Lagopus* spp.), while the forests zones harbor heath-cock (*Tetraster bonasia*), wood-grouse, tomtit (Paridae) and woodpecker. The steppe zone is home to partridge, wheatear (*Oenanthe* spp.) and lark (Alaudidae) (Dorzhiev and Elaev 1999; Galazii and Molozhannikov 1982). Likely the most commonly procured bird species were heath-cock, wood-grouse, hazel-grouse (*Lyrurus tetrix*), bustard (*Otis tarda*), as well as the variety of geese and ducks found on the lake and its rivers (Levin and Potapov 1956; Turov 1990).

Lake Baikal waterfowl are represented by more than 25 species of two families and four genera (Table 2.2). The majority of these are ducks (*Anas acuta, Anas crecca, Anas platyrhynchos, Anas clypeata, Anas formosa, Anas streepa, Bucephala clagula, Aythya baeri, Aythya ferina, Mergus merganser, Mergus serrator*), gulls (*Larus* spp.) and terns (*Sterna* spp.). The common goldeneye, merganser, mallard and green-winged teal nest further from the lake in the valleys of the large and medium size rivers. The watersheds are inhabited by the white-winged scoter and sometimes by the harlequin duck (Skriabin 1971). One of the interesting habitats for waterfowl migrating south in autumn is the upper reaches of Angara River, which stays unfrozen for 15–20 km downstream from its source (Kozhova and Izmest'eva 1998). The abundance of these species in the Baikal region fluctuates through the year due to migration patterns, although some bird species winter on the Upper Angara and are thus present year-round (Kozhov 1972). The density of waterfowl populations in the Lake Baikal region gradually decreases from the coast toward the mountain crests.

Fishes

The 61 species and subspecies of Lake Baikal fishes (belonging to 32 genera and 15 families) constitute approximately 2.2% of the total number of animal species in the region. Of these 61 species, 55 are native and 6 have been introduced. One subspecies, *Salvelinus alpinus erythrinus* (Georgy), is now extinct.

The ichthyofauna of Lake Baikal are divided into three complexes based on species adaptation, distribution, and degree of endemism (Sideleva 2003). These three complexes are termed Siberian, Siberian-Balkalian, and Balkalian. The Siberian complex includes 17 species and subspecies of fish belonging to nine families (Acipenseridae, Cyprinidae, Percidae, Cobitidae, Balitoridae, Esocidae, Lotidae, Salmonidae, Coregonidae), all of which are widely distributed in Central and Eastern Siberia. In Lake Baikal, they are found mostly in the shallow bays and lagoons, but move to the coastal zone during the summer. The Siberian-Baikalian complex includes four species and subspecies of the Thymallidae and Coregonidae families. Fish of this group, which include subspecies endemic to Lake Baikal, inhabit depths of 200–350 m, and have close genetic affinities with other species in freshwater habitats of Siberia. These fishes also reside in the mouths of cold mountain rivers and the littoral zone of the open lake. All species of this group reproduce mainly in rivers. The Baikal complex suborder Cottoidei represents 33 species and subspecies in three families, all of which are endemic. Most of these are found far from the shore to a maximum depth of 1600 m.

Fourteen fish species (belonging to 8 families and 11 genera) are historically documented as important food resources (Table 2.3) (Kozhov and Misharin 1958). One of the most prominent of these is the sturgeon (*Acispenser baeri baicalensis)*, an inhabitant of the lake's major tributaries and some areas of the lake itself. Most other procured fish, such as perch (*Perca fluviatilis*), pike (*Esox lucius*), dace (*Leuciscus leuciscus baicalensis*), ide (*Leuciscus idus*) and roach (*Rutilis rutilis lacustris*) spend a significant part of their lifecycle in the littoral or open shallow zones of the lake. They are also common in the warmer sections of the region's rivers.

The open water environment of Lake Baikal is home to a number of coldwater fish species, such as whitefish (*Coregonus lavaretus baicalensis*), black grayling (*Thymallus arcticus baicalensis*), white grayling (*Thymallus arcticus baicalensis brevipinnis*), lenok (*Brachymystax lenok*) and taimen (*Hucho taimen*). The latter two species are widely distributed in the lake only in summer, but are found in rivers and river mouths during the remainder of the year. Whitefish and burbot (*Lota lota*) move into the rivers only during the spawning season (Kozhov 1972), while some subspecies of *Coregonus lavaretus baicalensis* spawn in the shallow waters of the lake itself. White grayling lives mainly along the lake's eastern shores and spawn mainly in larger rivers such as Selenga. Black grayling occurs everywhere in the lake and spawns in smaller rivers such as Anga in Priol'khon'e (Kozhova and Izmest'eva 1998).

The omul' (*Coregonus autumnalis migratorius*) is the most economically important fish in the Baikal area today (Figure 2.1). Based on its three ecological morphotypes, omul' is the only fish species known to inhabit almost all ecological zones of Lake Baikal, including littoral, pelagic, and deep waters (Bronte et al. 1999). It is represented in the lake by three major populations (Smirnov 1977): North-Baikalian littoral/coastal, Selenga pelagic, and Chivyrkyi and Posol'sk deep water. Because of its feeding behaviors, omul' tend to concentrate closer to shore in the southern parts of the Little Sea (but at depths of 30–50 m) in spring and summer. Towards the middle of June adults concentrate in large shoals and move to river mouths for spawning (Figure 2.2). The omul' spawning period occurs from the end of August until the beginning of October. In October-November, omul' migrate to the deep regions of the lake for wintering (Kozhova and Izmest'eva 1998).

2.3 Archaeological context

The prehistory of Siberia (including the Lake Baikal area) is generally organized by archaeologists into broad developmental periods termed the Paleolithic, Mesolithic, Neolithic, Bronze, and Iron Age (summarized for non-Russian readers in Chard 1974; Michael 1958; Weber 1995). Briefly, these phases are distinguished based on typological characteristics. For example, the Mesolithic is seen as a transition from Pleistocene Paleolithic adaptations to Holocene adaptations prior to the adoption of pottery. In addition, it has generally been associated with a change in lithic technology from macro- to micro-blade tools, but this has since been proven too simplistic (Goebel 1999; Goebel et al. 2000). The end of the Mesolithic is placed at the supposed advent of ceramic production, which is termed the Neolithic. The term Neolithic refers to the period between the introduction of pottery and the introduction of metallurgy, rather than to the adoption of animal and plant domestication as it does in other parts of the world (Michael 1958). The Bronze and Iron Age are associated with the introduction of copper and iron objects into the technology, respectively. The Mesolithic, Neolithic and the Bronze Age peoples discussed in this thesis were foragers; ancient groups inhabiting the coast of Lake Baikal in the Iron Age were nomadic pastoralist.

The chronological and cultural context of prehistory in the Lake Baikal area has been extensively debated by researchers working in the region (Weber 1995). These models are founded predominantly on typological criteria and chronological sequences developed separately for habitation (Goriunova 1984, 2003; Goriunova et al. 1996; Khlobystin 1965, 1969; Svinin 1971, 1976) and mortuary sites (Aseyev 2002; Bazaliiskii 2003; Konopatskii 1982; Okladnikov 1950; 1955). The current model of regional culture history for the Neolithic and Bronze Age is that proposed by Weber et al. (2002, 2005, 2006) within the framework of the Baikal Archaeological Project (BAP), an international and multidisciplinary research team investigating prehistoric culture change and continuity in the region. This model is primarily based on the analysis of large sets of radiocarbon dates from mortuary sites (after Weber et al. n.d.):

Period	**Culture/Mortuary Complex**	**Angara, S.Baikal, cal. BP**	**Upper Lena, cal. BP**	**Little Sea cal. BP**
Late Mesolithic	n/a	8800–8000	8800–8000	8800–8000
Early Neolithic	Kitoi and other	8000–7000/6800	8000–7200	8000–7200
Middle Neolithic	**Hiatus**	**7000/6800–6000/5800**	**7200–6000/5800**	**7000/6800–6000/5800**
Late Neolithic	Isakovo, Serovo	6000/5800–5200	6000/5800–5200/5000	6000/5800–5200/5000
Bronze Age	Glazkovo	5200/5000–4000	5200/5000–3400	5200/5000–4000

In general, this model describes the Lake Baikal region as being inhabited by three cultural groups from approximately 8800–3400 years cal BP. These groups, namely the Kitoi, Serovo, and Glazkovo date to the Late Mesolithic-Early Neolithic, Late Neolithic, and Bronze Age, respectively, with a gap in the mortuary record occurring during the Middle Neolithic (7200–5800 cal. BP). This 'hiatus' or gap separates Kitoi from the later Serovo and Glazkovo groups. The main characteristics of these cultures are described and summarized in Weber (1995), Weber and Bettinger (2003), and Weber et al. (2002). Moreover, this model is supported by data from the analyses of human remains regarding demography, genetics, health, diet, mortuary practices, and mobility patterns (e.g. Ezzo et al. 2003; Katzenberg and Weber 1999; Lieverse 2005; Link 1996, 1999; McKenzie 2006; Metcalf 2006; Mooder et al. 2005; Weber et al. 2003; White 2006).

One main problem in the examination of the region's prehistory has been correlating mortuary traditions with those revealed through investigations of habitation sites, largely because most of the identified Neolithic habitation sites contain strata of culturally mixed materials (Goriunova 1984; Weber 1995). In addition, it is difficult to assign habitation site assemblages to specific archaeological cultures, primarily due to the fact that these cultures are defined based largely on mortuary practices. For example, Kitoi and Serovo artifacts are found in habitation site assemblages dating to the Developed (Middle) Neolithic in Priol'khon'e (Goriunova 1984, 2001, 2003). Based on this evidence, Goriunova suggested the coexistence of Kitoi and Serovo cultures in the Priol'khon'e until the Early Bronze Age, as was previously proposed by Khlobystin (1978). Radiocarbon dates, however, showed that Kitoi graves of the Early Neolithic in the Lake Baikal area, most of which are on the Angara River, were constructed exclusively during the Late Mesolithic to Early Neolithic and do not overlap whatsoever with dates on Serovo burials of the Late Neolithic period.

The information above is given only for general understanding of the processes concerning culture prehistory in the Lake Baikal area and these debates are not a focus of the present study. Culture names such as Kitoi, Serovo, and Glazkovo in this thesis are only used in the context of typological descriptions of artifacts found at habitation sites, mainly concerning fishing and hunting gear; it is unknown if these typological designations accurately reflect cultural affiliation. However, these typological characteristics are widely accepted by different researchers working in this area (Goriunova 1984, 2001, 2003; Konopatskii 1982; Okladnikov 1950, 1955) and their definitions will be provided in the following chapters when necessary.

Table 2.1. Mammals of the Lake Baikal area (after Shvetsov et al. 1984; Liamkin 2002).

Latin name	Common name in English/Russian	Latin name	Common name in English/Russian
LEPORIDAE		**FELIDAE**	
Lepus		*Felis*	
Lepus timidus L.	Mountain hare/Заяц-беляк	*Felis lynx* L.	Lynx/Рысь
SCIURIDAE		**PHOCIDAE**	
Sciurus		*Phoca*	
Sciurus vulgaris L.	Eurasian red squirrel/ Обыкновенная белка	*Phoca sibirica* Gmelin	Baikal seal/ Байкальская нерпа
CANIDAE		**SUIDAE**	
Canis		*Sus*	
Canis lupus L.	Gray wolf/Волк	*Sus scrofa* L.	Boar/Кабан
Vulpes			
Vulpes vulpes L.	Red fox/ Обыкновенная лисица	**CERVIDAE**	
		Moschus	
URSIDAE		*Moshus moschiferus* L.	Musk deer/Кабарга
Ursus			
Ursus arctos L.	Brown bear/Бурый медведь	*Cervus*	
		Cervus elaphus L.	Red deer/ Благородный олень
MUSTELIDAE			
Martes		*Capreolus*	
Martes zibellina L.	Sable/Соболь	*Capreolus pygargus* L.	Roe deer/ Сибирская косуля
Gulo			
Gulo gulo L.	Wolverine/Росомаха		
Mustela		*Alces*	
Mustela erminea L.	Ermine/Горностай	*Alces alces* L.	Elk/Лось
Mustela nivalis L.	Least weasel/Ласка		
Mustela sibirica Pallas	Siberian weasel/Колонок	*Rangifer*	
		Rangifer tarandus L.	Reindeer/ Северный олень
Mustela altaica Pallas	Mountain weasel/Солонгой	**BOVIDAE**	
Mustela eversmanni Lesson	Steppe polecat/Светлый хорек	*Ovis*	
		Ovis nivicola L.	Siberian snow sheep/ Снежный баран
Meles			
Meles meles L.	Eurasian badger/Барсук		
Lutra			
Lutra lutra L.	Otter/Выдра		

Table 2.2. Common waterfowl of Lake Baikal (after Skriabin 1971; Kozhov 1972; Fefelov 2001).

Latin name	Common name in English/Russian	Abundance	Presence in the region
ANATIDAE			
Anserinae			
Cygnus cygnus L.	Whooper swan/Лебедь-кликун	U	F, NE
Cygnopsis cygnoides L.	Dry-beak goose/Сухонос	R	L, NE
Tadorna ferruginea Pall.	Ruddy shelduck/Огарь	I	NE
Anatidae			
Anas platyrhynchos L.	Mallard/Обыкновенная кряква	N	NE, F, E
Anas poecilorhyncha Forst.	Spot-billed duck/Черная кряква	I	NE
Anas falcate Georgi	Falcated duck/Касатка	I	F, NE
Anas penelope L.	Eurasian wigeon/Свиязь	N	F, NE
Anas acuta L.	Northern pintail/Шилохвость	N	F, NE
Anas crecca L.	Green-winged teal/Чирок-свистунок	N	F, NE
Anas querquedula L.	Garganey/Чирок-трескунок	U	F, NE
Anas formosa Georgi	Baikal teal/Клоктун	U	F, NE
Anas clypeata L.	Northern shoveler/Широконоска	N	F, NE
Anas strepera L.	Gadwall/Серая утка	U	F, NE
Histrionicus histrionicus L.	Harlequin duck/Каменушка	R	NE
Bucephala clangula L.	Common goldeneye/Обыкновенный гоголь	N	NE, F, W
Aythya baeri Raddle	Baer's pochard/Хохлатый нырок (чернеть)		
Aythya ferina L.	Common pochard/Красноголовый нырок (чернеть)	U	F, NE
Melanitta deglandi BP	White-winged scoter/Горбоносый турпан	N	F, NE
Mergus merganser L.	Common merganser/Большой крохаль	I	NE, F, W
Mergus serrator L.	Red-breasted merganser/Длинноклювый крохаль	U	F, NE
Mergus albellus L.	Smew/Луток	U	NE, F. W
LARIDAE			
Larinae			
Larus cachinnans (?) Pall.	Yellow-legged gull/Серебристая чайка	U	NE
Larus canus L.	Mew gull/Сизая чайка	N	F, NE
Larus ridibundus L.	Black-headed gull/Озерная (обыкновенная) чайка	N	F, NE
Larus minutus Pall.	Little gull/Малая чайка	I	F, NE
Sterninae			
Chlidonias leucopterus Temm	White-winged tern/Белокрылая крачка	U	NE
Sterno hirundo (?) L.	Common tern/Речная крачка	U	F, NE

Abbreviations: RR=very rare, R=rare, I=innumerous or local and irregular distribution, U=regular, N=numerous, NE=nesting, F=migrating, L=summer meeting of young/mature without confirming about the nesting, W=wintering.

Table 2.3. Important fishes of Lake Baikal (after Berg 1962, 1964, 1965; Sorokin and Sorokina 1988; Weber 2003).

Latin name	**Common name in English/Russian**	**Distribution**							**Environment/ Behavior**
		1	**2**	**3**	**4**	**5**	**6**	**7**	
ACIPENSERIDAE									
Acipenser									
Acispenser baeri baicalensis Nik.	Baikal sturgeon/ Байкальский осетр	?	?		+			+	Demersal*, spawns in spring
SALMONIDAE									
Brachymystax									
Brachymystax lenok Pall.	Lenok/Ленок	?	+	+	+			+	Benthopelagic*, cold water fish; spawns in May-June
Hucho									
Hucho taimen Pall.	Taimen/Таймень	?	+	+	+			+	Benthopelagic; winters in lower river sections; spawns in May-June
COREGONIDAE									
Coregonus									
Coregonus autumnalis migratorius Georgi	Baikal omul'/ Байкальский омуль	+	+	+	+		+	+	Benthopelagic; enters lake tributaries; spawns in fall
Coregonus lavaretus baicalensis Dyb.	Baikal whitefish/ Байкальский Сиг	?	+	+	+		+	+	Benthopelagic; spawns in November
THYMALLIDAE									
Thymallus									
Thymallus arcticus baicalensis Dyb.	Baikal black grayling/ черный хариус	?	+	+	+		+		Benthopelagic; spawns in smaller lake tributaries in spring
Thymallus arcticus baicalensis brevipinnis Svet.	Baikal white grayling/ белый хариус	?	+	+	+			+	Benthopelagic; spawns in larger lake tributaries in spring
ESOCIDAE									
Esox									
Esox lucius L.	Northern pike/Щука			+	+	+	?	+	Demersal, brackish, generally sedentary; spawns in May-June
CYPRINIDAE									
Leuciscus									
Leuciscus idus L.	Ide/Язь		+	+	+	+		+	Benthopelagic, brackish, anadromous; spawns in April-May
Leuciscus leuciscus baicalensis Dyb.	Siberian dace/ Сибирский елец		+	+	+	+	+	+	Benthopelagic, brackish, spawns in lagoons in mid-April to May
Rutilus									
Rutilus rutilus lacustris Pall.	Siberian roach/ Сибирская сорога		+	+	+	+	+	+	Benthopelagic, forms large schools during spawning in May
Carassius									
Carassius auratus gibelio Bloch	Prussian carp/Карась					?			Benthopelagic; spawns in May and June
LOTIDAE									
Lota									
Lota lota L.	Burbot/Налим		+		+	+	+	+	Demersal, brackish; inhabits deep lakes; spawns in winter
PERCIDAE									
Perca									
Perca fluviatilis L	Eurasian perch/Окунь		+	+	+	+	?	+	Demersal, brackish, sedentary; spawns in spring

Abbreviations: 1=Pelagic Baikal, 2=Open littoral, 3=Little Sea, 4=Gulfs, river mouth, 5=Lagoons, 6=Small rivers, 7=Large rivers
* - definitions are taken from www.fishbase.org : 1.demersal - living on or near the bottom and feeding on benthic organisms; 2. benthopelagic - living and feeding near the bottom as well as in midwaters or near the surface; feeding on benthic as well as free swimming organisms.

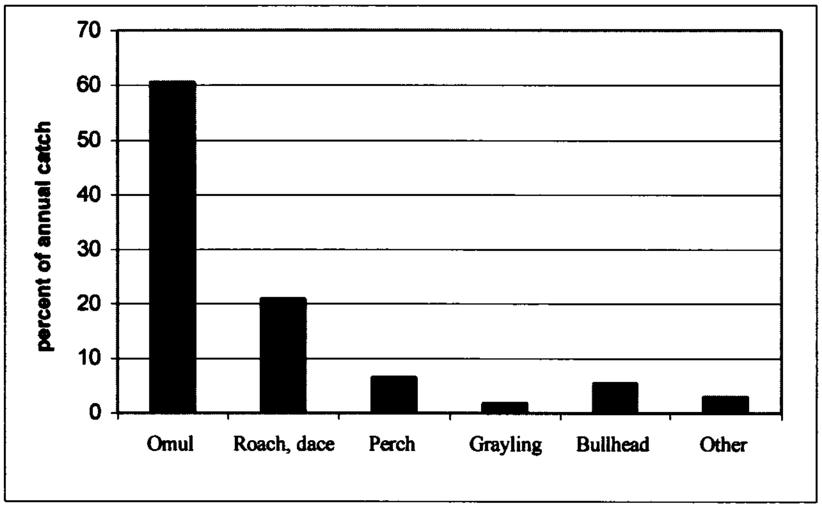


Figure 2.1: Average annual catch of food fishes in Lake Baikal (includes fishes taken in river mouths); after Nekipelov et al. 1965 (data from 1938–1955; average annual catch – 9,678,600 kg).

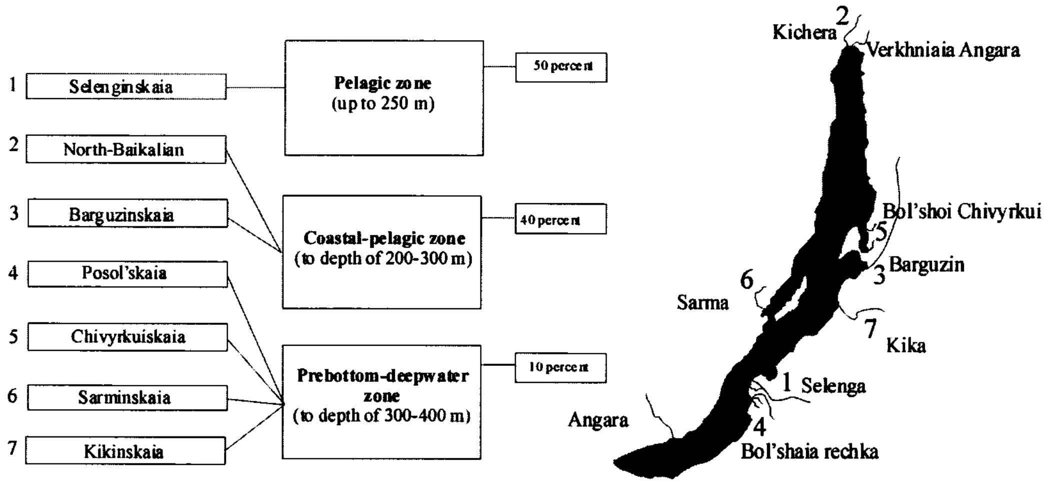


Figure 2.2: Population structure of Baikal omul' (after Kozhova and Izmest'eva 1999).

Chapter 3
History of Research in the Lake Baikal Region

This chapter provides a review of the history of research on prehistoric subsistence and the current state of zooarchaeology in the Lake Baikal region. First, I review existing models of ancient subsistence strategies in the area, all of which have dealt primarily with fishing or seal hunting. Second, I discuss the few zooarchaeological examinations previously conducted in the area. To conclude, I summarize the current state of subsistence studies in the Baikal region.

3.1 Subsistence research

Analyses of ancient subsistence practices have a long history in the archaeology of the Lake Baikal region. The greatest emphasis has been placed on fishing and to a lesser extent on sealing, with efforts specifically aimed at determining their beginning, development, and roles in ancient economies. Virtually nothing has been written about ancient plant use in the area, and these resources do not figure prominently in any existing model. As such, ancient plant food use is not discussed here. In the section below, I describe the main typological characteristics of fishing gear recovered from habitation and mortuary sites in the Lake Baikal area, and the models that have been built around these items. Following this, I provide an historical review of seal and terrestrial mammal hunting as well as the results of isotope analyses of human skeletons from ancient cemeteries.

3.1.1 Fishing

The role of fishing among prehistoric groups inhabiting the Lake Baikal area was first addressed during Petri's excavations of the Ulan-Khada habitation site in 1912 (Khlobystin 1969; Petri 1926; Figure 1.2). Based on the fishing implements and fish remains recovered, Petri suggested that fishing was the main subsistence activity during the Neolithic, and that the inhabitants were likely settled fishers who employed nets along the lake shore (Petri 1926:32). The fish images and fishing gear recovered from habitation sites and cemeteries along Lake Baikal and the Angara and Lena rivers, also stimulated hypotheses regarding the origins of fishing (Everstov 1988; Medvedev 1971; Novikov and Goriunova 2005; Okladnikov 1950), the contribution of fish to prehistoric diets (Georgievskaia 1989; Katzenberg and Weber 1999; Weber et al. 2002), and the role of fishing in human adaptations (Aseev 2003; Georgievskaia 1989; Konopatskii 1982; Medvedev 1971; Svinin 1971, 1976; Weber et al. 2002). The most important of these models are described below.

Okladnikov's Model

The first comprehensive study of ancient economies in the Lake Baikal area (mainly in Cis-Baikal) was conducted by Okladnikov (1950, 1955). He defined ancient foragers here as semi-sedentary hunters and fishers whose procurement strategy was a result of adaptation to environmental conditions. The earliest possible evidence of fishing in this region dates to the Upper Paleolithic at the Verkholenskaia Gora site (Figure 1.2), where a harpoon was found. However, due to the general paucity of fishing gear during this early period, Okladnikov suggested that fishing was likely not an important subsistence occupation at this time, and that the intensity of fishing likely varied culturally and temporally until the Neolithic. His overall model was a unilinear progression from hunting of terrestrial game to increasing exploitation of aquatic resources through the gradual development and improvement of fishing technology.

The bulk of Okladnikov's model is based on archaeological material from mortuary sites dated to the Early Neolithic through the Bronze Age (Okladnikov 1950, 1955) (Table 3.1). He argued that there was no archaeological evidence for fishing during the Isakovo and Khin' periods, which he believed dated prior to 3,000 BC. The later Serovo groups were characterized as hunters, and their fishing technologies and strategies were said to be based on hunting. This hypothesis was based on his examination of archaeological fishing gear such as harpoons and fish images, the latter of which were interpreted as lures used during winter to attract fish for spearing (Okladnikov 1948). Okladnikov believed that during the Kitoi period fishing played a more important role than hunting, and gained further importance in the Glazkovo culture, which was characterized by technological advances that included the use of metal for fishhooks. Of course, Okladnikov's culture history sequence now has been invalidated by radiocarbon dating (Mamonova and Sulerzhistkii 1989). Nonetheless, his characterization of the subsistence patterns of the various Cis-Baikal groups has continued to influence subsequent scholars working in the region.

Review of research from 1960 to 1985

Following the introduction of Okladnikov's model, most analyses of archaeological materials were conducted between 1960 and 1985 were concerned with two general issues: (1) the correlation of mortuary and habitation sites within the context of prehistoric culture change in the region and, (2) the age and character of the Kitoi culture (Weber 1995). The development of fishing in ancient subsistence economies and the evolution of fishing gear were assessed within frameworks of chronological and culture periodization based on analyses of material from habitation sites. Such research was conducted by Khlobystin (1965, 1969) and Svinin (1971, 1976) for the Lake Baikal area and by Medvedev for the Angara River valley (1967, 1969, 1971).

Khlobystin (1965, 1969) proposed that fishing first appeared during the Paleolithic, and that its role in ancient subsistence increased towards the beginning of the Holocene. The absence of hunting implements from some habitation sites was explained as the result of two distinct groups with different subsistence economies utilizing these sites. These groups were characterized as either fishers who settled on the coasts of the lake and adjacent rivers, or hunters with a different settlement pattern. Unfortunately, Khlobystin provides no additional speculation on how such settlement patterns or economies actually functioned.

Medvedev (1967, 1969, 1971) considered the subsistence economy of the Mesolithic inhabitants of the habitation site Ust'-Belaia (Figure 1.2) as including both hunting and fishing. His research concentrated on describing fishing and roe deer hunting because of the domination of these taxa in the Ust'-Belaia faunal assemblage, and he also employed some ethnographic data in his interpretations. Medvedev proposed that fishing was an "independent development" that appeared during the Mesolithic, as opposed to

Okladnikov's (1950) proposition that it appeared with the Serovo culture during the Neolithic. The most commonly procured fish species was said to be sturgeon, as its remains dominated the Ust'-Belaia faunal assemblage. However, it is unclear how such quantification was done, and sieves were almost certainly not employed in excavation, potentially biasing his samples. He also suggested that fishing occurred throughout the year, but was most important in the spring and autumn during the migration periods of sturgeon.

Svinin (1971) also addressed prehistoric subsistence among groups of the Lake Baikal area, in particular the role of fish in ancient diets. He proposed that archaeological material from habitation sites demonstrated that Holocene sites on the coast of the lake were utilized seasonally by ancient fishers. According to his assessment of the archaeological evidence, the earliest fishing in the region was evidenced by the appearance of fishhooks and net sinkers during the Mesolithic. He hypothesized that human movements along the Lake Baikal coast were dependent on the seasonally variable distribution and migration of omul' and sturgeon, while terrestrial animals and seals were of secondary importance.

Based on ethnographic analogies, Svinin (1976) speculated that prehistoric fish procurement was a part of a seasonal subsistence system. He argued that June, July, and October were likely the most productive months for fish procurement, and that prehistoric foragers needed to catch as many fish as possible to supply themselves for winter. This hypothesis was based on the seasonal availability of fish species, mainly the omul' that could have provided a stable source of food. Svinin also suggested (Figure 3.1) that fishing began in the large rivers during the spawning migrations of sturgeon and grayling, from May to the middle of June. From the second half of June to July people may have relied on net fishing of omul' and hook and line fishing of sturgeon in Lake Baikal bays. In particular, Svinin emphasized that July was likely the most important month for procurement and preparation of omul' for winter stores , as the weather during this month is relatively calm and thus safe for using nets from boats. In October and November, omul' fishing was carried out using different kinds of traps that captured these fish on their migration into rivers and subsequent return to the lake. In parallel to the procurement of sturgeon and omul', people likely fished for carp, perch, roach, dace and pike in the littoral lake bays. Winter was a period of ice fishing for littoral species.

The second major topic of discussion during this period was the role of fishing among Kitoi populations (Georgievskaia 1989, Studzitskaia 1976). Georgievskaia's model (1989) is based on her attempted correlation of Kitoi graves with habitation sites and typological analysis of the archaeological material from the Neolithic period in the upper Angara region. She suggested that Kitoi groups were concentrated near rivers where they could engage in both hunting and fishing, with a greater reliance on the latter. This supposition was supported by the numerous composite fishhooks recovered from Kitoi graves, and the location of Kitoi sites in areas where fish could be procured, such as the banks of the Irkut, Kitoi, and Belaia rivers and the south coast of Lake Baikal (Georgievskaia 1989:126–128). This ultimately led Georgievskaia to suggest that Kitoi groups were fishing specialists, but she envisioned this fishing as seasonal in character; summer was a time of fishing, and winter was a time for hunting (Geogievskaia 1989:130–131). Serovo groups, on the other hand, were seen as more dispersed, as their sites are located in numerous different geographic locations. Based on the rarity of fishing gear in Serovo graves, their subsistence was assumed to have been based on hunting.

Konopatskii (1982) analyzed the archaeology of cultural groups inhabiting the Lake Baikal area (specifically Priol'khon'e) during the Neolithic and Bronze Age, and characterized prehistoric settlement and subsistence as semi-sedentary and organized around seasonal resource availability. He also provided a description of some fishing techniques based on ethnographic data. Konopatskii recognized the large quantity of fishing gear in the Lake Baikal area, particularly the number of harpoons and composite fishhooks from Kitoi graves, but argued that there was not enough data to assume the existence of fishing specialists among Lake Baikal inhabitants (Konopatskii 1982:81–82).

Review of research conducted after 1985

Analyses of prehistoric subsistence patterns conducted after 1985 involved two main trends. First was the application of paleoenvironmental data to archaeological questions regarding subsistence change (Goriunova and Vorob'eva 1986, Novikov and Goriunova 2005). The second trend involved typological analyses of fishing gear from a chronological perspective (Everstov 1988, Novikov and Goruinova 2005), and the investigation of prehistoric subsistence of Baikal inhabitants in general (Aseyev 2002, Aseev 2003).

The study of Holocene paleoenvironmental conditions in the context of archaeological evidence was based on the stratified settlement sites in the Priol'khon'e microregion of Lake Baikal. Such research has been used to argue that environmental changes from the Mesolithic to the Bronze Age periods had little effect on major economic adaptations such as hunting and fishing (Goriunova and Vorob'eva 1986). Goriunova and Vorob'eva suggested Lake Baikal provided a stable food resource base that was little affected by climate change, and that changes in artifact assemblages reflect technological advancement of prehistoric inhabitants rather than ecological adaptations as was proposed earlier by Okladnikov (1950, 1955). Notably, no analyses of faunal remains from Priol'khon'e sites were used in these studies of the relationships between culture and environmental change.

Everstov (1988) conducted a comprehensive study of the beginning, importance, and variety of fishing strategies among prehistoric populations of the whole of Siberia. He argued that fish were first utilized at the end of the Pleistocene, and that global climatic changes were the main reason for the development of specialized fishing technologies such as nets. Everstov characterized ancient Siberians as employing various fishing strategies on sporadic, seasonal, or year-round bases, depending on the region, temporal period, and technology available (Figure 3.2). The Lake Baikal area was described as a year round fishery that was of primary importance to Neolithic diets, with terrestrial hunting playing a secondary role. The significance of fishing here was supported by numerous archaeological sites containing greater numbers of fishing tools than hunting implements, as well as the proximity of these sites to the lake coast, making them convenient for fishing. In addition, he suggested that omul' were an important species to ancient populations during spawning in August and September, as concentrations of spawning fish could be harvested for winter storage. Everstov also developed both terminology and a typology for fishing gear (harpoons, fishhooks and sinkers) for Siberia, including artefacts from the Lake Baikal area.

Aseev (2003) proposed that the environmental, climatic, and geomorphological characteristics of the Lake Baikal area were determining factors of hunter-gatherer subsistence organization during the Neolithic period. According to Aseev, fishing or seal hunting alone could not supply enough food and materials for ancient populations. It would have been necessary to supplement these procurement activities with terrestrial hunting to provide (at the least) materials for tools, clothing, and dwellings. Aseev agreed that there was likely subsistence specialization based on the seasonal availablity of resources, and that the presence of numerous fishing items in the Kitoi graves indicated that the Kitoi were primarily fishermen who relied to a lesser extent on hunting.

The only work that directly addressed the role of fishing in the Baikal region with locally-derived data is that of Novikov and Goriunova (2005). Based on material from stratified archaeological sites dating from the Mesolithic to the Bronze Age, they considered fishing an important economic activity that first appeared during the Mesolithic and reached its peak during the Neolithic. Throughout this period, new fishing techniques were being developed, including composite fishhooks, nets, and ice fishing. They also suggested that fishing became as important as hunting and gathering, and its role in subsistence depended on seasonal availability as well as regional and cultural differences. Unfortunately, they do not elaborate on these regional or cultural differences.

Fishing gear

Development of a classification system and terminology for describing fishing gear is of primary importance to those researchers investigating typological and chronological characteristics of prehistoric culture groups in the Lake Baikal region (Everstov 1988; Medvedev 1967, 1969, 1971; Okladnikov 1950, 1955; Svinin 1971, 1976). Special attention has been paid to distinguishing the differences in artifacts among Serovo, Kitoi, and Glazkovo cultures (Okladnikov 1950, 1955). In the section below I discuss different groups of fishing equipment including harpoons, fishhooks, fish lures, and other gear.

Harpoons (Figure 3.3) have been considered to be the earliest fishing implements in the region, the earliest of which was found in the Upper Paleolithic layer of Verkholenskaia Gora (Okladnikov 1955). Okladnikov (1950, 1955) defined the main characteristics of Neolithic and Early Bronze Age harpoon heads. Serovo harpoons were distinguished by the presence of unilaterally- or bilaterally-barbed shafts, with either shouldered or unilaterally notched bases (Okladnikov 1950:204–205). Kitoi harpoons were of various sizes, but could be differentiated from Serovo harpoons by the presence of a laterally perforated line attachment hole (Okladnikov 1950:366). Two kinds of Glazkovo harpoons were distinguished (Okladnikov 1955:79–84), the first group being composed of large harpoons with bilaterally barbed bodies and unilateral and bilateral `wing' style haft elements. Also assigned to this first group were bilaterally barbed harpoons with conical haft elements and peg-like line guard projections. The second group consisted of small points with smooth and rounded shafts forming the haft element. These are perhaps best considered 'fixed points', as true harpoons are designed to detach from the shaft of the implement and have attachment points for lines.

The study of fishhooks (Figure 3.4) was first conducted by Okladnikov (1950, 1955), and later by Medvedev (1971) and Svinin (1971). The earliest Mesolithic fishhooks are made from a single piece of bone (Medvedev 1971; Svinin 1971). Medvedev (1971) suggests that fishhooks from Ust'-Belaia (Figure 1.2) were made to a specific size for the purposes of taking specific species of fish. Based on Okladnikov's (1950, 1955) interpretations, the Serovo culture utilized two types of fishhooks. The first type was formed of a single piece of bone with an arched, flat shank and a barb on its end. The second type were composite fishhooks with shanks notched on the proximal end for line attachment, and notched on the distal end for barb attachment. The composite fishhooks are reportedly associated with the latter half of the Serovo period in Okladnikov's model (1950:260–261).

The Kitoi culture is associated with composite fishhooks that vary in size (from 2 to 20 cm in maximum length), are rounded in profile with crescent-shaped ends, and occasionally have notches for line attachment. Their barbs are usually made from the claws of animals (Okladnikov 1950:368). Georgievskaia (1989) suggested that the different sizes of Kitoi fishhooks reflect their use as angling and trot lines (a fishing method supposedly used for the procurement of large fish).

The Glazkovo culture is characterized by the appearance of metal fishhooks, which were interpreted as a reflection of innovation and evidence of technological progress (Okladnikov 1955). Glazkovo fishhooks include composite as well as single piece specimens (Okladnikov 1955:87–100). Composite fishhook shanks are generally flat on one side and convex on the other, with the distal end widened and drilled for the insertion of the barb. The proximal ends typically have notches for line attachment. Other composite fishhooks have straight or barrel-shaped shanks with grooves on one end and notches on the other. Glazkovo people also procured fish with large 'hooks' approximately 17–20 cm in length. These large hooks have thick, flat shanks made from bone or antler with a hole for the barb. Such implements are often interpreted as gaffs.

Fish figurines (Figure 3.5) found in the Lake Baikal region are made primarily from stone and more rarely from bone and clay, and range from 15 to 50 cm in length. Okladnikov (1948, 1950:242–247) was the first to describe and classify these items. He divided all Neolithic Serovo fish images into four different groups: (1) "burbot" type; (2) "whitefish" type, (3) "sturgeon" type (with very narrow shape of snout); (4) *Ianusovidnye* (with two heads oriented in opposite directions). Okladnikov (1936, 1948) argued that these fish figurines functioned as net sinkers and as fish lures, which were used in conjunction with spears.

Additional study of the Siberian Neolithic stone and bone fish images was continued by Studzitskaia (1976). Based on Okladnikov's typological classification of the images (1950), she divided the Kitoi fish figurines into three groups. The first group consists of white marble and limestone figurines with sizes up to 10 cm, which were said to represent taimen, omul', or dace. The second group is composed of small bone fish figurines 4–5 cm in size. The third type were large bone figurines possibly depicting taimen.

Studzitskaia (1976) proposed that the Serovo and Kitoi cultural traditions were responsible for making fish images during the Neolithic. For the Serovo, production and symbolic function of fish lures were a reflection of the "rational and irrational" in one object (1976:83). Exactly what is meant by this statement is not clear. Furthermore, Studzitskaia argued that the Kitoi may have differentiated the practical and ritual meanings of fish by manufacturing fish lures, amulets, and pendants for shaman clothes. She also emphasized the stylistic continuity of fish figurines from Serovo to Bronze Age Glazkovo based on the stability of the "whitefish" and "burbot" styles.

There is no direct evidence for the presence of nets in archaeological sites in the Lake Baikal area. Most researchers have assumed the prehistoric use of nets based on supposed net sinkers (notched stones), bone needles (interpreted by some as netting needles), and net-impressions on pottery from habitation and mortuary sites (Georgievskaia 1989; Novikov and Goriunova 2005; Okladnikov 1950, 1955). For example, Medvedev (1971) suggested that Mesolithic inhabitants of Ust'-Belaia (Figure 1.2) were familiar with netting technology for fish procurement based on the presence of net sinkers in this site. Possible additional support for net use was found in 1953 by Khoroshikh (1960) during excavation of a Neolithic habitation site on the Angara River (50 km northwest of Irkutsk). He found a single pottery sherd with depictions of fish and what may be a net on it (Figure 3.6). Khoroshikh (1960) suggested that this sherd may have belonged to the Kitoi group, but its actual age is yet to be demonstrated. There is also a depiction of net or trap (Figure 3.7) on the rock art from the Lena River, but its age is unknown (Okladnikov and Zaporozhskaia 1959).

While there is also no direct evidence of boat use by the Baikal prehistoric groups, many researchers have argued that the use of nets required boating technology (Georgievskaia 1989; Medvedev 1971; Okladnikov 1955). Some researchers view the appearance of boats as a phenomenon of the Developed Neolithic (Novikov and Goriunova 2005) or the Bronze Age (Khlobystin 1963), the latter of which is supported by the depiction of boats (Figure 3.8) in Bronze Age rock art (Okladnikov 1955; Okladnikov and Zaporozhskaia 1959). Note, however, that this rock art is not directly dated, and its Bronze Age chronology is based solely on typological grounds.

Goriunova's research on prehistoric fishing

In the section below, I review the most explicit analysis of prehistoric fishing in the Lake Baikal area. This study was conducted by Goriunova and summarized in Novikov and Goriunova (2005) (Table 3.2). Their examination focused on the review of stylistic attributes of fishing gear and how they change from the Mesolithic through Bronze Age. For the sake of consistency, the chronology here is that presented by Goriunova (1984, 1987, 2003) and Novikov and Goriunova (2005), which is at odds with the model developed by Weber et al. (n.d.) (see Table 4.3).

For the majority of the Mesolithic (10,300–6,500 BP) fish procurement gear is characterized by bone fishhooks and unilaterally barbed harpoons. Toward the end of this period (Final Mesolithic), a new Baikal type fishhook appears. This fishhook is composite and consists of a laterally grooved shank for barb attachment and lateral notches on the thinner end for line attachment. Possible net sinkers appeared also found for the first time in Final Mesolithic deposits (Goriunova 1978; Goriunova 1982; Goriunova and Khlobystin 1992; Novikov and Goriunova 2005).

The Neolithic (6,500–4,000 BP) is characterized by an increasing variety of fishing implements. Among these are composite fishhook shanks of the 'Baikal' type as well as a new Kitoi type. The Kitoi type appears during the Middle Neolithic and consists of a straight slate shank with grooves for barb fastening and crescent-shaped proximal ends. Stone fish lures of the Serovo and rare Kitoi type, needles for manufacturing nets, harpoons, and net sinkers with bilateral notches and/or biconical holes in their centers appear during this period (Goriunova 2001; Goriunova and Khlobystin 1992; Goriunova and Savel'ev 1990; Novikov and Goriunova 2005).

Bronze Age (4,000–2,600 BP) fishing implements include unilateral and bilaterally-barbed bone harpoons with lateral projections for line fastening, crystalline marble fish lures resembling whitefish, and composite bone fishhooks of the Verkholensk type, with a thickened and notched lower end. It also appears that the relative abundance of fishing gear decreases during the Bronze Age, as compared with the Neolithic period (Goriunova and Khlobystin 1992; Novikov and Goriunova 2005).

3.1.2 Seal hunting

Lake Baikal is home to one freshwater pinniped, *Phoca sibirica,* or *nerpa*, which appears to have been hunted throughout the Holocene. Seals historically have been utilized for fat, meat and fur by many populations of the Baikal region (Toporkov 1926). A number of analyses have been carried out to assess the importance of this animal to prehistoric groups.

The first effort to study the role of seal hunting among prehistoric populations was that of Khlobystin (1963, 1964b), who found archaeological seal bones on the Ushkan'i Islands (Figure 1.2). These materials may date from the Early Bronze to Iron Age. Based on seal ecology, he hypothesized that seal hunting began in the Neolithic period, possibly during the summer and autumn when seals were sun basking along the east coast of the lake. The author argues that seals could have been found on the islands at two times during the year: at the end of June to the beginning of August and during the latter half of the September until the lake freezes. He suggests that prehistoric hunters visited islands by boats only during summer because winds would have been too strong in autumn. It was also proposed that seal procurement was the main subsistence activity among the ancient inhabitants of the lake, and sealing likely occurred throughout the year along the mainland coast. Khlobystin (1963) further states that winter hunting was developed during the Middle Neolithic with the appearance of the harpoon as a seal-hunting tool. Notably, Khlobystin did not actually analyze any seal remains from the Ushkan'i Islands. It is thus unclear if the seal remains here accumulated as the result of human activity and their season(s) of death is unknown.

Later, Okladnikov and Konopatskii (974/1975) argued that seal procurement began during the Neolithic period, when seal remains become fairly abundant in the archaeological record, particularly at Glazkovo sites. They further stated that seal procurement could have occurred during the winter using harpoons. This speculation was based on recovery of harpoons in archaeological sites associated with seal remains, and ethnographic records of winter seal hunting among Eskimo groups. Notably, no attempt to determine the season(s) of death of the seals was made by these investigators. The authors also discovered an Early Bronze Age grave from the Khuzhir (also known as

Shamanskii Mys) cemetery on Ol'khon Island (Figure 1.2), which contained a human male whom they argued was possibly a specialized seal hunter.

As a response to Khlobystin (1963), Svinin (1976) speculated that seal procurement throughout the Lake Baikal area was secondary in importance to omul' fishing, primarily due to difficulties associated with seal hunting. Svinin also believed that seal hunting could only have occurred twice a year: from August to beginning of lake freeze-up (as a parallel activity to the hunting of terrestrial mammals and waterfowl), and from March through April.

Konopatskii (1982), disagreeing with both Khlobystin (1963) and Svinin (1976), argued that the ancient economy was a semi-settled hunting – fishing type of subsistence as proposed earlier by Okladnikov (1950, 1955), and that both activities were important, especially terrestrial mammal hunting. Konopatskii argued that seal hunting in the Little Sea area of Lake Baikal was limited to March and April, soon after appearance of seal pups. The hypothesis was based on the degree of epiphyseal fusion in seal bones from Neolithic and Bronze Age habitation sites identified by paleontologist Ovodov. Note however, that no specific sites are mentioned by Konopatskii and no quantified data were presented to support the arguments being made. However, these analyses were the earliest attempts to employ examination of faunal remains to describe the role of seal hunting in the subsistence of ancient Lake Baikal populations.

More recently, the examination of the seasonality of prehistoric seal hunting in the region was conducted by Weber et al. (1993, 1998). Their analyses of incremental growth structures in seal canine dentine from several archaeological sites (Khuzhir, Tyshkine II–III, Berloga, Ityrkhei, Sagan-Nuge, Ulan-Khada, and Sagan-Zaba; Figure 1.2) suggested that seal procurement was restricted to spring and early summer, as was proposed earlier by Konopatskii (1982). In addition, Weber et al. offered some explanation for this apparent pattern. During the late spring and early summer, animals congregate in large colonies on the ice and later on the coast, making them vulnerable to hunting. Seals are in very poor condition at this time, as they have lost most of their blubber over the winter and during the mating season. As such, the authors propose that the hunting season was determined mainly by the availability of seal during this particular time of year, and was not dictated by seal blubber content or fur quality.

This methodology was applied later to determine the temporal and spatial patterns of prehistoric seal procurement in the Lake Baikal area. Building on their previous work, Weber et al. (1998) revealed that seal hunting was occurring as early as the Mesolithic and continued through the Middle Bronze Age (based on the presence of seal bones at archaeological settlements). Sealing was seen as most intense during the Middle Neolithic and Early Bronze Age. The authors also suggested a possible territorial division between Serovo and Early Glazkovo groups based on seal exploitation, and/or deliberate selection of pups and nursing mothers.

Seals were also used for symbolic purposes in mortuary practices, the best example coming from the Glazkovo Khuzhir cemetery on Ol'khon Island. Here during the Bronze Age seals were apparently transported long distances across the island, consumed, and ritually interred, sometimes in association with human burials with unique grave goods (Weber et al. 1998, 2002). This may represent evidence for feasting or ritual consumption of seals associated with a select group of individuals interred at this special cemetery.

The symbolic use of seals among ancient Baikal populations was also explored by earlier researchers. Seal images in rock art are uncommon, but have been documented on rock art dated to Bronze Age (Okladnikov and Zaporozhskaia 1959) and on a phallic sculpture found by Khlobystin dated to 1000 BC (1964a). The latter of these was viewed as a possible totem for some groups of this area (Khlobystin 1964a). Some of the Neolithic and Bronze Age graves from Ol'khon Island are characterized by the presence of seal bones (Konopatskii 1982). Konopatskii (1982) argues that these inclusions suggest these animals may have played a role in some of the ritual activities of ancient populations.

3.1.3 Stable Isotope Studies

Examination of subsistence and dietary patterns was carried out through stable isotope analyses of human skeletons from several mortuary sites on Lake Baikal and the

Angara and Upper Lena rivers (Katzenberg and Weber 1999; Lam 1994; Weber et al. 2002). These studies mainly addressed the diets of pre- and post-hiatus groups inhabiting the region. Using the nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) stable isotopes from human and faunal bone samples, researchers have investigated the proportions of aquatic and terrestrial resources in the diets of different culture groups during the Middle Holocene.

Lam (1994) conducted a pilot study on human remains from the Lokomotiv and Ust'-Ida cemetries on the Angara River (Figure 1.2). The stable isotope ratios demonstrated that both pre- and post-hiatus cultures relied on aquatic resources in their diets. Moreover, there was similarity in stable isotope values between the post-hiatus Serovo and Glazkovo cultures. Lam concluded that technological factors did not influence the role of fishing and hunting among prehistoric groups through Early Neolithic to Early Bronze periods, as was proposed earlier by Okladnikov (1950, 1955).

Katzenberg and Weber (1999) and Weber et al. (2002) conducted similar analyses with a much larger number of specimens. The results of their examinations demonstrated that while both pre- and post-hiatus groups relied on aquatic foods and herbivore meat, individuals from cemeteries located close to productive fish habitats (such as the upper Angara River and Little Sea) exhibited higher levels of nitrogen isotopes, and thus a greater reliance on fish. In addition, the aquatic contribution to diet may have been more substantial among the Kitoi than among the Serovo and Glazkovo groups. Groups buried in the Little Sea area demonstrated some reliance on seal and local fish, but all groups in Cis-Baikal appear to have used aquatic resources to some extent. Interestingly, there was an absence of clear evidence for extensive procurement of omul', the most abundant and important commercial Baikal fish species today (Katzenberg and Weber 1999; Weber et al. 2002). In addition, stable isotope analyses indicated that Kitoi groups (pre-hiatus) likely had narrow diets that relied on fishing locally, while Serovo and Glazkovo people (post-hiatus) included many types of food resources, including fish likely obtained from across Cis-Baikal.

3.2 Zooarchaeological research in the area

Previous analyses of faunal remains from archaeological sites on Lake Baikal and in the Angara River basin have largely focused on determining the supposedly dominant animal species (Ermolova 1966, 1978; Khamzina 1991; Medvedev 1971; Ovodov and Panychev 1982; Savel'ev et al. 2001). These faunal collections have been analyzed by biologists and paleontologists, and the reports produced are generally limited to providing a list of taxa present, with little in the way of quantification. There is also little detail regarding the mammal and fish species present, and virtually nothing about the bird remains found (Lipnina et al. 2001; Medvedev et al. 1996). Typically, the recovery techniques were inadequate for proper zooarchaeological research. For example, sieves have rarely been employed in excavation, and when they have been used, have not been employed in a systematic manner. As such, all existing reports must be evaluated with a good deal of skepticism.

In general, most archaeological interpretations of prehistoric subsistence are simplistic and are reflective of the known presence of some animal species in a given site. Preliminary zooarchaeological work has provided some basic data on the relative abundance of faunal remains based on the number of identified specimens (NISP) (Medvedev 1971), and more rarely on minimum number of individuals (MNI) (Ermolova 1978; Ovodov and Panychev 1982). Description of quantitative methods used for most analyses is usually not provided (Khamzina 1991; Medvedev 1967, 1969, 1971; Tsepkin 1966; 1976). There are only a few works focused on intra- and inter site comparisons, and these are only in extremely broad contexts (Ermolova 1966, 1978; Khamzina 1990). Other zooarchaeological research in this area is limited to the study of osteomorphological characteristics of domesticated dogs (Klement'ev et al. 2005; Tsalkin 1970), and seal procurement based on the analysis of incremental dentine bands of seal canines as described above (Weber et al. 1993, 1998).

Nearly all previous work has focused on mammals, rarely on fish, and almost never on birds. The majority of mammal analyses have concentrated on the procurement of animal species at Paleolithic (e.g., Mal'ta; Figure 1.2) and Mesolithic sites (e.g., Ust-Belaia; Figure 1.2) (Gerasimov 1940; Lipnina et al. 2001; Medvedev 1971; Medvedev et al. 1996), as well as fauna from the sites spanning the Pleistocene-Holocene transition (Ermolova 1966, 1978). Some taphonomic analyses of remains from the Upper Paleolithic site of Kamenka (Figure 1.2) have also been conducted (Germonpré and Lbova 1996). Information regarding mammalian species from other Holocene sites is at best usually restricted to the site's species composition and their inferred role in the ancient economies (Khamzina 1991; Klement'ev et al. 2005; Ovodov and Panychev 1982; Savel'ev et al. 2001).

The analysis of fish remains from archaeological sites in the Baikal area has been carried out in one of two ways. The first and most common procedure was to report only the presence or absence of fish bones and their approximate quantity; no actual identification was done. For example, fish remains are reported at Priol'khon'e sites (Table 3.2) from the Middle Mesolithic to the Iron Age. The occurrence of fish bones in high frequencies at one site (Ityrkhei), especially in the Final Mesolithic and the Neolithic cultural strata, has served as the basis for the hypothesis that fishing was the dominant activity at the site (Khamzina 1991). Some archaeological sites (Ityrkhei and Ulan-Khada; Figure 1.2) have also been characterized by the presence of "kitchen pits" filled with fish bones (Novikov and Goriunova 2005).

To date, the identification of fish taxa has been undertaken on materials from only a few archaeological sites in the Lake Baikal area (Figure 1.2): Ulan-Khada (Lake Baikal coast), Nizhniia Berezovka and Nizhne-Ivilginskoe (Selenga River basin), Ust'-Belaia, Verkholensksia Gora and Ust'-Khaita (Angara River basin). Ichthyologists (Tsepkin and Mamontov) working in the region produced species identifications, but the methods of identification and quantities present are not usually provided. Also, approximate fish lengths (Tsepkin 1966, 1976, 1980; Medvedev 1971), weights (Medvedev 1971), and rarely season of catch (Mamontov et al. 2006; Savel'ev et al. 2001) have been supplied in only a few rare cases, but without description of the methods used.

Tsepkin (1966, 1976, 1980, 1986, 1995) carried out most of the research on fish remains from archaeological sites of the Lake Baikal region. One of the assemblages he analyzed was from the seventh layer of Ulan-Khada. Tsepkin identified 78 bones to either Siberian sturgeon, omul', or perch. He also mentioned that the average size of the identified fish was comparable to modern fish (Tsepkin 1966:8). Among other examples is a recent study of fish bones from the Ust'-Khaita site by the ichthyologist Mamontov (Savel'ev et al. 2001). Their analysis of fish remains from five cultural layers dated from 9,000 to 7,000 BP, indicate presence of pike, sturgeon, and cyprinids. All of the fish scales were identified as belonging to Siberian grayling, suggesting an early spring season of catch, during the grayling spawning period. Fish age at death was estimated to have been 5–10 years (Mamontov et al. 2002, 2006).

3.3 Summary

The study of subsistence strategies in the Baikal region has been based predominantly on analyses of archaeological fishing and hunting implements and through ethnographic analogy (Aseev 2003; Everstov 1988; Goriunova 1984; Konopatskii 1982; Novikov and Goriunova 2005; Okladnikov 1950, 1955; Svinin 1971, 1976). Stable isotope analyses have provided additional information with which to interpret diet and subsistence strategies (Weber et al. 2002).

Opinions regarding the origins of fishing in the Lake Baikal area differ according to specific region. For the coast of Lake Baikal, fishing is thought to have begun in the Mesolithic (Goriunova and Vorob'eva 1986; Svinin 1976). In the Angara and upper Lena River basins fishing is said to have begun during the Upper Paleolithic (Okladnikov 1950). This dating was based on the presence of harpoons and fish remains at archaeological sites (Everstov 1988; Novikov and Goriunova 2005; Tseitlin 1979).

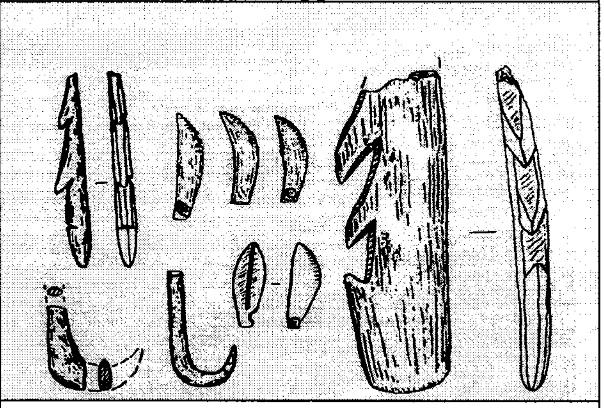
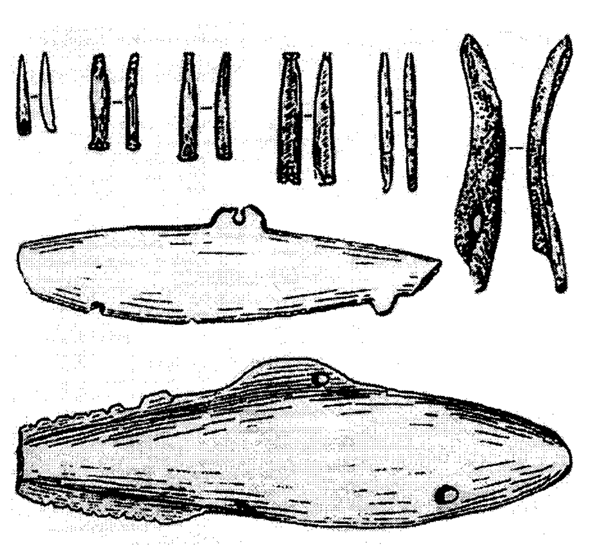
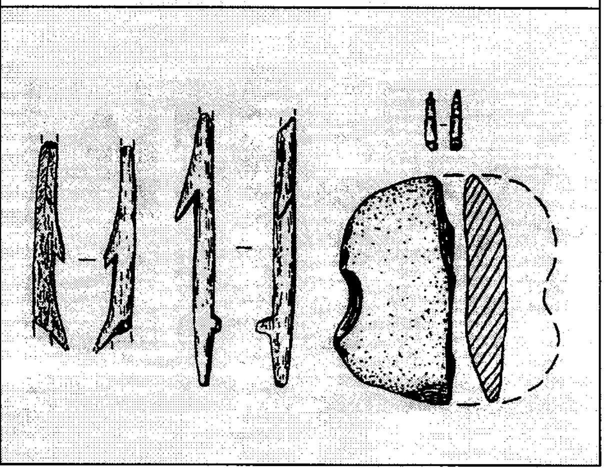
Few researchers have tried to analyze prehistoric fishing, and most of them restricted their examinations to the typology of fishing gear (Everstov 1988; Novikov and Goriunova 2005; Svinin 1976). The majority of studies of fishing were based on a unilinear approach that described subsistence through a transition from hunting to fishing, and a gradual development of more advanced gear through time (Okladnikov 1950, 1955; Goriunova and Vorob'eva 1986). Other researchers pointed out the differing environmental and geographic settings of Lake Baikal, and the Angara and upper Lena River basins as being major factors shaping the availability of aquatic resources (Everstov 1988; Weber et al. 2002). In addition, some hypotheses regarding prehistoric fishing have been based on local ethnographic analogies and have employed modern fishery data (Aseev 2003; Georgievskaia 1989; Konopatskii 1982; Okladnikov 1950, 1955). These have tended to describe Holocene fishing as a seasonal activity based on fish migrations, with a major focus being on the procurement of omul' in the Lake Baikal area (Everstov 1988; Novikov and Goriunova 2005; Svinin 1971, 1976) and sturgeon on the Angara (Medvedev 1971). In reality, there has been a general lack of identification of fish bone and few studies investigating seasonality, with the exception of a single very recent study by Mamontov et al. (2006).

In regard to seal hunting, the attempts to describe the role of this animal in the subsistence strategies of prehistoric inhabitants of the Lake Baikal coast were based mainly on reviews of seal behavioral characteristics and their relationship to proposed patterns of human mobility, but usually did not involve systematic analyses of seal remains recovered from sites (Aseev 2003; Khlobystin 1963; Konopatskii 1982; Okladnikov 1950). Despite this long-standing interest in seals and widespread discussion about their importance, almost no quantification or detailed description of seal remains from any site in the region presently exists (with the exception of seal canine examination by Weber et al. 1993, 1998). Hunting of terrestrial animals has been investigated to an even lesser degree. Therefore, there is a pressing need for examination of Holocene subsistence patterns on Lake Baikal that employs zooarchaeological investigations of faunal remains, particularly studies that apply well-established methods and quantification measures.

Table 3.1. Model of prehistoric fishing in the Lake Baikal region (after Okladnikov's 1950, 1955).

Years, BC	Period/culture	Fishing vs. hunting	Fishing gear	Fishing techniques
8000–6000	Late Paleolithic–Mesolithic	Hunting is the main subsistence; earliest evidence of fishing gear	Harpoon from Verkholenskaia Gora	Derived from hunting skills
5000	Khin' Early Neolithic			
4000	Developed Neolithic Isakovo			
3000	Serovo	Hunting is the main subsistence activity; beginning of intensive fishing	Harpoons, fish lures, fishhooks, net sinkers	Derived from hunting skills--hand capture, bow and arrow, and poisoning; harpooning in association with fish lures; angling; netting; summer and winter fishing
2500–2000	Kitoi	Fishing more important than hunting	Fishhooks of Kitoi type, fewer harpoons, few fish lures	Angling, less use of harpoons, netting
1700–1300	Glazkovo Eneolithic	Development of more efficient fishing gear, but gear is less abundant	Harpoons, fishhooks (appearance of metal fishhooks), gaffs, fixed barb points and lances, few fish lures, plummet, netsinkers, and net needles	Angling, using of harpoons, gaffs, and fixed barb points and lances, netting

Table 3.2. Fishing gear and its change through time from sites of Lake Baikal area (after Goriunova 1984, 1987, 2003; Novikov and Goriunova 2005).

Period	Site (Figure 1.2)	Layer	Fishing gear
Middle Mesolithic 10,300-8000 BP	Berloga	VIII	
	Ityrkhei	IX	
	Sarma I	IV	
	Khuzhir-Nuge XV	III	
Late and Final Mesolithic 8000-6500 BP	Ulan-Khada	XI	
	Berloga	VII–VI	
	Ityrkhei	VIII–VII	
	Sagan-Nuge	VI	
Early Neolithic 6500-5500 BP	Ulan-Khada	X	
	Ityrkei	VI–V	
Developed Neolithic 5500-4300 BP	Ulan-Khada	IX	
	Berloga	V–III	
	Ityrkhei	IV–II	
	Tyshkine III	IX	
	Kurkut III	IV	
	Kulara III	I	
	Katun' I	VII	
	Okunevaia 4	IV	
Late Neolithic 4200-4000 BP	Ulan-Khada	VIII	
Early Bronze 4000-3300 BP	Ulan-Khada	VII–II	
	Ityrkhei	I	
	Tyshkine III	VII–VI	
Developed Bronze 3300-2800 BP	Ulan-Khada	I	
	Tyshkine III	IV	
Late Bronze 2700-2600 BP	Berloga	II–I	

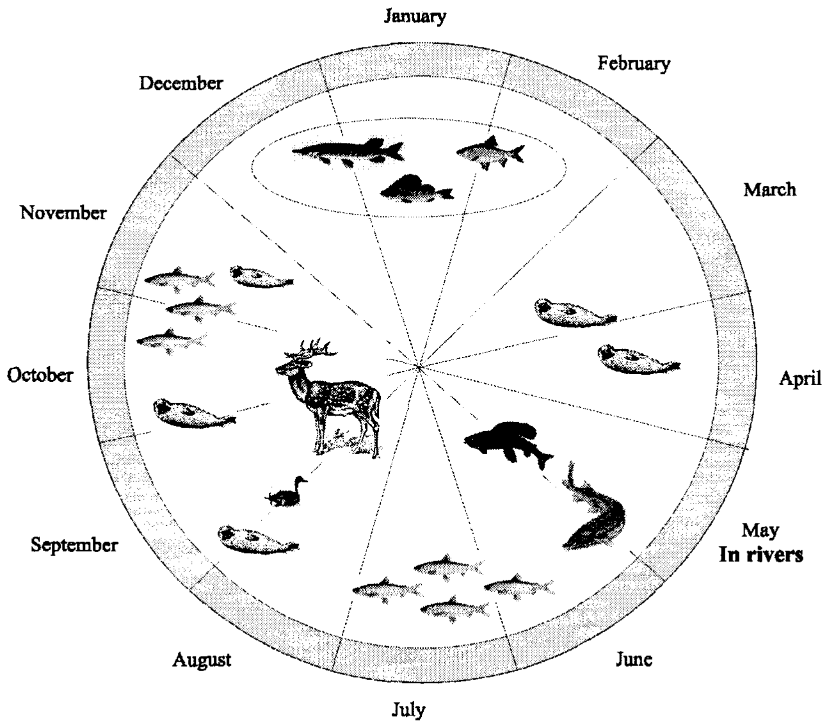


Figure 3.1: Prehistoric subsistence patterns in the Lake Baikal area (after Svinin (1976).

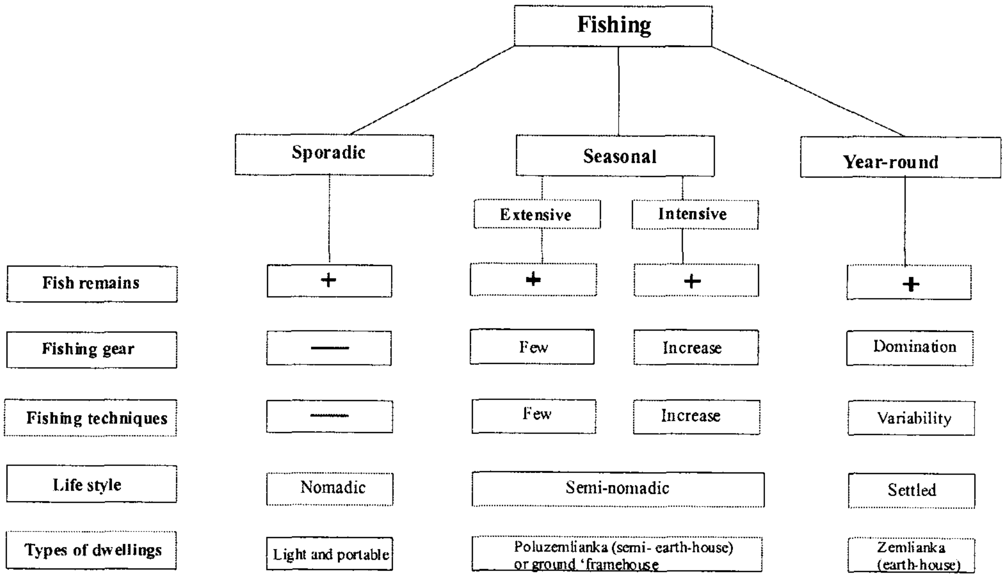


Figure 3.2: Types of prehistoric fishing in Siberia (after Everstov 1998).

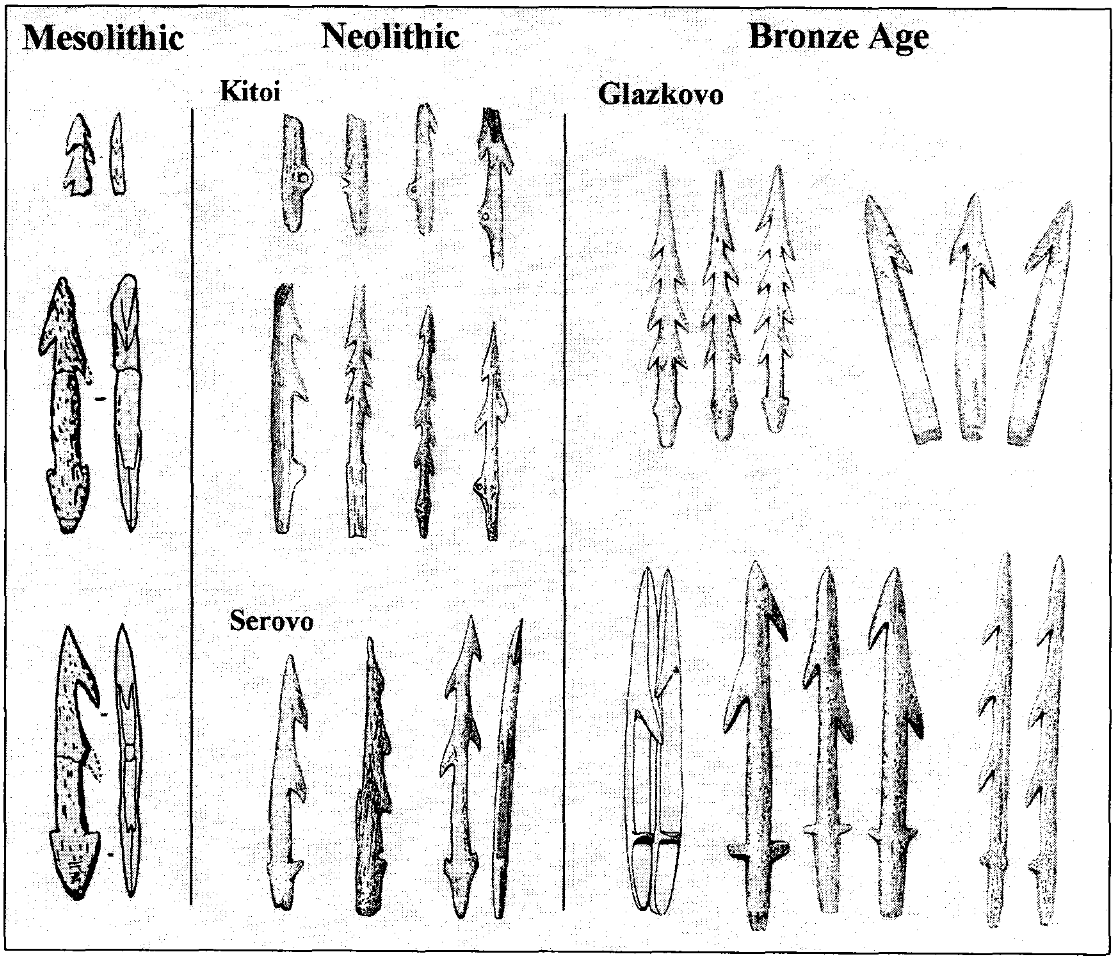


Figure 3.3: Harpoons of the Lake Baikal Region (after Medvedev 1967, 1971; Okladnikov 1950, 1955).

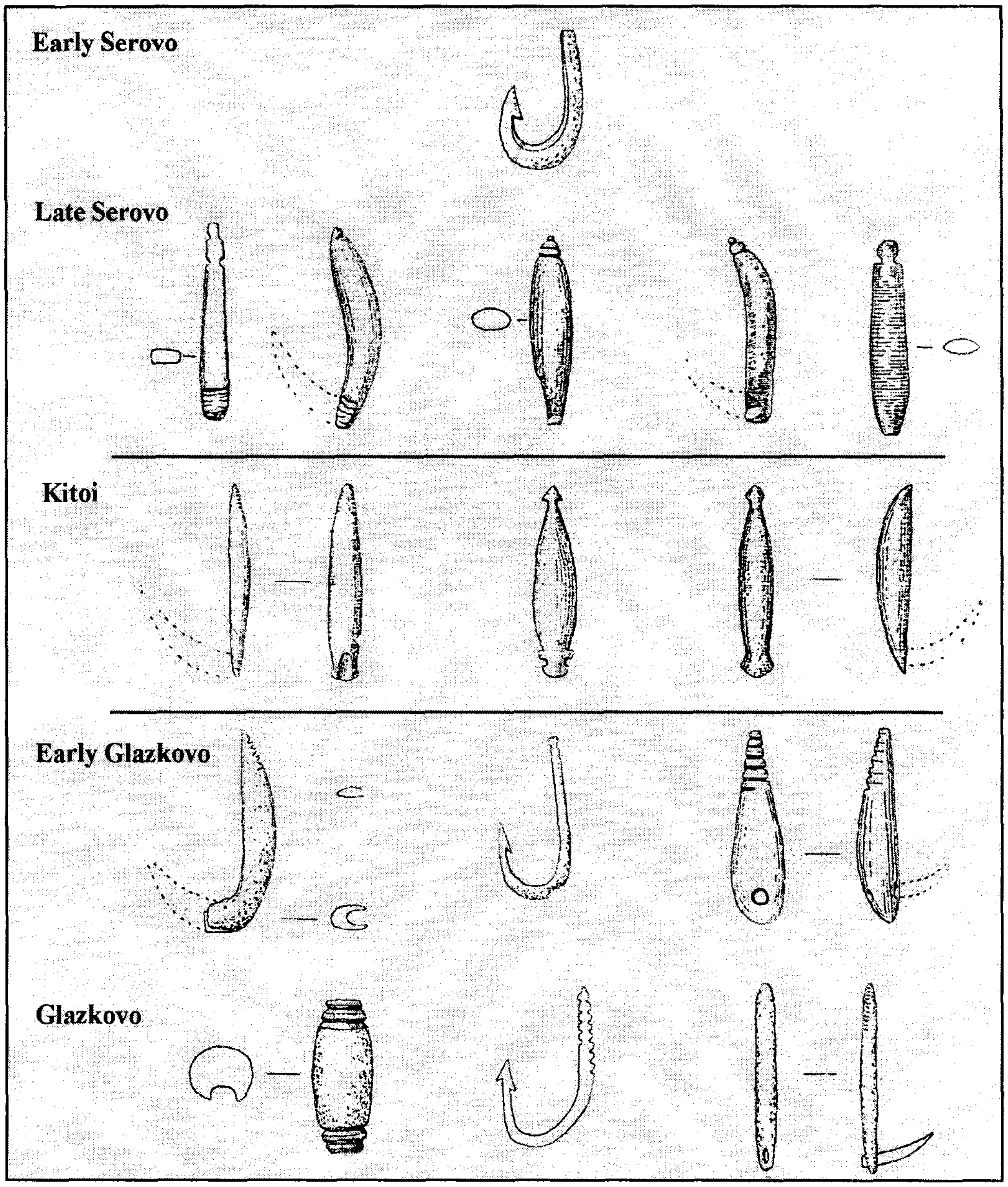


Figure 3.4: Fishhook types of the Lake Baikal Region (after Okladnikov 1950).

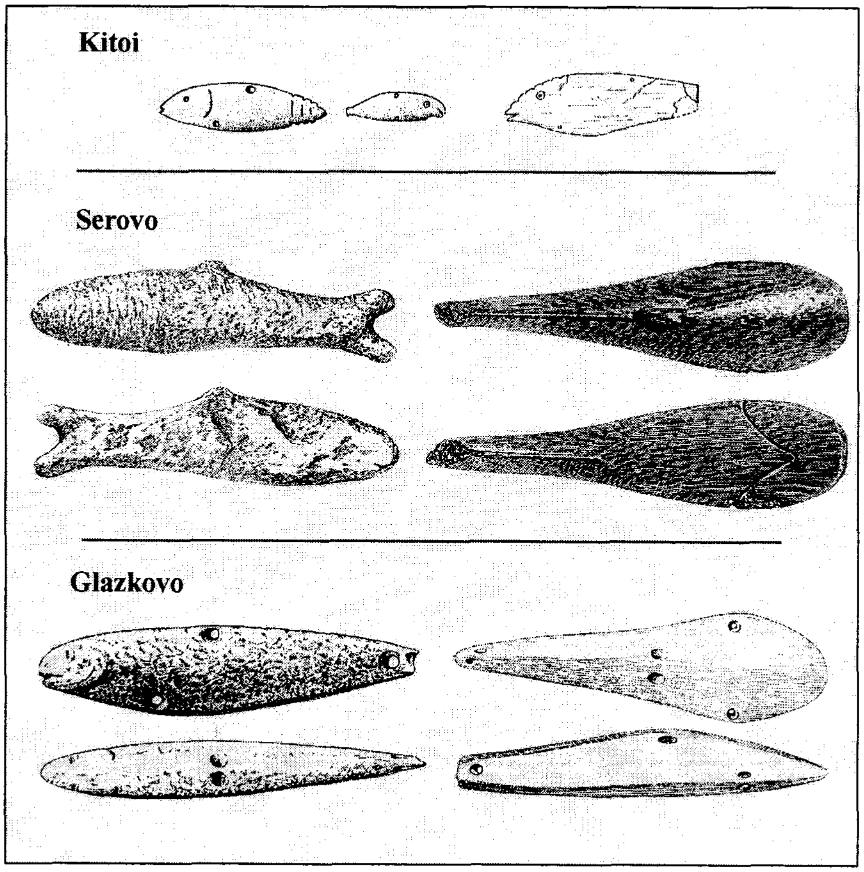


Figure 3.5: Fish figurines of the Lake Baikal region (after Okladnikov 1950, 1955; Studzitskaia 1976).

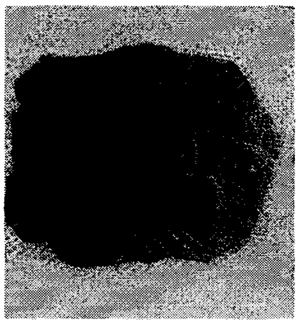


Figure 3.6: Fish and possible net or trap depictions on a ceramic fragment from the site on Angara River (Khoroshikh 1960).

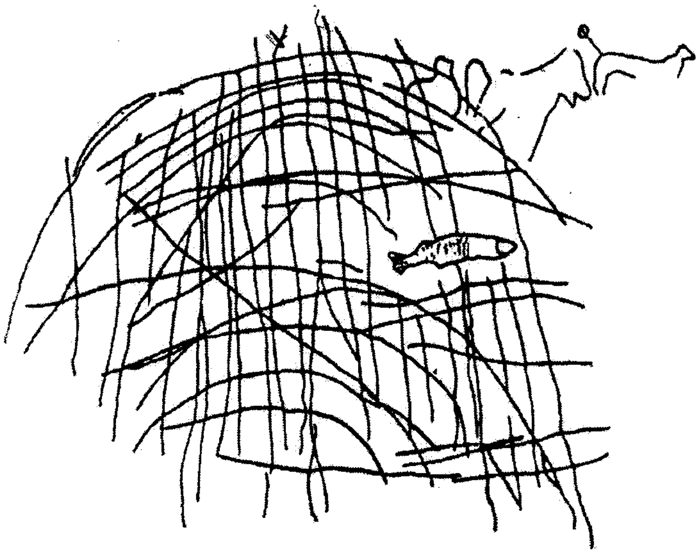


Figure 3.7: Possible depiction of fish net or trap in Shishkino rock art, Upper Lena (Okladnikov and Zaporozhskaia 1959).

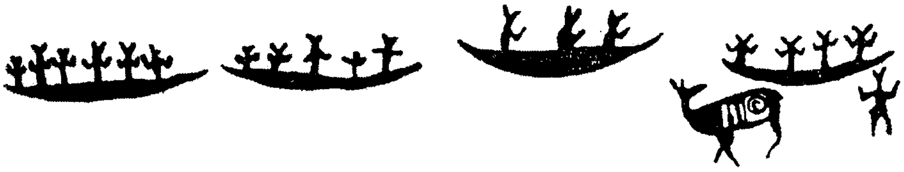


Figure 3.8: Depiction of boats and a deer in Shishkino rock art, Upper Lena (Okladnikov and Zaporozhskaia 1959).

Chapter 4
Materials and Methods

This chapter describes the data sets and methods used in this thesis. I provide a site summary, including details about the excavation techniques, site chronology, and artifacts recovered. Also provided are outlines of the analytical procedures used for examining faunal material, particularly identification and quantification measures. Sample biases and taphonomic considerations are also discussed.

4.1 Site description

The Ityrkhei multilayered habitation site is located on the western shore of Ityrkhei Cove (Figure 4.1) on the southeast coast of the Kurkut Gulf in Priol'khon'e microregion of Lake Baikal (Goriunova 1978; Goriunova and Savel'ev 1976; Goriunova and Svinin 2000). The nearest regional settlement is the village of Elantsy, about 39 km to the northeast (53°01'46.4"N; 106°50'45.2"E).

Ityrkhei Cove is a crescent shaped embayment extending in a northwest-southeast direction (Figure 4.2). It is bordered on the east and the south by outcrops of crystalline rock (mainly gneiss). The shore of the cove is composed of wide beaches of grey sand with sandy, pebbled, and/or rubbly deposits (Goriunova and Vorob'eva 1986). The central part of the small basin holding the site has been described as deflated basin. The Holocene archaeological deposits at Ityrkhei are 1–3 m thick, with the best preservation present at the bottoms of slopes, approximately 8–10 m above Lake Baikal and 20–25 m from its coast. The slope deposits formed under colluvial and eolian sedimentation processes. These processes produced clearly defined strata of relatively thick Holocene deposits primarily composed of sand (Goriunova and Vorob'eva 1986; Vorob'eva 1987; Vorob'eva and Goriunova 1984, 1996).

The stratification of Ityrkhei (Table 4.1; Figure 4.4) is represented by 19 lithological strata of four units in the regional scheme of soil formation (Vorob'eva and Goriunova 1984) with 2.37 m depth. Cultural layers are typically dark humus sandy loams with gruss inclusions (0.08–0.20 m thick) and are separated by sterile and lentiform light sand layers (0.03–0.08 m thick) (Goriunova 1984).

4.1.1 Archaeological fieldwork at Ityrkhei

Ityrkhei was first discovered by P. P. Khoroshikh during an archaeological survey conducted from 1921 to 1923. He distinguished two cultural layers and assigned them to the Neolithic period (Khoroshikh 1924). The Malomorsk subdivision of the Complex Archaeological Expedition (under the supervision of O. I. Goriunova) from Irkutsk State University excavated at Ityrkhei in 1975–1976 (Goriunova and Savel'ev 1976; Goriunova and Kuz'minskii 1976; Goriunova 1978). Fieldwork was conducted in the southwest part of the Ityrkhei landform (Figure 4.3), with a total area of 127 m^2 being excavated (Goriunova 1984). Faunal remains were found in each cultural layer.

The excavated archaeological material was analyzed by O. I. Goriunova. A complete description of the analysis of the Ityrkhei material is a part of her Ph.D. dissertation, which is not publicly available. A brief summary of her dissertation (Goriunova 1984) and several subsequent publications provide information about the excavations and archaeological material recovered (Goriunova 1978, 1982, 1987; Goriunova and Kuz'minskii 1976; Goriunova and Novikov 2000; Goriunova and Savel'ev 1976; Goriunova and Svinin 2000; Goriunova and Tkacheva 1989; Goriunova and Vorob'eva 1986; Goruinova et al. 1996; Vorob'eva and Goriunova 1984, 1997).

A detailed analysis of stratification at Ityrkhei was made in 1982 by paleopedologist G. A. Vorob'eva from the Faculty of Biology and Soil Studies, Irkutsk State University. This study was a part of a broader program involving paleogeography and paleoclimate reconstructions for the Lake Baikal area, including the Priol'khon'e. The research was based on the combination of stratigraphic, pedological and palynological data coupled with corresponding archaeological material (Goriunova and Vorob'eva 1986; Vorob'eva and Goriunova 1984, 1997; Vorob'eva et al. 1992). Palynological analyses were made by L. A. Filimonova (Palynological Laboratory of Irkutsk Geological Department) and A. D. Popliakovskaia (Department of Soil Studies, Irkutsk State University). Radiocarbon dating was conducted in three laboratories (Goriunova et al. 1996) and seven radiocarbon dates are available for the site (Table 4.1). In 1994, K. S. Burakov and I.E. Nachasova (Institute of Earth Physics, Russian Academy of Science) carried out preliminary paleomagnetic studies on site sediments to reconstruct paleoclimate (Burakov et al. 2000).

The first analysis of Ityrkhei faunal remains excavated in 1975–1976 was performed by A. A. Khamsina (1991). The results of her identification are provided in Table 4.2. The identified taxa consist of seven mammal species (roe deer, red deer, reindeer, ram, seal, bear and fox) as well as undifferentiated bird and fish specimens. The dominant identified species were seal (approximately 38%), red deer (30%), and roe deer (17%). Fish bones were not included in her analysis, but when I examined the collection it was clear that they constituted the majority of all bones recovered. Fish bones were found in all cultural layers, either in concentrations or scattered through the sediments. Despite the lack of quantification of fish and bird remains, Khamzina clearly recognized fish as dominating the assemblage, and concluded that fishing was the dominant subsistence activity at Ityrkhei (Khamzina 1991:73). She also argued that seal hunting was an important endeavor at the site.

The field methods used in 1975–1976 included hand collecting all artefacts and faunal remains. All faunal remains from the 1970s excavations were examined in this study, with the exception of the fish remains from layer IV, which could not be located within the curated collections. For these reasons, a 3 m^2 area (Figure 4.3) was excavated by T. Nomokonova and A G. Novikov, under supervision of O. I. Goriunova (Malomorsk subdivision of Irkutsk Laboratoty of Archaeology and Paleoecology) in 2005 with the intent largely being to assess the recovery biases in the earlier excavations. In 2005 all cultural deposits were screened with a 2 mm mesh. Strata 0, III, V, and IX contained no faunal material (Table 5.2).

In sum, this thesis is based on fauna recovered from Ityrkhei excavated in 1975–1976 and 2005 (total area of excavations – 130 m^2)[1]. The total number (NISP) of faunal remains analyzed is 19,729, of which 19,510 are fish. The remainder includes mammal and birds (further discussed in chapter 5). The faunal material was examined by the

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[1] Materials 1975–1976 and 2005 excavations at Ityrkhei are stored at the Irkutsk Laboratory of Archaeology and Paleoecology at the Institute of Archaeology and Ethnography, Siberian Branch of Academy of Science and Irkutsk State University, and were made available for analyses by Dr. Goriunova.

author and R. J. Losey (Department of Anthropology, University of Alberta) in 2005 and 2006. Preliminary results of this project are provided in Nomokonova et al. (2006).

4.1.2 An evaluation of site chronology

The chronology of archaeological cultures in the Lake Baikal area has long been debated by researchers working in the region (Weber 1995; Chapter 2). Weber et al. (n.d.) have proposed the most recent model of regional culture history for the Neolithic and Bronze Age based largely on the analyses of large sets of radiocarbon dates from mortuary sites. Unlike previous versions of this model, the latest contains slightly different chronologies for the various micro-regions of Cis-Baikal, including the Little Sea area where my study is situated. For the sake of simplicity, I retain Goriunova's original chronological designations in the text. However, Table 4.3 shows how these periods would be revised under the most recent Weber et al. (n.d.) model.

Up until the early 1980s, archaeological material from Ityrkhei was primarily dated on the basis of typology, stratification, and three radiocarbon dates for layers VIII, VII and VI (Goriunova 1984). Provenience of material used for radiocarbon dating was not recorded during field work (Table 4.3). Since then, four additional dates have been obtained for layers IX, V, IV, and II. These new dates forced a reevaluation of previous chronological destinations. For example, cultural layer II has a radiocarbon date within the Developed Neolithic rather than Bronze Age as was previously suggested (Goriunova et al. 1996). To evaluate the Ityrkhei chrono-stratigraphic sequence additional radiocarbon dating is necessary. Seventeen bone samples have been sent by Dr. R. Losey for radiocarbon dating and results are pending.

For incorporation into the Weber et al. (n.d.) model, all dates needed to be calibrated. Note that the original chronological designations used by Goriunova (Table 4.3) are in uncalibrated radiocarbon years before present and thus calibration of the radiocarbon ages was not necessary for use in her model. Table 4.3 presents calibration of these dates using Oxcal 3.10 and employing the INTCAL04 calibration dataset. Note that all dates were obtained through conventional radiocarbon dating techniques (Figure 4.5). Information on material dated is not available for all samples. Where such information is available, all but one sample appears to have consisted of charcoal saturated sediment from hearths. The single sample from layer VI was of animal bone. Because the composite samples do not date a single event but rather represent an average date for various events (deaths of trees burnt in the hearth), they are likely slightly older than the event of interest (the use of the hearth itself). The single bone sample does not pose such a problem, but may or may not have had sufficient collagen present to provide a reliable date (see Weber et al. 2005).

Nonetheless, when the dates are considered stratigraphically (calibrated or uncalibrated), no stratigraphic reversals are present and no dates appear suspect. As such, I use here the ten cultural strata originally defined at Ityrkhei based on stratigraphy and dated with use of typological assessments and radiocarbon dates (Table 4.1; Goriunova 1984; Goriunova et al. 1996). Occupation of the site appears to have spanned much of the Holocene, from the Mesolithic through Iron Age (Table 4.3), but was probably most intensive from about 8000 to 4300 BP, or roughly 9000 to 4800 cal BP.

4.1.3 Artefacts from Ityrkhei

The majority of Goriunova's (1984) work focused on distinguishing chronological criteria in the functional and typological characteristics of artifacts, mainly in pottery manufacturing techniques and styles. A summary of archaeological material by chronological period is provided below.

The Mesolithic (9300–7000 BP) is broken into two chronological periods (Table 4.1): Middle Mesolithic (cultural layer IX) and Late Mesolithic (cultural layers VIII and VII). Archaeological materials from these layers have similar typological features. Subdivisions of stage are relative and based on the change of morphological characteristics of lithic tools and reduction in quantity of some lithic material. For example, a decrease of longitudinal burins and the appearance of multifaceted polyendral burins in the Late Mesolithic was used to distinguish it from the Middle Mesolithic (Goriunova and Novikov 2000).

Mesolithic assemblages at Ityrkhei are dominated by prismatic blades, around 40% of which are blades for insert tools, longitudinal burins, and perforators. The rest of the lithic assemblages includes different small cores (pseudo-wedge and prismatic) and end scrapers. Bone tools are represented by a single unilaterally-barbed harpoon with a notch for the line attachment (Figure 4.6–2), insert tools (Figure 4.6–4, 8–9), a knife (Figure 4.6–10), and unspecified worked bone (Figure 4.6–7) and antler fragments (Goriunova 1978, 1991).

The Neolithic (6500–4300 BP) is divided by Goriunova in two chronological periods at Ityrkhei (Table 4.1): Early Neolithic (cultural layers VI–V) and Developed Neolithic (cultural layers IV–II). These chronological divisions were based predominantly on morphological and stylistic changes in pottery (Goriunova 2001; 2003; Goriunova and Kuz'minskii 1976; Goriunova and Vorob'eva 1986). The Early Neolithic layers were typologically distinguished from the Mesoltihic layers due to the presence of pottery. For the most part, lithic artifacts were typologically reminiscent of those found in Mesolithic assemblages, but some 'new' lithic artifacts were also found, among which are arrowheads with a straight bases and a slate saw.

The Early Neolithic layers (V–VI) contained pottery fragments with net impressions decorated with dotted lines. Other artifacts include arrowheads, bilateral knife fragments, a slate saw, and a bone awl (Figure 4.6–6) and needle (Goriunova 1984). The Developed Neolithic at Ityrkhei (II–IV) is characterized by increasing density of archaeological materials, especially in Layer IV (Goriunova and Kuz'minskii 1976). Pottery sherds in these layers have net impressions, imprints of a thin thread-like cordage, and smooth texture on their remainder of their exterior surfaces. Other decorative motifs include dotted lines, stamped impressions, geometric patterns, appliqué, and incised lines. Some sherds are of Posol'sk type, characterized by thick walls in the neck of the vessel and decoration consisting of stab-and-drag horizontal lines and lines of dots parallel to the rim (Goriunova and Khlobystin 1992). Other artifacts in the Developed Neolithic layers are slate saws, arrowheads, (net?) sinkers, a fragment of a marble ring, scrapers, and bone tools. Among the bone tools are a shank of a composite fishhook (Figure 4.6–3), a 'net' needle (Figure 4.6–5), and an incised bone (Figure 4.6–1) with an anthropomorphic design (Goriunova 1984; Goriunova and Kuz'minskii 1976).

A small amount of Early Bronze (4000–3300 BP) and Iron Age (2500–600 BP) artefacts were found at Ityrkhei. The Early Bronze Age layer (I) contained only a few pottery sherds decorated with lines of stamped inclusions. The Iron Age layer (0) contained a few pottery fragments with smooth surfaces and stamped appliqués (Goriunova and Svinin 2000).

4.2 Approach and methods

The approach taken here is based on the application of standard zooarchaeological methods of analyses of animal bones. More specifically, this study is focused on the diachronic variability in faunal remains at Ityrkhei. In addition, biological, ecological, and ethnographic data are used to examine animal distribution, habitat, and seasonal movements to add further insight into subsistence patterns and ecological zones of prehistoric procurement.

The methods relevant to this research include taxonomic identification and bone specimen quantification. These analyses are also used to address a number of site-specific taphonomic issues, such as the general state of preservation of bones at the site. The information produced by these analyses will aid in the interpretation of prehistoric subsistence strategies for this particular site, for the Priol'khon'e, and the Lake Baikal area in general.

4.2.1 Identification

Faunal remains excavated in 1975–1976 and 2005 were examined and identified to element, portion, side, and to the most specific taxonomic level possible using standard zooarchaeological methods (Reitz and Wing 1999). Preliminary identifications were first done in 2005; however, many of these identifications required reassessments due to the absence of a modern comparative collection at my disposal. In addition, as this study was one of the very first zooarchaeological projects on Lake Baikal, there was little in the literature to aid in identifications. Some of the problematic faunal remains were photographed or drawn, and these images were brought to the Zooarchaeological Laboratory at the University of Alberta for comparison with osteological collections.

Moreover, to ensure consistency and accuracy, the initially identified Ityrkhei faunal materials were entirely reexamined in 2006. During this second round of identification, a taxonomically broader comparative collection was available, and my level of knowledge about the range of taxa present had increased significantly.

Modern collections of animal species at the Limnological Institute of the Siberian Branch of the Russian Academy of Science (M.V. Pastukhov), Irkutsk State Academy of Agriculture (A.P. Demidovich), and the University of Alberta were used for comparative morphological identifications of mammal and bird bones. Holocene collections of animal bones at Irkutsk State University were also employed. In addition, published guides on mammal (Adams 2004; Gromova, 1950, 1960; Hillson 1992, 1996; Kasper 1980; Miles 1990; Post 2004; Schmid 1972; Sisson 1953) and bird (Cohen and Serjeantson 1996) osteology were utilized (Table 4.4).

Fish identification was based on the osteological collection of modern Baikal fish created in parallel to the analyses of Ityrkhei fauna in 2005–2006 and stored at Irkutsk State University. Eleven species of Lake Baikal and Angara River fish (Table 2.3) were collected and processed (Appendix 1). They include families of Cyprinidae (*Rutilus rutilus lacustris, Leuciscus leuciscus baicalensis*, and *Carassius auratus gibelio*) and Cottocomephoridae, genus *Coregonus* (*Coregonus autumnalis migratorius* and *Coregonus lavaretus baicalensis*) and *Thymallus* (*Thymallus arcticus baicalensis* and *Thymallus arcticus baicalensis brevipinnis*), and specimens of *Brachymystax lenok, Esox lucius, Lota lota*, and *Perca fluviatilis*. In addition, the recent published *Atlas for the Identification of Bony Fish Bones from Archaeological Sites* (Radu 2005), which features many Eurasian taxa, was regularly employed. Manuals on fish osteology published by Cannon (1987) and Wheeler and Jones (1989) served as guides to the bone terminology and element siding procedures. Notably, all of the fish identified in the archaeological collection were well-represented in our comparative collection, and I believe none of the specimens listed as unidentifiable where placed in this category due to a lack of reference specimens.

Even with representative comparative skeletal samples it was often still difficult to identify some fish specimens to species, and sometimes they were not identified even to genus; some identification was limited to family or genus level (Table 5.1, 5.2). For the purpose of understanding ancient fish procurement, the inability to identify bones to a lower level than genus is not a serious disadvantage, and is in fact common in zooarchaeological studies. For example, there are two species of the family Cyprinidae at Ityrkhei, the roach and dace. The differentiation of these mainly relies on the external features that do not preserve archaeologically. To complicate this matter, some of the Cyprinidae bones (e.g., basioccipital and pharyngeal plate) are easily identifiable to species (Figure 4.7), and others are not (Horoszewicz 1960; Le Gall 1984; Susłowska 1968). However, all Cyprinidae occupy very similar habitats (Chapter 2), and no significant information is lost (or gained) when we identify specimens only to the family level for these fishes.

One particular problematic group of fishes in Lake Baikal is the Coregonidae. There are two species in this group found in the lake: *Coregonus autumnalis migratorius* and *Coregonus lavaretus baicalensis*. In this case, it would be very useful to make identifications to the species level, because their individual behavioral characteristics are quite different and might have required significantly different fishing techniques and season of procurement. However, identifying these Coregonidae bones to species level appears to be very difficult and may not be possible osteologically. Perhaps only DNA analyses will provide secure identification of such specimens in the future (Nicholls et al. 2003; Politov et al. 2000; Sukhanova et al. 2004; Yong et al. 2004).

The taxonomic identification of fish bones is based mainly on cranium and pectoral girdle elements, and to a less degree, on vertebrae. Scales were not analyzed in this study and instead were categorized as 'to be identified scales' for future study. They were summed in the graphs and tables as unidentifiable fish fragments.

4.2.2 Quantification

Quantification of the faunal assemblages by taxon is an important and basic step toward the recognition and explanation of the changing patterns of animal exploitation at Ityrkhei. Variation over time is expected in the range of taxa represented and their relative frequencies. Such variability may be due to changes through time in cultural preferences, the season of site occupation, environmental change, or various taphonomic factors. These potential changes in taxon frequencies or relative taxonomic abundance (Grayson 1984) should be visible in the quantified archaeological sample recovered from Ityrkhei. Therefore, the quantification measures were carefully selected for my analyses and deserve brief discussion here.

Quantification analyses include data collection on elements and portions represented, size, context, modifications, measurements, and weights. The number of identified specimens (NISP), minimum number of individuals (MNI), and total taxon weight were calculated for comparative purposes for each stratigraphic level. Such data are considered primary data of zooarchaeological studies (Driver 1992; Reitz and Wing 1999).

NISP is specimen or fragment counts for both whole and incomplete specimens. The total NISP includes all specimens present in the collection, regardless to which taxonomic level they have been identified. NISP for the Ityrkhei sample was calculated separately for each cultural layer. This measure is also the easiest to employ when combining different faunal samples (Table 5.1 and 5.2).

MNI is the minimum number of individuals necessary to account for all of the skeletal elements present for a given taxon within an analytical unit. To calculate MNI, the most abundant element or element portion for a given taxon in the assemblage is counted; this can also include consideration of age, sex, and element size (Reitz and Wing 1999). MNI for the Ityrkhei faunal sample was based on the number of elements, with side, age, and size being taken into account. MNI was calculated for each individual cultural layer. Total MNI in the assemblages is based on the sum of MNI for particular taxa from all layers combined. Different excavation methods were also considered during this quantification (MNI for the 1975–1976 faunal sample was estimated separately from the 2005 collection). The total MNI per one layer from both samples (1975–1976 and 2005) was calculated by summing of all bones from both samples together to distinguish the most abundant element within the total bone assemblage from that layer. The dissimilarity is represented in Table 5.1, where the MNI count for the total site assemblage is different from the MNI calculated from summing of both samples.

There are some limitations produced by NISP and MNI measures that need to be taken onto consideration. For example, the major criticism of NISP is that an individual animal may be counted many times as it is represented by numerous bone fragments (Casteel 1977; Grayson 1984; Klein and Cruz-Uribe 1984; Ringrose 1993). This can be misleading if one or more taxa are represented by entire individuals, while other taxa are represented only by fragmented bones. On the other hand, MNI generally underestimates the actual number of individuals at archaeological sites and under-represents taxa with higher bone counts in comparison with those of lower bone counts (Grayson 1984).

Selection of these quantification methods was ultimately based on the research questions posed and the wide use of these measures in archaeological studies world-wide. NISP provides better overview of relative taxonomic abundances at the site and their changes through time. MNI is more useful, for example, in the analyses of fish remains recovered from the 'fish pits' at Ityrkhei, where it is interesting to know the minimum number of individuals deposited in these features. Both measures have their biases, but when used together, essentially balance out one another.

Another quantitative procedure for the Ityrkhei material was to weigh all animal remains to the hundredth of a gram. Mammal and bird specimens were weighted separately, but individual fish elements for a given taxon and single stratigraphic layer were weighed together. This measure is useful in establishing the relative frequencies among the animals. It is particularly helpful in quantifying the degree of fragmentation for various taxa (Reitz and Wing 1999), and has been employed by some investigators in other studies to examine meat weight contributions for taxa. Notably, meat weight conversion factors, mathematical expressions that allow for the estimation of meat weight contributions of specific species, are currently not available for the Lake Baikal fauna and thus are not applied here.

Relative frequency of skeletal elements from a given taxon was also examined. Due to the small number of mammal and bird remains at Ityrkhei, this was possible only with the fish specimens. Such studies are important because they can sometimes provide information on taphonomy, butchering and transportation patterns, or site function. The quantification of skeletal element frequencies allows for the distinguishing between taxa that are relatively complete skeletally and those that are skeletally incomplete. For example, high degree of skeletal completeness may indicate that animals were killed close to the site and transported to a residential location prior to dismemberment (Reitz and Wing 1999). This approach is common and based on the classification of fragmentary specimens or elements into skeletal portions, and anatomical regions (e.g. Hofman et al. 2000; Lubinskii 1996).

4.2.3 Recovery biases

The recovery techniques employed in archaeological excavation are one of the crucial factors influencing the resulting sample of animal remains obtained (Lyman 1991). There are a number of studies examining the effect of sampling on the analysis of taxonomic abundance and diversity, and interpretation of subsistence patterns in general. The effects of screen mesh size on differential taxonomic recovery have been discussed mainly in regards to the poor recovery of small terrestrial faunal remains (Clason and Prummel 1977; Gordon 1993; James 1997) and on fish bone recovery in particular (Barker 1975; Colley 1990; Mellars and Payne 1971; Nagaoka 2005).

A comparison of techniques used at Ityrkhei (1975–1976 was based on hand collection only, 2005 was entirely sieved with 2 mm mesh sieves) demonstrates that the 1975–1976 excavations produced an average of 66.3 bones per 1 m^2 (Table 4.5), while the 2005 excavations resulted in the recovery of an average of 3768 bones per 1 m^2. In other words, 56.8 times more specimens per square meter were recovered in 2005 than in 1975–1976. As such, it must be realized that the 1975–1976 sample likely severely underrepresents the true density of faunal remains once present at the site. At the same time, the inclusion of its larger excavation area (in contrast to just utilizing the 2005 data), as will be shown below, allowed for the detection of rare taxa that were entirely absent in the more spatially limited 2005 excavation.

4.2.4 Taphonomic evaluation

Consideration of the taphonomic processes affecting faunal remains is an essential step in assessing any assemblage (Gilbert and Singer 1982; Lyman 1994; Marshall 1989;

Wheeler 1978). Taphonomic analyses are extremely varied, but a major focus of study has been on bone mineral density (Binford and Bertram 1977; Lam et al. 2003; Lyman 1984). Many such studies have examined bone density and its influence on skeletal element abundance and species representation of mammals (Klein 1989; Lam and Pearson 2005; Watson 1979). Others have addressed soil conditions (acidity) and the survivability of small faunal remains (Nicholson 1996). However, only a few studies have dealt specifically with fish bone density (Butler and Charters 1994; Hoffman et al. 2000; Lubinski 1996; Nicholson 1992; Zohar and Dayan 2001). Unfortunately, no bone density information exists for the dominant fish taxa identified at Ityrkhei.

Bone density figures have been estimated for many mammal species, but at Ityrkhei mammal remains are so rare that statistically significant results are impossible to generate. The taphonomic evaluation of faunal remains from Ityrkhei thus must be focused on fish bones, but can only be carried out in a qualitative manner. Here I examine whether certain elements and/or taxa appear to be differentially preserved, possibly as a result of their ability to better withstand destruction due to their density, shape, and/or structure.

The structure and shape of fish bones vary markedly between taxa (Colley 1990; Gregory 1933; Nicholson 1992; Wheeler and Jones 1989), and such variability likely has an effect on bone survival. To evaluate the potential differential destruction of *Coregonus* elements, for example, the relative abundance of head versus trunk elements (by MNI) can be compared. Whitefish and other salmonids have highly cartilaginous skulls (low density) compared to other fishes, and more ossified post-cranial elements (particularly vertebrae centra) (Butler and Chatters 1994; Gregory 1933; Lubinski 1996). Therefore, taxon-specific preservation of head elements versus post-cranial elements can reveal whether significant post-depositional attrition of select elements or taxa may be occurring.

In sum, methods that are applied to the analyses of Ityrkhei faunal assemblages are aimed at addressing two main research goals. The first is to provide the quantitative measurements necessary for examination of the relative abundance of taxa at Ityrkhei and how such relative abundances change through time. The second is to estimate the potential limitations introduced by different taphonomic and recovery biases, more specifically by excavation techniques and the differential resistance of skeletal elements to taphonomic agents of destruction. These subjects are discussed in detail in the following chapter.

Table 4.1. Stratification and chronology of the Ityrkhei site (after Goriunova 1978; Goriunova and Vorob'eva 1986; Goriunova et al. 1996; Goriunova and Novikov 2000).

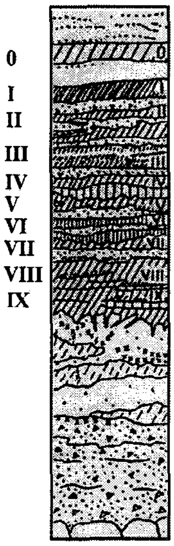
Stratigraphy	**Lithological unit/stratum**		**Deposits**	**Thickness (m)**	**Cultural layer**	**Relative age (regional scheme of the Lake Baikal area)**	**Uncalibrated radiocarbon age**
	4	1	Top soil	0.18–0.24			
		2	Layer of grey-yellow sand with small quantity of gruss inclusions	0.16–0.20	**0**	Iron Age 2000–600 BP	
		3	Dark humus sandy loam with gruss inclusions	0.12–0.20	**I**	Early Bronze Age 4000–3300 BP	
		4	Sterile interlayer of gray-yellow sand	0.04–0.08			
	3	5	Dark humus sandy loam with gruss inclusions	0.06–0.10	**II**	Developed Neolithic 5500–4300 BP	4485±45 SOAN–1585
		6	Interlayer of yellow sand	0.04–0.08			
		7	Humus gruss sandy loam	0.08–0.12	**III**	Developed Neolithic 5500–4300BP	
		8	Sterile sand interlayer	0.04–0.05			
		9	Humus sandy loam with gruss inclusions	0.10–0.18	**IV**	Developed Neolithic 5500–4300 BP	4740±155 SOAN–3342
		10	Lentiform sand interlayer	0.03–0.06			
		11	Humus sandy loam layer	0.16–0.20	**V**	Early Neolithic 6500–5500 BP	5680±60 SOAN–3341
		12	Sterile lentiform sand interlayer	0.06–0.08			
		13	Layer of humus fallow sandy loam	0.09–0.16	**VI**	Early Neolithic 6500–5500 BP	5700±200 GIN–4881
	2	14	Sterile sand interlayer	0.07–0.16			
		15	Dark humus sandy loam layer with large quantity of gruss inclusions	0.18–0.20	**VII**	Late Mesolithic 8000–7000 BP	7300±290 IMSOAN–402
		16	Lentiform sand interlayer	0.03–0.05			
		17	Dark humus sandy loam (different from above layers by increasing quantity of gruss and soil density)	0.16–0.20	**VIII**	Late Mesolithic 8000–7000 BP	8010±100 GIN–4882
		18	Dense dark fallow humus layer with large quantity of gruss	0.08–0.16	**IX**	Middle Mesolithic 9300–8000 BP	8720±210 COAH-3171
	1	19	Bellow these layers – bed of yellow and white lacustrine sands				
	Maximum excavated depth (m)			**2.35**			

Table 4.2. Fauna identified at Ityrkhei by Khamzina (1991:73).

Species	Chronological periods										Total of bones, %
	Iron Age	Bronze Age		Neolithic				Mesolithic			
	Cultural strata										
	0	I	II	III	IV	V	VI	VII	VIII	IX	
Roe deer		1		1	4				10		17.0
Red deer		2	6	1	2		1	8	8		29.8
Reindeer								8			8.5
Ram	1										1.1
Seal	1		1	2	4	3	5	4	4	11	38.9
Bear				1							1.1
Fox				1	2						3.2
Bird							1				1.1
Fish	+	+	+	+	+	+	+	+	+	+	
Total of bones	2	3	7	6	12	3	7	20	22	11	100

Table 4.3. Calibration of Ityrkhei radiocarbon dates and correlation of models developed by O.I. Goriunova and A. Weber. Radiocarbon dates calibrated using Oxcal 3.10 and the IntCal04 calibration dataset.

Layer	**Goriunova (1984, 2003) Period**	**Uncalibrated Radiocarbon dates**	**Material**	**1 Sigma Range, cal BP**	**2 Sigma Range, cal. BP**	**Weber et al. (n.d.) Period for Little Sea region**
0	Iron Age 2000–600 BP					
I	Early Bronze Age 4000–3300 BP					
II	Developed Neolithic 5500–4300 BP	4485 ± 45 SOAN–1585	Composite charcoal from hearth	5290–5040	5310–4970	Late Neolithic 6000/5800–5200/5000 cal BP
III	Developed Neolithic 5500–4300 BP					Late Neolithic 6000/5800–5200/5000 cal BP
IV	Developed Neolithic 5500–4300 BP	4740 ± 155 SOAN–3342	Composite charcoal from hearth	5660–5290	5900–4950	Late Neolithic 6000/5800–5200/5000 cal BP
V	Early Neolithic 6500–5500 BP	5680 ± 60 SOAN–3341	Composite charcoal from hearth	6550–6400	6640–6310	Middle Neolithic 7000/6800–6000/5800 cal BP
VI	Early Neolithic 6500–5500 BP	5700 ± 200 GIN–4881	Animal bone	6730–6290	7000–6000	Middle Neolithic 7000/6800–6000/5800 cal BP
VII	Late Mesolithic 8000–7000 BP	7300 ± 290 IMSOAN–402	Unknown	8400–7800	8850–7550	Late Mesolithic 8800 to 8000 cal BP
VIII	Late Mesolithic 8000–7000 BP	8010 ± 100 GIN–4882	Unknown	9020–8710	9250–8550	Late Mesolithic 8800 to 8000 cal BP
IX	Middle Mesolithic 9300–8000 BP	8720 ± 210 COAH-3171	Composite charcoal from hearth	10,150–9500	10,300–9250	

Table 4.4. List of reference collections and manuals used for the identification of faunal remains.

Species name	BAP collection, Irkutsk	Collections from different Irkutsk institutes	Photo guide of specimens from UA zooarch. lab.	Photo/ drawing identification	Published guides	Archaeofaunal collection, Irkutsk
Mammalia						
Cervus elaphus		Irkutsk State Academy of Agriculture	▼	▼	Gromova, 1950, 1960; Hillson 1992, 1996; Miles 1990; Schmid 1972	Ust'-Khaita
Alces alces		Irkutsk State Academy of Agriculture	▼	▼	Gromova, 1950, 1960; Hillson 1992, 1996; Miles 1990; Schmid 1972	
Capreolus capreolus					Gromova, 1950, 1960; Hillson 1996	Ust'-Khaita, Khuzir-Nuge XIV
Phoca sibirica	▼	Limnological Institute SO RAN			Kasper 1980; Post 2004	
Canis familiaris			▼	▼	Adams 2004; Hillson 1992; Sisson 1953	Lokomotiv
Gulo gulo			▼	▼	Hillson 1992; Sisson 1953; Schmid 1972	
Aves						
Anas spp.				▼	Cohen and Serjeantson 1996	
Pisces					Radu 2005	
Perca fluviatilis	▼					
Rutilus rutilus lacustris	▼					
Leuciscus leuciscus baic.	▼					
Esox lucius	▼					
Coregonus spp.	▼					

Table 4.5. Comparison of excavation methods and faunal samples.

Excavation/ Methods	Excavation area	Mammal		Bird		Fish		Total		Average per 1 m^2
		#	%	#	%	#	%	#	%	
1975-1976/ **Hand collecting**	**127 m^2**	184	2.18	21	0.25	8220	97.57	8425	42.70	66.3
2005/ **Sieving, 2mm**	**3 m^2**	14	0.12	-		11290	99.88	11304	57.30	3768
Total	130 m^2	198	1.00	21	0.11	19510	98.89	19729		

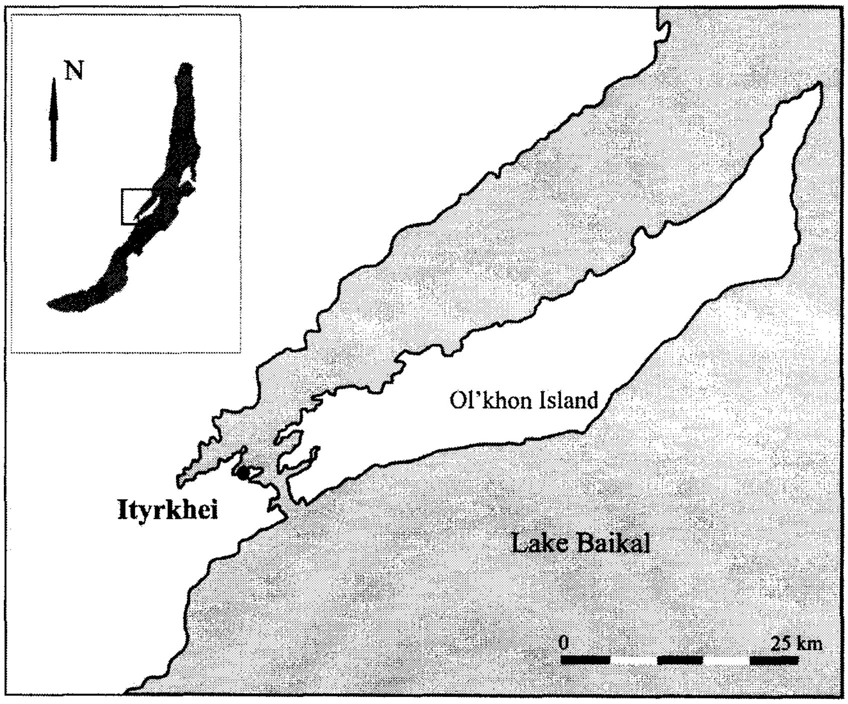


Figure 4.1: Location of the Ityrkhei site.

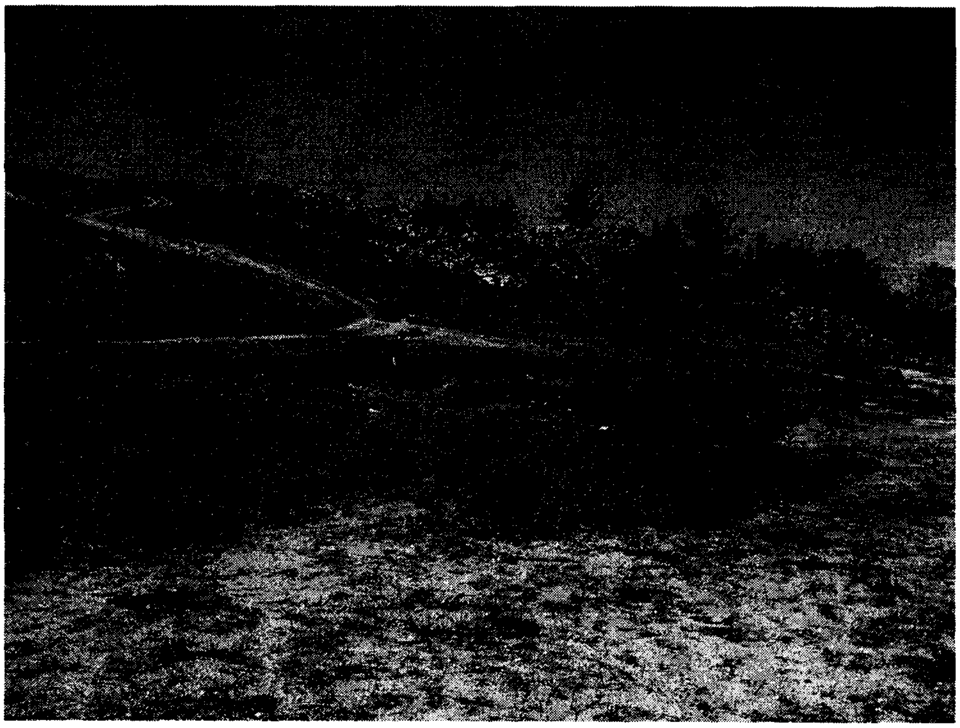


Figure 4.2: View of the Ityrkhei Cove from the northeast (photo R. Losey).

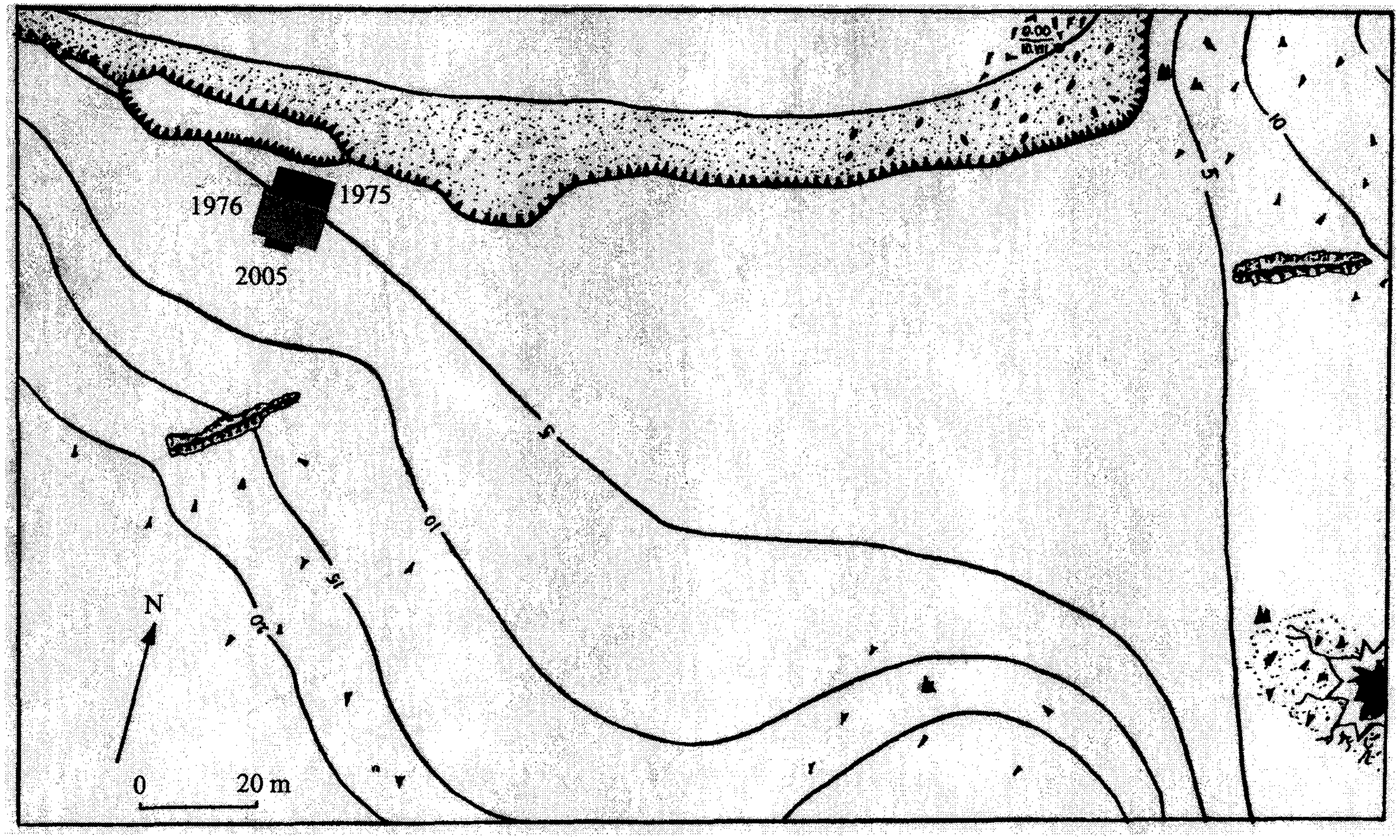


Figure 4.3: Topographic plan of Ityrkhei Cove (after Goriunova 1978).

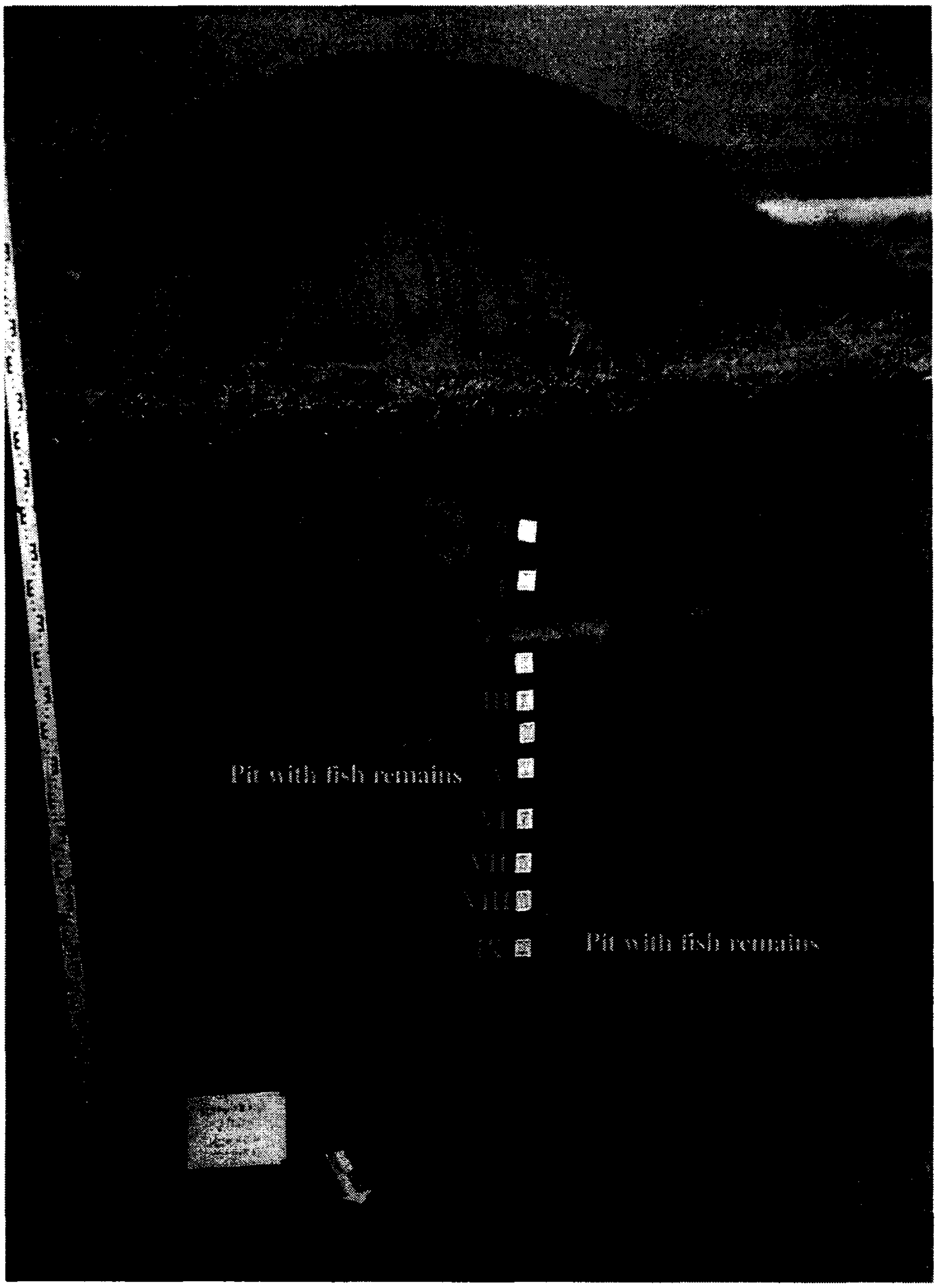


Figure 4.4: Stratigraphic profile of 2005 excavation trench at Ityrkhei (south wall).

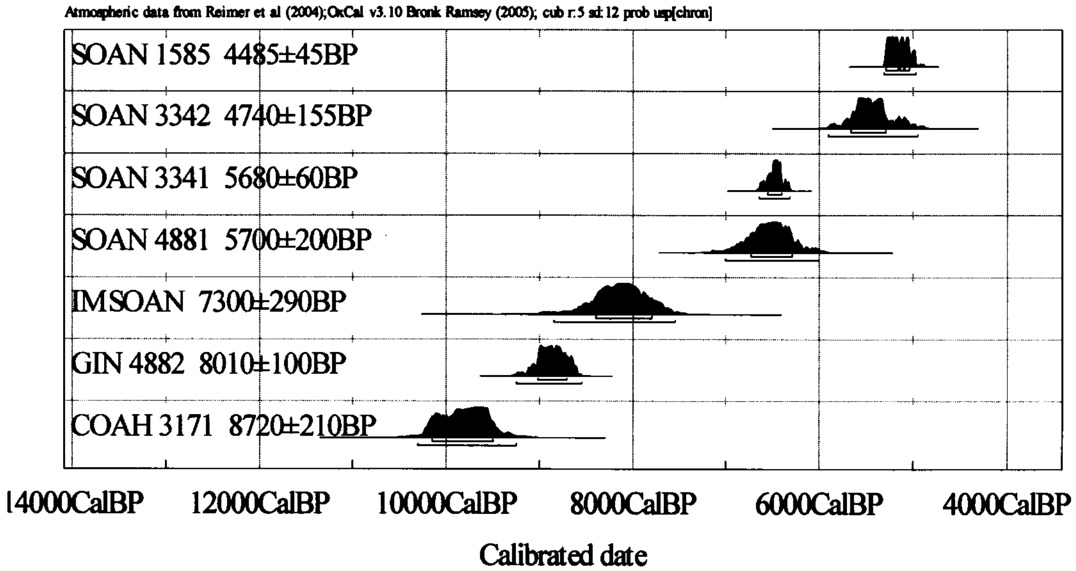


Figure 4.5: Calibrated radiocarbon dates from Itrykhei (Oxcal 3.10).

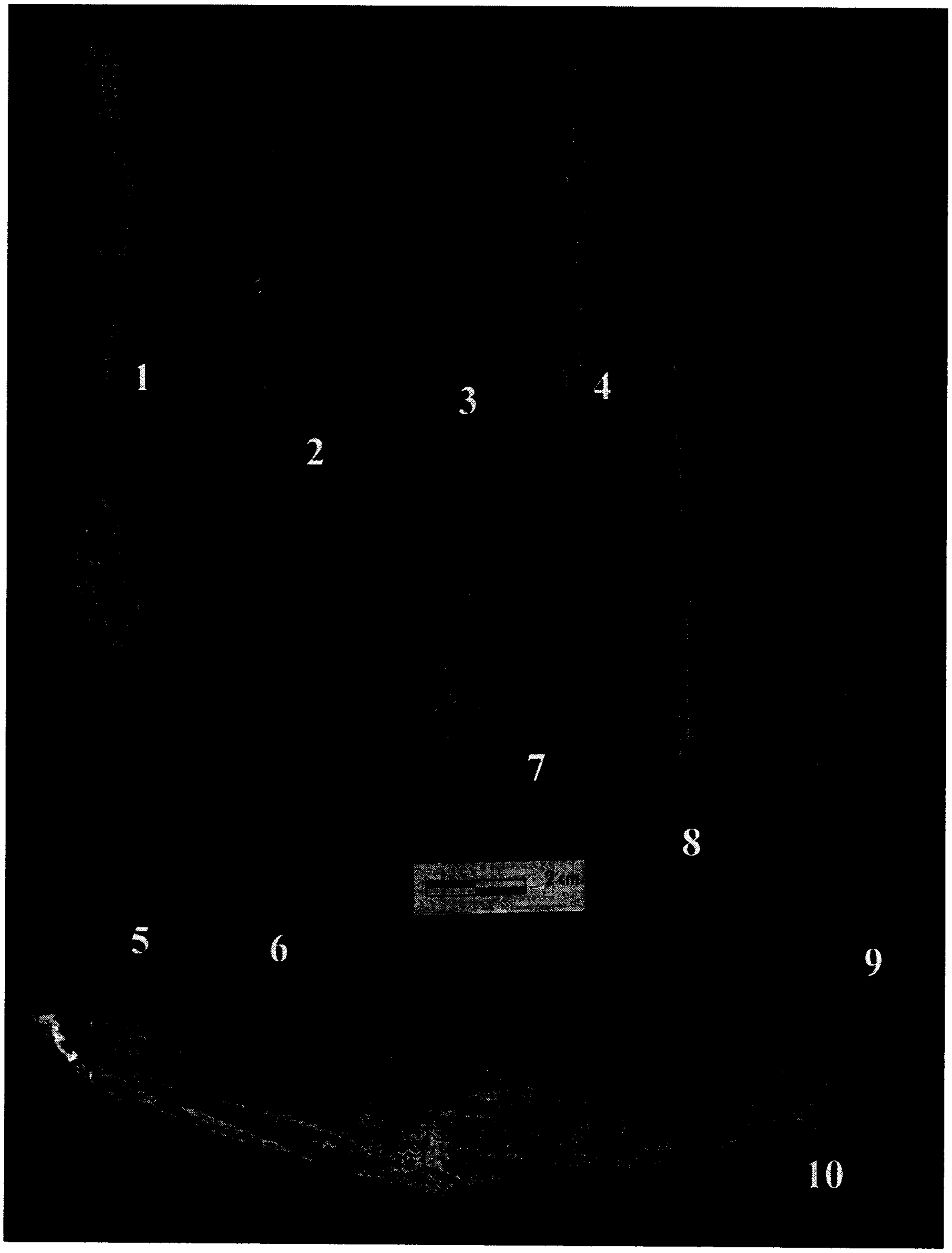


Figure 4.6: Bone artefacts from the Ityrkhei site (photo M. Metcalf).

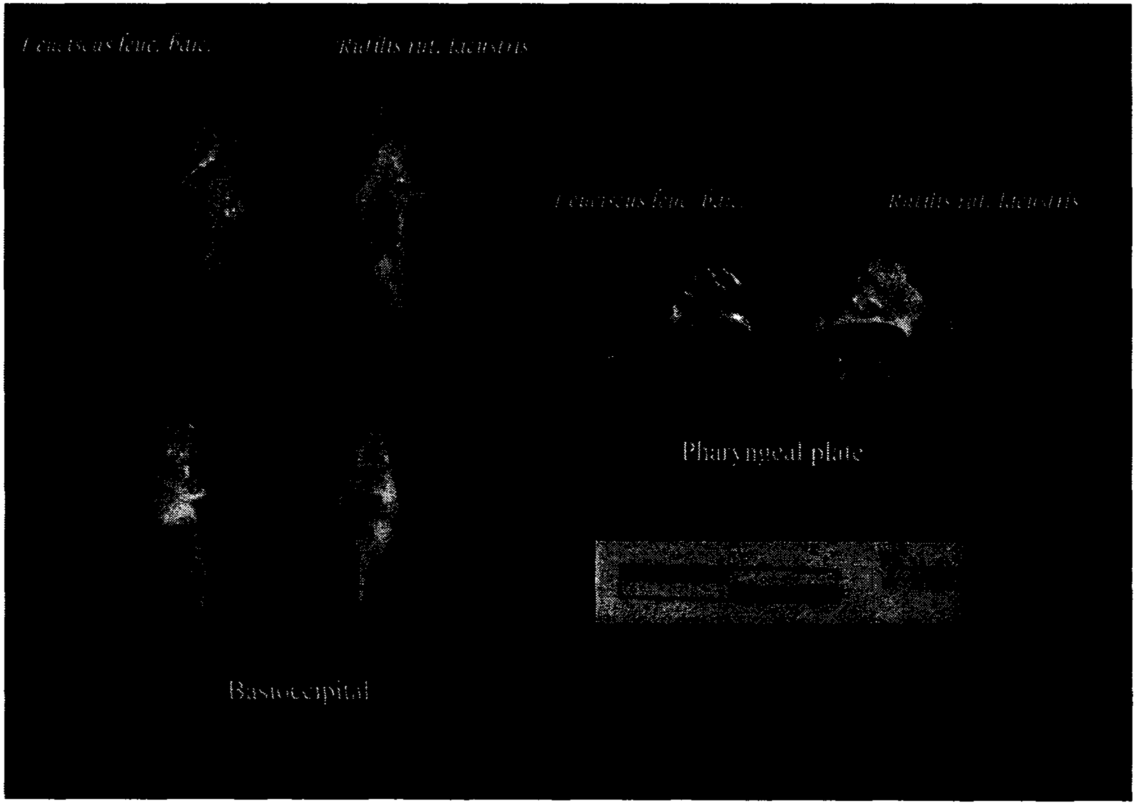


Figure 4.7: *Rutilus rutilus lacustris* and *Leuciscus leuciscus baicalensis*, basioccipital and pharyngeal plate elements (photo M. Metcalf).

Chapter 5
Ityrkhei Fauna and its Taphonomic Evaluation

This chapter provides information on the main characteristics of the faunal assemblage recovered from Ityrkhei, including taxonomic composition and skeletal element frequency through time. Following this is a brief discussion of the limitations imposed by various taphonomic and recovery issues, including the effects of differential processing, deposition, survivability, and lack of sieving in the earlier phases of excavation. Due to the dominance of fish specimens at the site, the primary focus of this chapter is on the evaluation of fish remains and their relevance to the interpretation of the faunal assemblage as a whole.

5.1 General description of fauna

The following data are based on the material recovered from the 1975–1976 and 2005 excavations at Ityrkhei, which consist of excavated areas of 127 m^2 and 3 m^2, respectively. Note that none of the fish bones from cultural layer IV excavated in the 1970s could be located for this analysis, and the 2005 sample lacked faunal material in layers 0, III, V, and IX (Table 5.2).

The Ityrkhei entire faunal assemblage consists of 19,729 faunal specimens (Table 5.1), with 98.89 % (19,510) of the total being fish. Around 19% (3797) of the faunal remains were identifiable to at least the family level. These remains include 98 mammal (total = 198), 1 bird (total = 21), and 3,698 fish (total = 19,510) specimens. Overall, 80.74% of the faunal remains from Ityrkhei were unidentifiable to at least the class level. Just over 81.04 % of these are fish bones, but could not be further identified.

Mammals are represented by six species, including *Alces alces* (elk), *Capreolus pygargus* (roe deer), *Cervus elaphus* (red deer), *Canis familiaris* (domesticated dog), *Gulo gulo* (wolverine) and *Phoca sibirica* (Baikal seal). Birds are represented by one genus, *Anas* spp. (ducks). Identified fish include four species, namely *Leuciscus leuciscus baicalensis* (dace), *Rutilis rutilis lacustris* (roach), *Perca fluviatilis* (perch) and *Esox lucius* (pike). Other fish remains were identified to the genus *Coregonus* spp.

(whitefishes/omul') or family Cyprinidae. Faunal remains at Ityrkhei have been assigned to 10 species, two genera, one family, and one order.

The following information describes the skeletal elements used in assigning specimens to their taxonomic category. For paired elements, the abbreviations L equals left and R equals right. Descriptions of anatomical locations for seal specimens are based on Lyman's bone density scan sites (Lyman 1994; Appendix 2 in this thesis) and were used only to record the portions of elements present in the collection.

Mammalia (mammals)

Identified specimens (NISP=90, weight=298.52 g): 27 skull fragments, 4 teeth, 2 vertebrae, 1L fibula, 1 distal portion of phalanx, 4 metapodial fragments, 1 scapula, 59 unidentified specimens (mainly long bones fragments).

Remarks: Twenty skull fragments are burnt to some degree, and 23 of the mammal bones are worked or represented as tools.

Order Artiodactyla (even-toed ungulates)

Identified specimens (NISP=18, weight=202.28g): 3 skull fragments (1L auditory bulla), 1 tooth fragment, 2 incisors, 7 antler fragments, 1 rib fragment.

Remarks: All antler specimens are tools/tool fragments.

Cervidae (elk and deer)

Alces alces L. (elk)

Identified specimens (NISP=2, MNI=1, weight=75.71 g): 1L mandibular, 1L cuneiform.

Capreolus pygargus L. (roe deer)

Identified specimens (NISP=8, MNI=3, weight=77.83 g): 1 molar, 1R radius, 2 intermediate phalanges, 3 proximal phalanges (1L, 1R), 1 metatarsal.

Remarks: 1 proximal phalanx is worked.

Cervus elaphus L. (red deer)

Identified specimens (NISP=14, MNI=4, weight=322.62 g): 3 fragments from 1 molar, 1L scapula, 1 tibia distal epiphysis, 1R metatarsal, 1R sesamoid, 1R pisiform, 2L carpals, 1L intermediate phalanx, 2 proximal phalanges (1L, 1R), 1L distal phalanx.

Remarks: both proximal phalanges and distal tibia epiphysis are unfused; scapula is worked.

Order Carnivore (flesh eaters)

Canidae (wolves, foxes, dogs)

Canis familiaris L. (domesticated dog)

Identified specimens (NISP=1, MNI=1, weight=13.05 g): 1L innominate.

Remarks: appears to be from an old individual.

Mustelidae (weasels, badgers, otters, lynx, wolverines)

Gulo gulo L. (wolverine)

Identified specimens (NISP=1, MNI=1, weight=7.11 g): 1R innominate.

Phocidae (seals)

Phoca sibirica Gmelin (Baikal seal)

Identified specimens (NISP=54, MNI=11, weight=348.05 g): 14 skull fragments (2R occipital condyle, 1L and 2R auditory bulla, 4L and 3R with parooccipital and postglenoid processes), 5 premaxillae (1L, 2R, 2 with both sides), 1R mandibular (DN3–4), 1 canine, 2 humeri (1L of HU2–4, 1R of HU2–5), 3 radii (2L of RA1–4, 1 proximal epiphysis), 3 ulnae (2R of UL2–3, 1L proximal end), 1L scapula (SP1–2), 1L innominate (AC1, PV1–2, IS1–2), 5 femora (3L, 2R of FE1–5), 4L tibiae, 2 lumbar vertebrae, 7 metatarsals, (1L, 4R), 5 phalanges (4R).

Remarks: 1R phalanx belongs to juvenile; 1 phalanx is malformed, possibly due to disease; 1 humerus, 1 femur, and 1 radius have carnivore gnaw marks.

Aves (birds)

Identified specimens (NISP=20, weight=12.95 g): portion of 1L coracoid, 27 unidentified to element.

Remarks: one bone is worked.

Order Anseriformes (waterfowl)

Anatidae (ducks, geese, swans)

Anas spp. (ducks)

Identified specimens (NISP=1, MNI=1, weight=0.85 g): 1R coracoid.

Pisces (fish)

Identified specimens (NISP=15811, weight=196.85): 2 cleithra (?), 2 pterygiophori, 3975 rays, spines and ribs, 1069 scales, 10763 unidentified to element, but most appear to be rays, ribs and other remains too fragmented to identify.

Remarks: 1 fragment is burned.

Order Salmoniformes (salmonids)

Coregonidae (whitefishes)

Coregonus spp. (whitefish, omul)

Identified specimens (NISP=173, MNI=13, weight=3.95 g): 1 premaxilla, 5 interoperculae (2L, 3R), 12 operculae (5L, 7R), 155 vertebrae.

Order Esociformes (pikes and mudminnows)

Esocidae (pikes)

Esox lucius L. (Northern pike)

Identified specimens (NISP=73, MNI=8, weight=31.42 g): 4 angularia (3L, 1R), 1 basioccipital, 4 cleithra (1L, 2R), 12 dentalia (5L, 2R), 1R frontal, 1R hyomandibular, 1R maxilla, 2 parasphenoidea, 2 preoperculae (1L), 1L subopercula, 39 vertebrae, 5 unidentified elements.

Order Cypriniformes (carp)

Cyprinidae (carp)

Identified specimens (NISP=940, MNI=40, weight=23.43 g): 30 angularia (14L, 16R), 30 atlas vertebrae, 13 basioccipitali, 24 basipterygia (12L, 11R), 41 ceratohyalia (17L, 24R), 23 cleithra (9L, 10R), 2 coracoidea, 23 dentalia (12L, 11R), 8 epihyalia, 17 frontalia (9L, 5R), 40 hyomandibularia (19L, 21R), 1L interopercule, 34 operculae (11L, 23R), 1 parasphenoid, 5 preoperculae (3L, 2R), 189 pharyngeal plates (27L, 39R), 19 maxillae

(11L, 5R), 1 prootic, 28 quadrata (12L, 16R), 12 scapulae (4L, 7R), 2 sphenotica (1L, 1R), 5 supracleithra (2L, 3R), 2 supraoccipitalia, 8 urohyalia, 2 vomer, 344 vertebrae, 36 unidentified.

Leuciscus leuciscus baicalensis Dyb. (Siberian dace)

Identified specimens (NISP=8, MNI=4, weight=0.17 g): 1 basioccipital, 7 pharyngeal plates (4L, 3R).

Rutilis rutilis lacustris Pall. (Siberian roach)

Identified specimens (NISP=83, MNI=31, weight=9.00 g): 8 basioccipital, 3 parasphenoidea, 72 pharyngeal plates (32L, 30R).

Order Perciformes (perch-like fish)

Percidae (perch)

Perca fluviatilis L. (Eurasian perch)

Identified specimens (NISP=2422, MNI=84, weight=153.67 g): 6 alisphenoid (3L, 3R), 102 angularia (41L, 45R), 39 atlas vertevrae, 19 basioccipitali, 52 basipterygia (18L, 29R), 30 ceratohyalia (17L, 12R), 69 cleithra (27L, 29R), 1R coracoid, 98 dentalia (53L, 44R), 4 ectopterygoidea (2R), 33 epihyalia (17L, 16R), 6 epiotica (4L, 2R), 17 exooccipitalia (7L, 9R), 116 frontalia (46L, 56R), 35 hyomandibularia (16L, 18R), 4 hypohyalia (2L, 1R), 28 interoperculae (15L, 13R), 75 maxillae (35L, 23R), 47 mesocoracoidea (21L, 26R), 1L nasal, 118 operculae (61L, 52R), 7 opisthotica (4L, 2R), 19 palantina (7L, 12R), 24 parasphenoidea, 1 pharyngel plate, 72 postcleithra (43L, 26R), 58 premaxillae (30L, 26R), 139 preoperculae (51L, 63R), 10 prootica (3L, 7R), 14 pterotica (6L, 9R), 86 quadrata (41L, 44R), 12 scapulae (5L, 4R), 2 sphenotica (1L, 1R), 26 suboperculae (14L, 12R), 97 supracleithra (51L, 45R), 5 otolithus (3L, 1R), 12 supraoccipitalia, 28 vomer, 6 urohyalia, 868 vertebrae, 42 unidentified.

Remarks: 4 vertebrae are burned.

5.1.1 Description of faunal remains by layer

The following section provides a detailed description, by layer, of the faunal material recovered from Ityrkhei (Table 5.2). For each cultural layer, the number of identified specimens, minimum number of individuals, element description, and relative taxonomic abundance of taxa is provided. The bone and antler tools are included within these descriptions.

Cultural layer IX (Middle Mesolithic)

This layer produced 58 specimens. Mammals are represented by 31 specimens: *Phoca sibirica* (MNI=1) – 1L tibia and the 1R mandibular; 1 proximal phalange of *Capreolus pygargus*; 1 Artiodactyla antler fragment and 27 unidentifiable fragments (20 of them are burnt skull fragments). Among the mammal specimens are 3 worked bones and 1 harpoon. In this layer, 4 unidentified bird and 26 fish specimens also were found. The latter is represented by *Perca fluviatilis* – 10 (MNI=2) and *Esox lucius* – 3 (MNI=1).

Cultural layer VIII (Late Mesolithic)

There were 5316 faunal remains found in this layer. Mammals are represented by 60 bones: *Phoca sibirica* (MNI=2) – 5 skull fragments, 1 canine, 2R ulna, 2 radii (1L), 1L humerus, 2L femora and 1L scapula; Artiodactyla – 2 incisors, 2 teeth and 5 antler fragments; 37 unidentified bones (15 of them are worked). Fish remains consisted of 5254 fragments, including *Perca fluviatilis* – 475 (MNI=8), *Esox lucius* – 10 (MNI=2), *Coregonus* spp. – 22 (MNI=7), Cyprinidae – 378 (MNI=14), *Rutilis rutilis lacustris* – 10 (MNI=3), *Leuciscus leuciscus baicalensis* – 5 (MNI=2), and 4354 unidentified specimens.

Most of the fish remains (4803 out of 5254) were found within a pit during the 2005 excavation. This pit was oval in shape with a NNE-SSW orientation. Its size was 0.41–0.20 m in maximum width, and had a capacity of 0.05–0.08 m. The fish identified in the pit include *Perca fluviatilis* – 428 (MNI=8), *Esox lucius* – 5 (MNI=1), *Coregonus* spp. – 3 (MNI=1), Cyprinidae – 366 (MNI=14), *Rutilis rutilis lacustris* – 5 (MNI=3), *Leuciscus leuciscus baicalensis* – 5 (MNI=2) and 3991 unidentified specimens. In total, the pit MNI is 24 individuals from 5 species (MNI for Cyprinidae, *Rutilis rutilis lacustris* and *Leuciscus leuciscus baicalensis* are combined).

Cultural layer VII (Late Mesolithic)

There were 3280 faunal remains found in this layer. Mammals are represented by 16 specimens: *Phoca sibirica* (MNI=2) – 1L auditory bulla, 1R and 1L femur, 1L innominate, 2 lumbar vertebrae, 1R metatarsal and 1R phalanx; 8 unidentified fragments (6 of which are tools). In this layer 9 unidentified bird bones and 3255 fish remains were found. They consist of *Perca fluviatilis* – 379 (MNI=9), *Esox lucius* – 11 (MNI=1), *Coregonus* spp. – 35 (MNI=1), Cyprinidae – 82 (MNI=4), *Rutilis rutilis lacustris* – 4 (MNI=1) and 2744 unidentifiable fragments.

Cultural layer VI (Early Neolithic)

There were 3032 faunal remains found in this layer. Mammals are represented by 16 specimens: *Phoca sibirica* (MNI=1) – 2 skull fragments, 1 premaxilla, 1L radius, 1R humerus, 1R femur, 1L tibia and 2 metatarsals; 1 skull fragment of Artiodactyla; 6 unidentified. In the layer, 3 birds (one is worked) and 3013 fish remains were also found. Among the latter, perch (*Perca fluviatilis*) is represented by 403 specimens (MNI =11), *Esox lucius* – 14 (MNI=1), *Coregonus* spp. – 10 (MNI=1), Cyprinidae – 222 (MNI=9), *Rutilis rutilis lacustris* – 222 (MNI=6), *Leuciscus leuciscus baicalensis* – 1, and unidentifiable – 2340 fragments.

Cultural layer V (Early Neolithic)

There were 2915 faunal remains found in this layer. Mammals are represented by 6 specimens: *Phoca sibirica* (MNI=1) – 1L premaxilla, 1L tibia and 2 metatarsals; 2 unidentified fragments, one of which is worked. Among the faunal remains are 3 bird bones, one of which appears to be a coracoid of *Anas* spp. Among the fish remains are (NISP=2907): *Perca fluviatilis* – 525 (MNI=25), *Esox lucius* – 30 (MNI=1), *Coregonus* spp. – 96 (MNI=2), Cyprinidae – 145 (MNI=7), *Rutilis rutilis lacustris* – 39 (MNI=12), and unidentified – 2106.

Cultural layer IV (Developed Neolithic)

There were 2927 faunal remains found in this layer. Mammals are represented by 31 specimens: *Cervus elaphus* (MNI=1) – 1L proximal scapula, 2L carpals; *Capreolus pygargus* (MNI=1) – 1R radius, 1 metatarsal, 2 intermediate and 2 proximal phalanges; *Canis familiaris* – 1L innominate (possibly from an old individual); *Phoca sibirica* (MNI=1) –1R premaxilla fragment, 2 skull fragments, 1L tibia, 2R metatarsals and 2 phalanges; Artiodactyla – 1 antler and 2 skull fragments; 10 unidentified specimens.

All fish specimens from this layer (NISP=2896) were found in a pit during the 2005 excavation. This pit was oval in shape, oriented NW–SE. It ranged in width from 0.64–0.32 m, and had a capacity of 0.03–0.07 m. The species of fish from the pit include: *Perca fluviatilis* – 449 specimens (MNI=15), *Coregonus spp.* – 6 (MNI=1), Cyprinidae – 135 (MNI=5), *Rutilis rutilis lacustris* - 9 (MNI=7) and unidentified – 2297. In total, the MNI in the pit is 28 fish from 3 species (MNI for Cyprinidae and *Rutilis rutilis lacustris* are combined).

Cultural layer III (Developed Neolithic)

There were 366 faunal remains found in this layer. Mammals are represented by 15 specimens: *Cervus elaphus* –1 distal part of a tibia and 1 metatarsal with an unfused distal epiphysis (MNI=1); *Phoca sibirica* (MNI=2) – 1 premaxilla, 3 skull fragments, 1L ulna and 2R phalanges; 1 rib fragment of Artiodactyla; 5 unidentified mammal bones. Fish remains numbered 351 and include: *Perca fluviatilis* – 21 (MNI= 4), *Esox lucius* – 3 (MNI=1), Cyprinidae – 4 (MNI=1), *Rutilis rutilis lacustris* – 1, and 322 unidentifiable specimens.

Cultural layer II (Developed Neolithic)

Excavation of this layer produced 1571 faunal remains. Mammals are represented by 15 specimens: *Alces alces* (MNI=1) - mandibular fragment and cuneiform; *Cervus elaphus* (MNI=1) – 3 fragments of 2nd molar, 1R sesmoid, 1R pisiform, and 1R unfused proximal and 1L distal phalanges; *Phoca sibirica* (MNI=1) – 1 premaxilla and 1 auditory bulla; 4 unidentifiable specimens (2 of them are skull fragments). Among the fish remains (NISP=1556) are: *Perca fluviatilis* – 137 (MNI=7), *Esox lucius* – 1, *Coregonus* spp. – 4 (MNI=1), Cyprinidae – 6 (MNI=1), *Rutilis rutilis lacustris* – 1, and 1407 unidentified specimens.

Cultural layers 0 (Iron Age) and I (Early Bronze Age)

Faunal material (NISP=3) from layer 0 is represented by 1 molar of *Capreolus pygargus*, 1R innominate of *Gulo gulo*, and 1 sacral vertebra of a mammal. Layer I produced 257 faunal remains. Among them are specimens of *Cervus elaphus* (MNI=1) – 1L intermediate and 1 unfused proximal phalanges; 1 distal epiphysis of an Artiodactyla metapodial; 2 mammal and 252 fish bones. Of the fish remains, *Perca fluviatilis* is represented by 23 specimens (MNI=3).

Description of culturally modified faunal remains

All modified faunal remains retrieved from Ityrkhei were grouped into two categories based on the degree of modification: (1) bone/antler implements and tools as finished products, and (2) bone/antler displaying some degree of human modification where the function is unclear (Table 5.3). Overall, during the 1970s excavation 33 faunal remains were found showing traces of human modification. With the exception of a single bird bone, all were from mammals.

The artifacts retrieved from layer IX, dating to the Middle Mesolithic, include a unilaterally barbed bone harpoon with a notch in the base for line attachment (Figure 4.6–2), a modified proximal phalanx from a *Capreolus pygargus* (Figure 4.6–7), an antler fragment with longitudinal cut marks, and a worked bone fragment. Layers VIII– VII, dating to the Late Mesolithic, contained 22 modified faunal remains: 10 unilateral and bilateral insert tools or tool fragments (Figure 4.6–8, 9), a knife with a unilateral blade, 6 worked bone fragments, and 5 worked antler fragments.

Early Neolithic artifacts at Ityrkhei are represented by a modified fragment of mammal bone and an awl made from bird bone. Composite fishhooks with lateral fastenings (Figure 4.6–3), a needle that Goriunova (1984) suggested was for sewing nets

(Figure 4.6–5), an anthropomorphic figure (Figure 4.6 – 1), and a *Cervus elaphus* scapula with longitudinal cut marks were found in Developed Neolithic layers (IV–II).

5.1.2 Skeletal element frequencies

Because fish remains dominate the Ityrkhei faunal assemblage, skeletal element frequencies were examined only for fish. In most studies of fish skeletal element representation, analysts examine the ratio of 'head' versus post-cranial elements (Butler and Chatters 1994; Hoffman et al. 2000; Lubinski 1996). Head elements would include all elements of the fish except the vertebrae and the elements of the dorsal, caudal, anal, and pelvic fins. However, given that most of these non-head elements are typically not identified, the issue of skeletal element representation is largely restricted to an examination of head elements versus vertebrae. These types of analyses are often undertaken with the goal of examining processing techniques. However, the differential resiliency of 'head' elements versus vertebrae has presented serious problems for interpreting these data. Given that skeletal element bone density values are not available for the fish taxa in this study (see section 5.4 below), the meaning of the differential representation of skeletal elements is difficult to attribute to any one cause.

With regard to the frequency of fish remains (Table 5.4–5.7), vertebrae compose a substantial portion of the identified elements in the Ityrkhei sample. Vertebrae account for 37.3% of the identified *Perca fluviatilis*, 36.86% of the Cyprinidae (*Rutilis rutilis lacustris* and *Leuciscus leuciscus baicalensis*), 54.17% of *Esox lucius*, and 89.6% of the *Coregonus* spp. In total, vertebrae comprise 39.72 % of the total identified fish bones (Table 5.8). However, vertebrae appear to be under-represented for most fishes in the sample. For example, comparisons can be made for each taxa (within the total assemblage) by calculating MNI values for head elements versus vertebrae (Table 5.9). These figures show that the MNI calculated for perch head elements is 2.9 times greater than that for perch vertebrae. For the Cyprinidae the same MNI ratio is 4.9, for pike 5.0, and for *Coregonus* spp. 2.3. These figures indicate vertebrae are in fact under-represented for all fish taxa, and this under-representation is greatest among the Cyprinidae and pike.

The majority of head elements from the Ityrkhei sample are from two taxa: *Perca fluviatilis* and Cyprinidae. Among the perch remains, the angular, dentary, frontal, maxilla, opercle, preopercle, quadrate, cleithrum, posttemporal, and supracleithrum are all relatively abundant (Table 5.4). Cyprinidae remains were dominated by pharyngeal plates, which represent 41.17% of the sample (NISP=268). The remaining elements consisted of angular, ceratohyal, hyomandibular, opercle and quadrate fragments (Table 5.5). Specimens of *Esox lucius* are few, represented by only 10 head and pectorial girdle bones, and variability of element type is low (Table 5.6). Head bones are also rare for *Coregonus* spp. at Ityrkhei, represented by only three elements: interopercle, opercle, and premaxilla (Table 5.7). Factors that might account for these patterns are discussed in section 5.4 below.

5.2 Recovery biases

In general, studies on the effects of different field techniques have been based on the comparison of recovery rates for particular archaeological samples that have been subject to differing recovery methods (Barker 1975; Clason and Prummel 1977; Gordon 1993; James 1997). These studies evaluate the effects on taxonomic richness, relative species abundance and skeletal element representation. The general consensus in all cases is that when larger mesh-size sieves are employed, larger-bodied taxa are recovered in greater proportions compared to smaller fauna, particularly fish (Colley 1990; Nagaoka 2005).

As discussed in Chapter 4, the total number of animal bones recovered from Ityrkhei during the 1970s and 2005 excavations varied widely and this was likely due to the different recovery techniques employed (Table 4.5). In sum, the 2005 sample produced far more specimens per 1 m^2 than the 1970s sample and the recovery rate was 3,768 bones per 1 m^2. If faunal remains were present throughout the site at even half this density (~1800 specimens per square meter), around 228,600 fish remains could have been recovered at the site if 2 mm sieves had been used. Recall that instead only 8,425 specimens were recovered from the 127 m^2 excavated in the 1970s. Clearly, the technique used in the 1970s excavations had an enormous impact on the recovery rate of faunal remains, particularly those of fish. However, fish remains are the prevailing taxa in both samples, comprised 98–99 % of total number of specimens. At the same time, most of the fish remains came from the 2005 sample, despite only 3 m^2 being excavated. Similar extreme biases may affect all Baikal area assemblages where fish and other small fauna dominate assemblages.

These biases raise two important issues regarding the assemblage. First, the variety and quantity of faunal remains correlate, to some extent, with the field technique used and the size of the excavated area. Second, the recovery technique used affects my ability to address questions concerning ancient diets and subsistence practices at Ityrkhei. Figure 5.1 clearly shows how the recovery techniques affect the Ityrkhei fish sample. Species diversity for the purpose of this section is defined as richness, or number of taxa present at the site, and the relative abundance of species or distribution of abundance values across taxa (Gordon 1993).

At Ityrkhei, 60% of the total fish remains were retrieved from the 2005 sample from 3 m^2 versus 40% from the 1970s sample of 127 m^2. Surprisingly, the use of sieves in 2005 did not substantially increase the fish taxonomic richness, but overall assemblage richness was clearly affected by the small area excavated in 2005. Almost all mammal bones recovered were found in the 1970s assemblage (Table 5.2), which is to be expected, given that they are relatively rare and thus likely to enter the assemblage only after fairly extensive sampling. The relatively small 2005 sample is clearly biased against these rare taxa.

I also explored the potential influence of recovery bias on the relative abundance of fish species through an examination of NISP from layers VI and VII, as both samples contain abundant fish remains in these layers (Figures 5.2 and 5.3). A comparison of the data from both excavations shows that widely different NISP values exist between the samples. But, the relative abundance of the fish taxa in the two samples is very similar despite the sample size differences. This pattern is characterized by a preponderance of *Perca fluviatilis* and Cyprinidae remains and a minimal number of *Coregonus* spp. and *Esox lucius* in the two layers.

Slight variation does exist in the recovery rates for the 2005 and 1970s samples when NISP values for a particular species are compared between the two samples. For example, the relative abundances of pike and Coregonidae are lower in the 2005 sample, but this discrepancy may be due to their overall minimal representation at Ityrkhei. A clearer bias is observed for the cyprinids, where almost 70% of these specimens were retrieved in 2005 (Figure 5.1). The under-representation of Cyprinidae in the 1970s sample can also be observed in skeletal element frequencies. For example, most of the very small cyprinid elements (angular, ceratohyal, and quadrate) recovered were found in 2005 (Table 5.5). This is significant because cyprinids are the smallest fish taxa (Kozhov and Misharin 1958) identified at Ityrkhei, and therefore have the smallest skeletal elements. This suggests that Cyrprinidae may have been somewhat more abundant at the site than is suggested by the 1970s sample.

While there are some substantial differences in the samples due to recovery techniques, the general trend of the dominance of perch and cyprinids is consistent in the two samples. Also, due to different recovery techniques and disparate excavation areas, there are strata in the 2005 sample that lack faunal material (Table 5.2). However, when both samples are combined, a sample of faunal material is available for all layers allowing for an examination of diet and subsistence strategies throughout the course of site occupation. Outright exclusion of either sample is clearly not warranted.

5.3 General condition of Ityrkhei fauna

Bone preservation at Ityrkhei was generally good and faunal remains exhibited minimal damage related to excavation. All specimens were examined for evidence of burning, butchering, and other forms of human modification (grinding, polishing, etc.). This investigation revealed rare evidence of modification. Burned specimens include 20 mammal skull fragments from layer IX and five fish bones, four of which were perch vertebrae, from layers I, III, IV, and VI. Cut marks were observed on seven mammal bones: five antler portions from layers VIII and IX, a metapodial from layer VII, and a *Cervus elaphus* scapula from layer IV. The degree to which burning and butchering activities influenced bone preservation at Ityrkhei is considered negligible as they represent only 0.001% (n=32) of the total faunal assemblage (NISP=19,729).

It is possible that non-human scavengers may have been responsible for the destruction of some of the faunal remains at Ityrkhei. Among the specimens identified as damaged were three seal bones (radius, humerus, and femur) from layer VI that exhibit carnivore gnaw marks (Figure 5.4). At least one domesticated dog is represented in the fauna at Ityrkhei (in layer IV), which indicates that carnivores capable of inflicting significant damage to bone were present at the site. There are several studies examining the potential effects of dog scavenging and human consumption activities on fish bones (e.g. Butler and Schroeder 1998; Jones 1986). The results of these analyses demonstrate that digestive processes often modified specimens and reduced the rates of fish bone recovery by 85% to 100%. Although little evidence for gnawing or digestive erosion have been observed in the Ityrkhei fish bone sample, one cannot rule out dog or human consumption and mastication as potential agents of bone destruction.

5.4 Fish taphonomy: bone density and element preservation at Ityrkhei

Substantial amounts of data have been published regarding bone density and its influence on skeletal element abundance among mammals (see Klein 1989; Lam and Pearson 2005; Watson 1979; Binford and Bertram 1977; Lam et al. 2003; Lyman 1984; and references therein). The general consensus is that bone density is a key factor (but not the only factor) in determining the degree to which taphonomic processes affect faunal remains. For example, lower density bones are believed to be more likely to be affected by biological and chemical processes than higher density bone. There are also a number of studies that deal specifically with fish remains and their densities (Butler and Charters 1994; Hoffman et al. 2000; Nicholson 1992, Zohar and Dayan 2001). Such studies have suggested that although fish remains are common in the archaeological record, they tend to be rare relative to mammal bones in some depositional settings, or some elements of certain fish tend to be recovered disproportionally to their true skeletal abundance. This disparity is generally explained as resulting from the fragility (and low density) of fish remains relative to that of most mammal bones and the differential resistance to destruction of elements and element portions within a given fish's skeleton (Colley 1990; Wheeler and Jones 1989).

No bone density information exists for the specific fish species identified at Ityrkhei. Nonetheless, there are a number of bone density studies on fishes of the Salmonidae family (which includes the subfamily Coregonidae). These studies have proposed that the low recovery rates of salmon and whitefish in the archaeological record (compared to other taxa) is partially due to the relatively low density of salmonid cranial bones compared to vertebra centra (Lubinski 1996; Matsui 1996; Filipiak and Chełkowski 2000). This pattern of differential density is also thought to relate to the under-representation of salmon 'head' elements relative to vertebrae in many assemblages, particularly those from the Northwest Coast of North America (Butler and Chatters 1994). Salmonidae have highly cartilaginous skulls (low density) compared to other fishes (Gregory 1933), particularly Cyprinidae and *Perca fluviatilis* (Kłyszejko et al. 2004). Whitefish in particular reportedly exhibit a marked difference in the destruction of skeletal parts – whitefish have less robust mouth elements compared to salmon and this fragility decreases the likelihood that these skeletal parts will survive in the archaeological record (Lubinski 1996).

The taphonomy of *Coregonus* spp. at Ityrkhei requires additional consideration as these fishes may have been subject to taphonomic bias that resulted in their under-representation compared to other fishes with more robust skeletons. For example, some researchers analyzing prehistoric fishing and subsistence patterns in the Lake Baikal area have assumed that omul' was the main food source for the ancient inhabitants along the shores of Lake Baikal (Everstov 1988; Svinin 1976, Novikov and Goriunova 2005). However, *Coregonus* spp. comprise only 5% of the identified fish specimens at Ityrkhei. This rises a question of whether the low representation of *Coregonus* spp. in the archaeological record is a result of taphonomic processes, or an indication that omul' was not a dietary staple for the people of Lake Baikal or both.

Data on skeletal element frequencies for *Coregonus* spp. (Table 5.7) demonstrate that vertebrae comprise 89.6% of the total elements recovered. The low survival rate of cranial remains may be due to the premise that vertebra density far exceeds cranial bone density for these fishes. Therefore, as bone density correlates with the degree of skeletal element survival, it is possible that the actual minimum number of *Coregonus* spp. is underestimated at Ityrkhei. However, based on the estimation of the MNI for cranial bones versus vertebrae (Table 4.9), vertebrae (possibly higher density elements) are probably under-represented, but no more so than in any other Ityrkhei fish. Also, based on density studies for Salmonidae, gill cover bones (opercle, interopercle) should have a lower density than jaw elements (angular, maxilla, dentary) (Butler and Chatters 1994:416; Lyman 1994:442). In the case of the Ityrkhei faunal remains, the presence of some of these low density elements (interopercle, opercle) might imply that taphonomic factors were not responsible for the minimal amount of *Coregonus* spp. recovered from the site. Notably, the suitability of Salmonidae bone density data to the study of whitefish/omul' skeletal representation is completely unknown. The question as to whether these fishes are under-represented in the assemblage remains unanswerable until more applicable bone density datasets will be available.

Some studies consider survivorship rates of fish elements as dependent on shape and structure, not simply density (Filipiak and Chełkowski 2000; Lebedev 1960; Nicholson 1996; Susłowska 1968). For example, Susłowska (1968) analyzed rates of bone recovery among European freshwater fishes, including some of the same species identified at Ityrkhei (perch, roach, and pike). The author suggested two main conclusions. First is that most of viscerocranium bones (preopercle, opercle, cleithrum, dentary and parasphenoid) are commonly recovered in archaeological sites, while elements of the neurocranium (e.g., alisphenoid, epiotic) tend to be more rarely encountered. Susłowska argues that this is explained by bone structure: viscerocranium elements are more compact and originate as connective tissue as opposite to neurocranium elements, which consist mainly of cartilage, have greater porosity, and lower ossification. Better survivorship of some largely cartilaginous bones such as hyomandibular, angular, and quadrate is explained by their close location to the conjunctions with elements of connective tissue origins (Susłowska 1968:202–204).

Furthermore, Susłowska (1968:205–206) states that resistance of fish bones to the decay processes depends somewhat on the function of different elements and on the biological characteristics of the fish, such as their classification as omnivores (Cyprinidae) or predators (perch and pike). She suggests that jaw elements are dominant among predatory species in archaeological assemblages, while gill cover elements are most prevalent among omnivores. This is explained by the fact that predators actively gain their food using strong jaws while omnivores procure food by way of water currents passing through gill slits. In other words, the more "active" the bone is in the lifecycle of the fish, the more robust it is and thus the better its survivorship rate in archaeological settings.

Two patterns are evident when skeletal element abundance is examined along these lines. First, the Ityrkhei fish samples contain elements with supposed low survivorship rates, namely those of the neurocranium (e.g., alisphenoid, prootic). Second, elements for both omnivorous (Cyprinidae) and predatory (perch) fish are present in abundance at Ityrkhei (Table 5.4–5.8). Given this, it might be suggested that the assemblage can be viewed as relatively well-preserved and not overly biased by differential preservation.

In sum, this chapter provided a detailed description of the primary data sets used in this thesis. This includes quantitative data on species composition and relative abundance, skeletal element frequencies, and a subjective evaluation of site taphonomy. Based on an examination of this data, I suggest that even if there are significant differences in the number of remains in the two samples due to the recovery techniques employed, these biases did not have a drastic effect on the relative abundance of various taxa, particularly of fish, the dominant class of fauna at the site. The specimens recovered from the site, while undoubtedly affected by numerous agents of destruction, do not appear to have been so heavily affected by taphonomic processes that the meaningful patterns are obscured.

Table 5.1. Faunal remains from Ityrkhei.

Taxa	**Common name**	**1975–1976 (127 m^2)**			**2005 (3 m^2)**			**Total (130 m^2)**		
		NISP	MNI	Weight (g)	NISP	MNI	Weight (g)	NISP	MNI	Weight (g)
Mammalia-unidentified	mammal	91		319.66	11		1.86	102		321.52
Artiodactyla	even-toed ungulates	17		307.63				17		307.63
Alces alces	elk	2	1	75.71				2	1	75.71
Capreolus pygargus	roe deer	8	4	77.83				8	3	77.83
Cervus elaphus	red deer	13	4	325.94				13	4	325.94
Canis familiaris	domesticated dog	1	1	13.05				1	1	13.05
Gulo gulo	wolverine	1	1	7.11				1	1	7.11
Phoca sibirica	baikal seal	51	11	359.62	3	1	3.52	54	11	363.14
Total mammal		**184**		**1486.55**	**14**		**5.38**	**198**		**1491.93**
Pisces-unidentified	fish	6475		115.83	9337		81.02	15812		196.85
Cyprinidae	carps	236	17	8.76	704	32	13.67	940	40	22.43
Rutilis rut.lacustris	roach	62	22	7.29	21	16	1.71	83	31	9.00
Leuciscus leucis.	dace	1	1	0.09	7	3	0.08	8	4	0.17
Coregonus spp.	whitefishes. omul'	144	12	3.61	29	4	0.34	173	13	3.95
Perca fluviatilis	perch	1245	63	104.75	1177	40	48.92	2422	84	153.67
Esox lucius	pike	57	9	30.69	15	3	0.73	72	8	31.42
Total fish		**8220**		**271.02**	**11,290**		**146.47**	**19,510**		**417.49**
Aves-unidentified	bird	20		12.95				20		12.95
c.f. *Anas spp.*	ducks	1	1	0.85				1	1	0.85
Total bird		**21**		**13.80**				**21**		**13.80**
Total		**8425**		**1771.37**	**11,304**		**151.85**	**19,729**		**1923.22**

Table 5.2. Faunal remains at Ityrkhei by layer and year of excavation.

Taxa	Layer																				Total	
	Iron Age		Early Bronze		Developed Neolithic						Early Neolithic				Late Mesolithic				Middle Mesolithic			
	0		I		II		III		IV		V		VI		VII		VIII		IX			
	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)	n	Wt(g)
1975–1976																						
Mammalia-unidentified	1	21.40			3	11.35	5	6.55	8	12.62	2	4.63	2	8.09	8	101.54	35	120.48	27	33.00	91	319.66
Artiodactyla			1	2.26	1	6.68	1	13.26	3	41.03			1	24.37			9	204.63	1	15.40	17	307.63
Alces alces					2	75.71															2	75.71
Capreolus pygargus	1	3.17							6	70.58									1	4.08	8	77.83
Cervus elaphus			2	15.28	6	29.16	2	221.63	3	59.87											13	325.94
Canis familiaris									1	13.05											1	13.05
Gulo gulo	1	7.11																			1	7.11
Phoca sibirica					2	8.09	7	30.67	8	36.73	4	33.06	9	80.30	8	73.76	11	74.92	2	22.09	51	359.62
Total mammal	**3**	**31.68**	**3**	**17.54**	**14**	**130.99**	**15**	**272.11**	**29**	**233.88**	**6**	**37.69**	**12**	**112.76**	**16**	**175.30**	**55**	**400.03**	**31**	**74.57**	**184**	**1486.55**
Pisces-unidentified			229	3.02	1407	22.85	322	3.18			2106	45.07	693	15.85	1469	17.32	236	7.82	13	0.72	6475	115.83
Cyprinidae					6	0.28	4	0.31			111	4.26	96	2.78	15	0.55	4	0.58			236	8.76
Rutilis rut. lacustris					1	0.05	1	0.05			39	4.71	14	1.93	2	0.12	5	0.43			62	7.29
Leuciscus leucis.													1	0.09							1	0.09
Coregonus spp.					4	0.04					96	1.72			27	0.52	17	1.33			144	3.61
Perca fluviatilis			23	3.19	137	11.83	21	3.02			525	49.38	209	15.70	285	13.69	35	6.25	10	1.69	1245	104.75
Esox lucius					1	0.88	3	0.99			30	10.47	11	11.12	4	2.54	5	3.91	3	0.78	57	30.69
Total fish			**252**	**6.21**	**1556**	**35.93**	**351**	**7.55**			**2907**	**115.61**	**1024**	**47.47**	**1802**	**34.74**	**302**	**20.32**	**26**	**3.19**	**8220**	**271.02**
Aves-unidentified											2	1.23	3	2.18	9	8.22	2	0.30	4	1.56	20	13.49
c.f. *Anas spp.*											1	0.31									1	0.31
Total bird											**3**	**1.54**	**3**	**2.18**	**9**	**8.22**	**2**	**0.30**	**4**	**1.56**	**21**	**13.80**
Total in 1975-1976	**3**	**31.68**	**255**	**23.75**	**1570**	**166.92**	**366**	**279.66**	**29**	**233.88**	**2916**	**154.84**	**1039**	**162.41**	**1827**	**218.26**	**359**	**420.65**	**61**	**79.32**	**8425**	**1771.37**
2005																						
Mammalia-unidentified			2	0.32	1	0.08			2	0.17			4	0.97			2	0.32			11	1.86
Phoca sibirica																	3	3.52			3	3.52
Total mammal			**2**	**0.32**	**1**	**0.08**			**2**	**0.17**			**4**	**0.97**			**5**	**3.84**			**14**	**5.38**
Pisces-unidentified									2297	29.52			1647	15.86	1275	9.41	4118	26.23			9337	81.02
Cyprinidae									135	4.7			126	2.08	67	1.48	374	6.14			702	14.40
Rutilis rut. lacustris									9	0.08			7	0.40	2	0.27	5	0.24			23	0.99
Leuciscus leucis.													2	0.02			5	0.06			7	0.08
Coregonus spp.									6	0.07			10	0.09	8	0.12	5	0.06			29	0.34
Perca fluviatilis									449	22.01			194	7.46	94	2.70	440	16.74			1177	48.91
Esox lucius													3	0.11	7	0.41	5	0.21			15	0.73
Total fish									**2896**	**56.38**			**1989**	**26.02**	**1453**	**14.39**	**4952**	**49.68**			**11,290**	**146.47**
Total in 2005			**2**	**0.32**	**1**	**0.08**			**2898**	**56.55**			**1993**	**26.99**	**1453**	**14.39**	**4957**	**53.52**			**11,304**	**151.85**
Total 1975-76. 2005	**3**	**31.68**	**257**	**24.07**	**1571**	**167.00**	**366**	**279.66**	**2927**	**290.43**	**2916**	**154.84**	**3032**	**189.40**	**3280**	**232.65**	**5316**	**474.17**	**61**	**79.32**	**19,729**	**1923.22**

Table 5.3. Modified faunal specimens at Ityrkhei.

Layer	Taxa	Element	Description	#	Figures
IV	Mammal	bone	composite fishhook	1	4.5–3
	Mammal	bone	worked	1	
	Mammal	bone	anthropomorphic fugura	1	4.5–1
	Artiodactyla	antler tip	fish net needle	1	4.5–5
	Cervus elaphus	left proximal scapula	longitudinal cut mark	1	
	Total			**5**	
V	Mammal	long bone fragment	worked	1	
	Total			**1**	
VI	Bird	unidentified	awl	1	4.5–6
	Total			**1**	
VII	Mammal	bone	unilateral and bilateral insert tools	4	4.5–8. 9
	Mammal	metapodial?	worked. longitudial cut mark	1	
	Mammal	scapula	knife with one blade	1	4.5–10
	Total			**6**	
VIII	Mammal	bone	tool fragment	1	
	Mammal	long bone metapodials?	unilateral insert tool	6	
	Mammal	bone	tool fragment?	1	
	Mammal	bone	worked	3	
	Artiodactyla	antlers	4 have cut marks. 2 applicable to each other	5	
	Total			**16**	
IX	Artiodactyla	antler	worked by longitudinal cut marks	1	
	Capreolus pygargus	proximal phalanx	distal part is cut	1	4.5–7
	Mammal	bone	worked	1	
	Mammal	bone	unilateral 2 barbed harpoon laterally notched for the line attachment	1	4.5–2
	Total			4	
Total				**33**	

Table 5.4. Skeletal element frequencies for *Perca fluviatilis*.

Element	**Early Bronze Age**	**Developed Neolithic**			**Early Neolithic**			**Late Mesolithic**				**Middle Mesolithic**	**Total NISP**
by excavation	**1970s**	**1970s**	**1970s**	**2005**	**1970s**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	
by layer	I	II	III	IV	V	VI	VI	VII	VII	VIII	VIII	IX	
Head elements													
Alisphenoid							2				4		**6**
Angular		5		26	25	8	8	14	2	3	11		**102**
Basioccipital				2	3	2	2	3	1		6		**19**
Ceratohyal				10	10	2	3	2			3		**30**
Dentary		5	4	25	28	8	6	9	1	4	7	1	**98**
Ectopterygoid		2		1	1			1			1		**6**
Epihyal				9	8	3	4	3			4		**31**
Epiotic				1	1			1			3		**6**
Exoccipital				1	4	1	1	4			6		**17**
Frontal	6	10	3	11	46	17	2	6		4	9	2	**116**
Hyomandibular		3		8	10	5	1	6	1		1		**35**
Hypohyal				2							2		**4**
Interopercle		3		6	9	2		6			2		**28**
Maxilla		3		23	15	9	11	6			8		**75**
Mesopterygoid		4		8	8		4	2		1	6		**33**
Metapterygoid				1	1		1						**3**
Nasal					1								**1**
Opercle	4	10	2	19	52	14	4	8		2	3		**118**
Opisthotic						1	1	1			4		**7**
Otolith	2	1		1				1					**5**
Palatine		1		9	5		1	2			1		**19**
Parasphenoid	1		1	5	5		5	1		2	3	1	**24**
Pharyngeal plate				1									**1**
Premaxilla	1	2		19	4	4	4	6	4	3	11		**58**
Preopercle	3	3	2	29	47	11	15	13	4	6	6		**139**
Prootic				1		2	1	5	1				**10**
Pterotic				3	4	3		2			2		**14**
Quadrate		13		21	11	11	8	11	2		9		**86**
Sphenotic									2				**2**
Subopercle				3	8	3		9	2		1		**26**
Supraoccipital				2	1	2	1	5	1				**12**
Urohyal				2	1		1				2		**6**
Vomer		4		5	6		4	2	3		3	1	**28**
Pectoral girdle													
Cleithrum		1	6	9	25	6	4	8		7	1	2	**69**
Coracoid				1									**1**
Mesocoracoid?											11		**11**
Postcleithrum											2		**2**
Posttemporal	4	7		17	10	1	7	5	4		14	1	**70**
Scapula		1		2		1		2	1		5		**12**
Supracleithrum	1	11	1	25	25	8	9	2	4	1	9	1	**97**
Pelvic girdle													
Basipterygium		1		11	19	4	1	9		1	6		**52**
Vertebral column													
atlas		5		4	2	1	8	2	9		8		**39**
vertebrae	1	36	2	120	125	79	73	125	51		249	1	**862**
Unidentified		6		8	5	1		3	1	1	17		**42**
Total NISP	**23**	**137**	**21**	**451**	**525**	**209**	**192**	**285**	**94**	**35**	**440**	**10**	**2422**
Total by subperiod	23			609			926				854	10	
Total by period	**23**						**1535**					**864**	

Table 5.5. Skeletal element frequencies for Cyprinidae (including *Rutilis rutilis lacustris* and *Leuciscus leuciscus baicalensis*).

Element	**Developed Neolithic**			**Early Neolithic**			**Late Mesolithic**				**Total NISP**
by excavation	**1970s**	**1970s**	**2005**	**1970s**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	**2005**	
by layer	**II**	**III**	**IV**	**V**	**VI**	**VI**	**VII**	**VII**	**VIII**	**VIII**	
Head elements											
Angular			1			4		3		22	**30**
Basioccipital			3	5	3		1	1		9	**22**
Ceratohyal			7	3	1	2		4		24	**41**
Dentary			7	1	2	2		1		10	**23**
Epihyal										8	**8**
Frontal	1		8	2					1	5	**17**
Hyomandibular	1		8	5	4	1	3	2	1	15	**40**
Hypohyal							1				**1**
Opercle	2	1	8	11	3			1		8	**34**
Parasphenoid				1		1		1	1		**4**
Pharyngeal plate	2	2	27	52	34	41	5	16	4	85	**268**
Premaxilla			4	2				2		11	**19**
Preopercle			2	1					1	1	**5**
Prootic						1					**1**
Quadrate			2		2	2		2		20	**28**
Sphenotic			2								**2**
Supraoccipital				1						1	**2**
Urohyal			4	1	2		1				**8**
Vomer										2	**2**
Pectoral girdle											
Cleithrum	1	1	8	6	2	2	1		1	1	**23**
Coracoid			2								**2**
Scapula			1			1				10	**12**
Supracleithrum			1							4	**5**
Pelvic girdle											
Basipterygium			6	1	2	4		2		9	**24**
Vertebral column											
atlas			6	4	2	7		3		8	**30**
vertebrae		1	29	54	54	67	5	28		106	**344**
Unidentified			6			2		3		25	**36**
Total NISP	**7**	**5**	**142**	**150**	**111**	**137**	**17**	**69**	**9**	**384**	**1031**
Total by subperiod			154			398				479	
Total by period						**552**				**479**	

Table 5.6. Skeletal element frequencies for *Esox lucius*.

Element	**Developed Neolithic**		**Early Neolithic**			**Late Mesolithic**				**Middle Mesolithic**	**Total NISP**
by excavation	**1970s**	**1970s**	**1970s**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	
by layer	II	III	V	VI	VI	VII	VII	VIII	VIII	IX	
Head elements											
Angular			2	2							**4**
Basioccipital										1	**1**
Dentary			6	1		2		3			**12**
Frontal			1								**1**
Hyomandibular								1			**1**
Maxilla								1			**1**
Parasphenoid				1				1			**2**
Preopercle	1					1					**2**
Subopercle			1								**1**
Pectoral girdle											
Cleithrum		2	1	1							**4**
Vertebral column											
vertebrae		1	15	5	3	1	7		5	2	**39**
Unidentified			3	1							**4**
Total NISP	**1**	**3**	**29**	**11**	**3**	**4**	**7**	**6**	**5**	**3**	**72**
Total by subperiod		4			43				22	3	
Total by period					47					25	

Table 5.7. Skeletal element frequencies for *Coregonus* spp.

Element	**Developed Neolithic**		**Early Neolithic**		**Late Mesolithic**				**Total NISP**
by excavation	**1970s**	**2005**	**1970s**	**2005**	**1970s**	**2005**	**1970s**	**2005**	
by layer	II	IV	V	VI	VII	VIII	VIII	VIII	
Head elements									
Interopercle				1			4		**5**
Opercle							12		**12**
Premaxilla							1		**1**
Vertebral column									
vertebrae	4	6	96	9	27	8		5	**155**
Total NISP	**4**	**6**	**96**	**10**	**27**	**8**	**17**	**5**	**173**
Total by subperiod		10		106				57	
Total by period				116				57	

Table 5.8. Sum of skeletal element frequencies for Itrykhei fish taxa.

Element	***Perca fluviatilis***			**Cyprinidae**			***Esox lucius***			***Coregonus* spp.**			**Total NISP**
by excavation	**1970s**	**2005**	**Total**	**1970s**	**2005**	**Total**	**1970s**	**2005**	**Total**	**1970s**	**2005**	**Total**	
Head elements													
Alisphenoid		6	**6**										**6**
Angular	55	47	**102**		30	**30**	4		**4**				**136**
Basioccipital	8	11	**19**	9	13	**22**	1		**1**				**42**
Ceratohyal	14	16	**30**	4	37	**41**							**71**
Dentary	59	39	**98**	3	20	**23**	12		**12**				**133**
Ectopterygoid	4	2	**6**										**6**
Epihyal	14	17	**31**		8	**8**							**39**
Epiotic	2	4	**6**										**6**
Exoccipital	9	8	**17**										**17**
Frontal	94	22	**116**	4	13	**17**	1		**1**				**134**
Hyomandibular	24	11	**35**	14	26	**40**	1		**1**				**76**
Hypohyal		4	**4**										**4**
Interopercle	20	8	**28**	1		**1**				4	1	**5**	**34**
Maxilla	33	42	**75**				1		**1**				**76**
Mesopterygoid	15	18	**33**										**33**
Metapterygoid	1	2	**3**										**3**
Nasal	1		**1**										**1**
Opercle	92	26	**118**	17	17	**34**				12		**12**	**164**
Opisthotic	2	5	**7**										**7**
Otolith	4	1	**5**										**5**
Palantine	8	11	**19**										**19**
Parasphenoid	11	13	**24**	2	2	**4**	2		**2**				**30**
Pharyngeal plate		1	**1**	99	169	**268**							**269**
Premaxilla	20	38	**58**	2	17	**19**				1		**1**	**78**
Preopercle	85	54	**139**	2	3	**5**	2		**2**				**146**
Prootic	7	3	**10**		1	**1**							**11**
Pterotic	9	5	**14**										**14**
Quadrate	46	40	**86**	2	26	**28**							**114**
Sphenotic		2	**2**		2	**2**							**4**
Subopercle	20	6	**26**				1		**1**				**27**
Supraoccipital	8	4	**12**	1	1	**2**							**14**
Urohyal	1	5	**6**	4	4	**8**							**14**
Vomer	13	15	**28**		2	**2**							**30**
Pectoral girdle													
Cleithrum	48	21	**69**	12	11	**23**	4		**4**				**96**
Coracoid		1	**1**		2	**2**							**3**
Mesocoracoid		11	**11**										**11**
Postcleithrum		2	**2**										**2**
Posttemporal	28	42	**70**										**70**
Scapula	4	8	**12**		12	**12**							**24**
Supracleithrum	50	47	**97**		5	**5**							**102**
Pelvic girdle													
Basipterygium	34	18	**52**	3	21	**24**							**76**
Vertebral column													
atlas	10	29	**39**	6	24	**30**							**69**
vertebrae	369	493	**862**	114	230	**344**	24	15	**39**	127	28	**155**	**1400**
Unidentified	16	26	**42**		36	**36**	4		**4**				**82**
Total NISP	**1238**	**1184**	**2422**	**299**	**732**	**1031**	**57**	**15**	**72**	**144**	**29**	**173**	**3698**

Table 5.9. Comparison of NISP and MNI values derived from fish 'head" elements and vertebrae.

Species	**% vertebrae out of total NISP**	**MNI on 'head' elements**	**MNI on vertebrae**	**'head' elements MNI: vertebrae MNI**
Perca fluviatilis	37.30	61 (R opercle)	21 (NISP 862/41 per individual)	2.9
Cyprinidae	36.86	39 (R pharyngeal plate)	8 (NISP 344/43 per individual)	4.9
Esox lucius	54.17	5 (L dentary)	1 (NISP 39/50 per individual)	5
Coregonus spp.	89.60	7 (R opercle)	3 (NISP155/61 per individual)	2.3

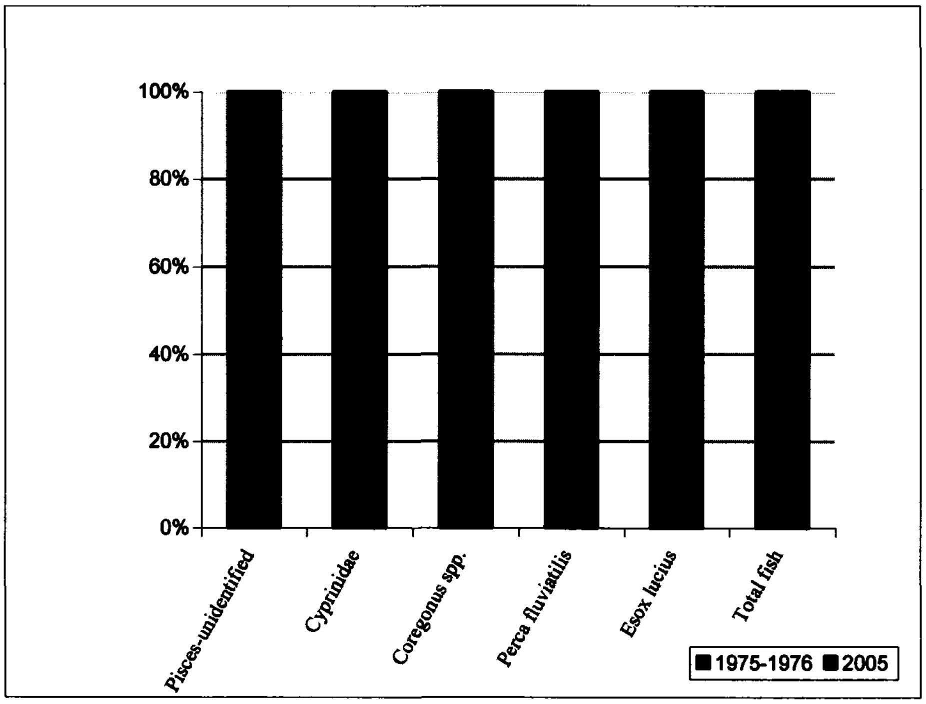


Figure 5.1: Percentages of total fish remains recovered at Ityrkhei in 1975–1976 and 2005.

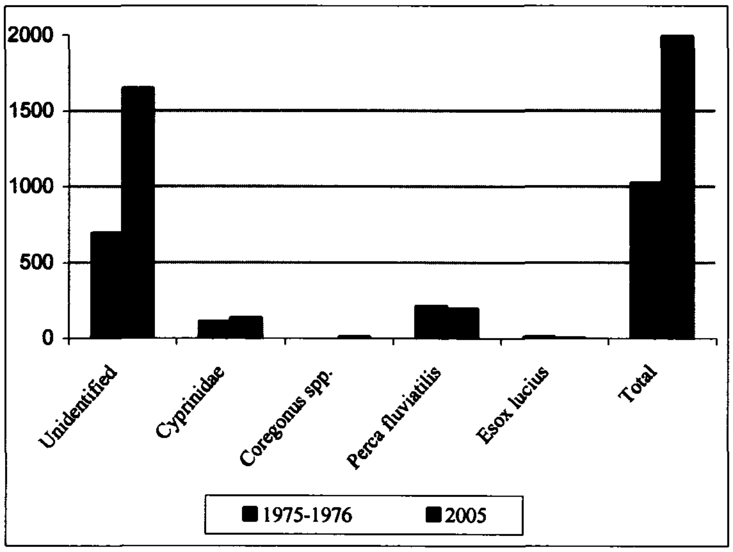


Figure 5.2: Comparison of fish taxa recovered from cultural layer VI at Ityrkhei in 1975–1976 and 2005.

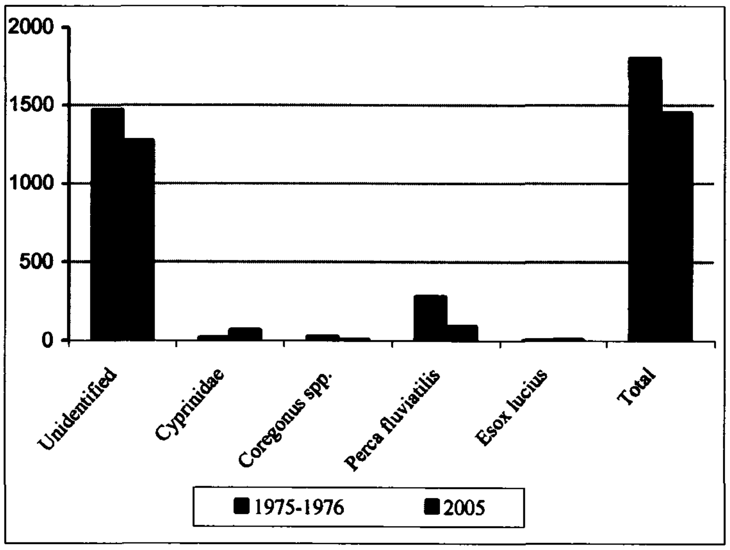


Figure 5.3: Comparison of fish taxa recovered from cultural layer VII at Ityrkhei in 1975-1976 and 2005.

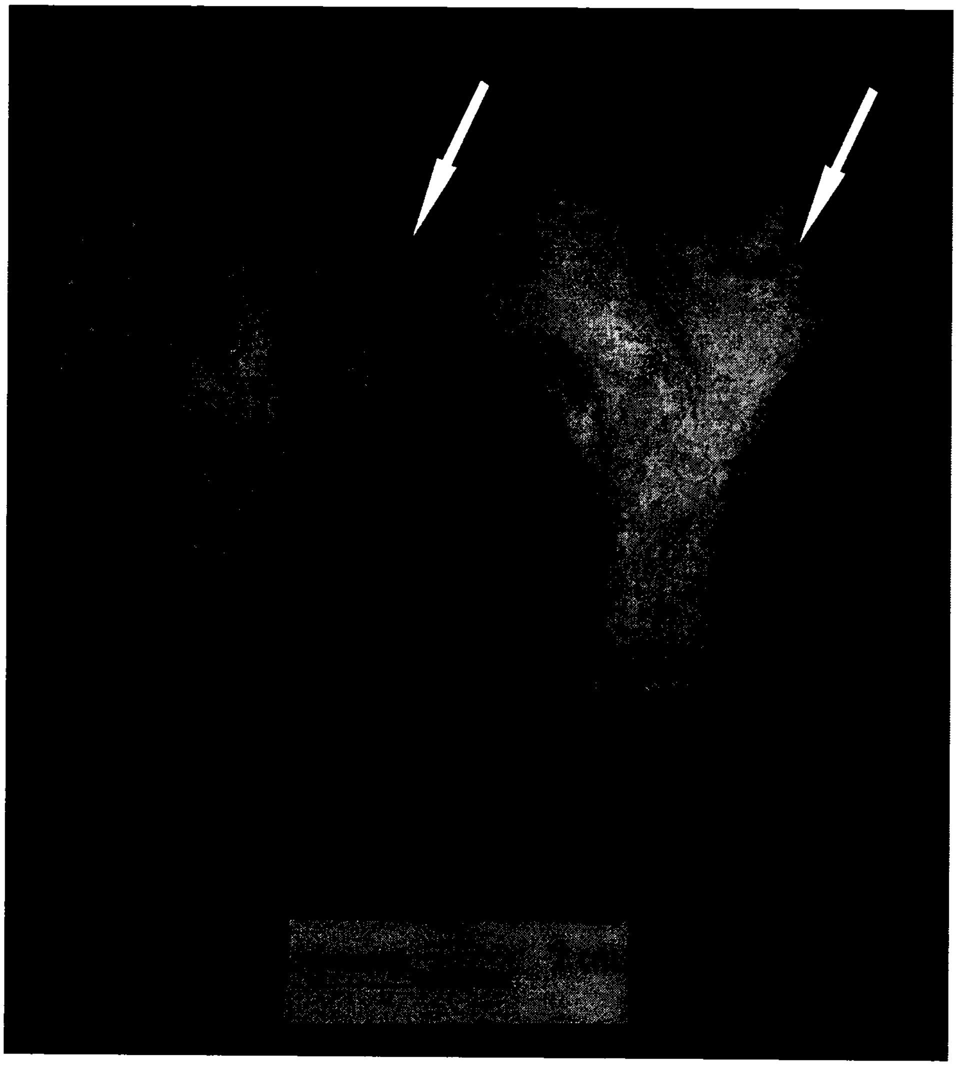


Figure 5.4: Carnivore gnawing on the seal bones from Ityrkhei (photo M. Metcalf).

Chapter 6
Discussion

In the discussion below, I use the data collected from the Ityrkhei faunal assemblage to reconstruct several aspects of subsistence activities undertaken at the site. Specifically, I discuss the kinds of fauna used, and the relative importance of the species utilized at the site. Following this, I examine the implications of the faunal data for fishing and hunting strategies, and explore the function of the Ityrkhei site itself.

6.1. Use of Fauna at Ityrkhei

The use of fauna at Ityrkhei can be studied in several different ways. Species diversity (after Gordon 1993) at Ityrkhei can be examined along two lines, namely taxonomic richness (number of taxa identified at site) and relative abundance of species (distribution of values among taxa). In terms of richness, the assemblage demonstrates that at least 12 taxa were utilized, including mammals (elk, roe deer, red deer, domesticated dog, wolverine and seal), birds (ducks), and fish (perch, pike, whitefish/omul', roach and dace).

Ityrkhei was clearly used during most chronological periods as a base for fishing. Fish remains dominated the faunal material, composing 98.89 % of the total specimens recovered. They were found in almost all layers except Iron Age layer 0. Most were recovered from Late Mesolithic through Developed Neolithic cultural deposits (Figure 6.1–6.2). During these periods, the Ityrkhei Cove was clearly being intensively fished. The most abundant species in these deposits were perch, which composed 66.5% of all identified fish bones (Figure 6.3), and dominated in layers IV–VIII (Late Mesolithic – Developed Neolithic). The next most common were cyprinids (mainly roach, with less dace) that comprised 27.9% of fish remains from layers II–VIII (Figure 6.3), and being nearly as abundant as perch in layer VIII (Figure 6.1). Whitefish/omul' comprised only 4.7% of remains from layers II and IV–VIII (Figure 6.3), and were slightly more abundant in layer V (Early Neolithic). Pike was the least common species, representing only 1.9% of remains from layers II–IX (Figure 6.1–6.3). When fish were being intensively harvested at Ityrkhei, the focus clearly was on species that regularly inhabit shallow, littoral areas of the Little Sea.

Mammals were also utilized, but in terms of raw number of recovered specimens, do not appear to have been nearly as important at the site as were fish. Mammal bones were found in all cultural layers, but predominantly in layer VIII (Figure 5.2). The most numerous Ityrkhei mammals were seals, recovered from layers II–IX, which date from the Middle Mesolithic to the Developed Neolithic (Figure 6.5). Bones of Artiodactyla were present in smaller quantities, and included red deer, roe deer, and elk. These species were found in almost all cultural layers with exception of layers V and VII. Bones of wolverine and domestic dog were identified in Iron Age and Developed Neolithic layers, respectively. Bird bones were found in Middle Mesolithic through Early Neolithic layers, but were never abundant (Figure 5.2).

The following patterns of change in species use through time can be observed (Table 5.2). The Middle Mesolithic layer (IX) contained few faunal remains, namely those of seal, roe deer, unidentified mammals, unidentified birds, and a few fish bones consisting mainly of perch and pike. Perhaps the site was only used for short periods of time during this period. Late Mesolithic layers (VII–VIII) differed substantially in the quantity of bones. There was no change in the composition of mammalian species, but in comparison with Middle Mesolithic layers, the number of fish taxa increased with the appearance of whitefish/omul' and cyprinids. The Late Mesolithic also witnessed an increasing rate of fish deposition at the site, probably marking the first period when Itrykhei was utilized as a base for relatively intensive fishing. In the Early Neolithic layers (V–VI), changes in species composition were not observed, but the Developed Neolithic layers (II–IV) were characterized by an increase in the number of mammalian species identified as red deer, elk and domestic dog. In the Early Bronze Age (I) and Iron Age (0) layers, a sharp decrease in the overall quantities of faunal remains and species diversity was observed.

Given the length of occupation at Ityrkhei and the different cultures inhabiting the Lake Baikal shores over this time, it seems reasonable to expect that the Ityrkhei faunal assemblage would show evidence of changes in patterns of animal exploitation during the

Holocene. Such does appear to be the case, as the data above demonstrate that layers IV–VIII contained the bulk of the animal bones, while layers II–III were characterized by substantially fewer remains, and layers 0–I contained only a few specimens. Additionally, in terms of relative species abundance, the Developed Neolithic layers (II–IV) had the highest taxonomic variety, specifically in regards to mammal composition. However, these data also indicate that during the most intensive period of site use (from 8000–4300 BP) there is little evidence for changes in species selection. As such, it seems that ancient groups were hunting, and especially fishing, in Ityrkhei Cove in a similar way throughout most of the Middle Holocene.

The only variation that exists at Ityrkhei in terms of both species composition and their relative abundances pertains to the Early Bronze and Iron Age layers. Specifically, there is a decrease not only in the quantity of faunal remains, but also in artefacts in general during these late periods (Goriunova 1984). This decline of animal remains and artifacts at the site suggests that for some reason Ityrkhei Cove was less intensively used by ancient populations beginning in the Early Bronze Age. However, the site is not particularly well-dated, and this apparent pattern must be interpreted with caution. Ityrkhei is only one of numerous Middle Holocene sites in the Little Sea area. The decline in the intensity of use at Ityrkhei may not be a valid indicator of settlement history for the entire region. For example, it is quite clear from stable isotope studies of Little Sea Bronze Age cemeteries (Katzenberg n.d.) that fish continued to be important in the regional diet throughout the Bronze Age and the presence of cemeteries themselves suggests the region was still intensively occupied during this period.

A decline in species diversity reported has been observed in the Lake Baikal area in other Late Bronze Age sites, and fish remains are reportedly absent from Late Iron Age deposits (Goriunova 1984; Goriunova 1987; Goriunova and Vorob'eva 1986; Khamzina 1991). Notably, this apparent shift in species diversity was not quantified in any way. Such patterns could be explained by broader changes in subsistence patterns occurring throughout this area of Eastern Siberia. The Bronze Age has commonly been associated with the beginnings of domestication in the broader region (Aseev 2003; Kharinskii 2005), particularly in areas to the east and southwest, while local Iron Age inhabitants were clearly pastoral nomads relying in part on animal husbandry (Dashibalov 1995). Neither the Bronze or Iron Age deposits at Itrykhei provide support for the presence of domesticated animals, but it is clear that the site was no longer being used as a residential base for fishing during these periods. However, given the dearth of detailed faunal analyses on assemblages from the Lake Baikal shore, it is quite unclear how important domesticated animals truly were among the region's Late Bronze inhabitants. Clearly, other late period faunal assemblages from this region are needed, and site chronologies need to be more thoroughly examined before any definitive statements can be made about trends in subsistence practices.

The decline in utilization of aquatic resources during these late periods is in many ways consistent with ethnographic subsistence patterns for the region. In general, most populations inhabiting the Lake Baikal area and adjacent territories that based their subsistence economy on the pastoralism looked upon fish with some disapproval. Such attitudes were shared by the Buriaty, Mongoly, Kazakhi, Iakuty, and other nomadic pastoral cultures (Tokarev and Gurvich 1956; Vainshtein 1980; Vyatkina 1956). The only Buriat group that engages in seasonal fishing parallel to their nomadic activities is that inhabiting the shores of Lake Baikal, including Ol'khon Island. Their fishing, however, was primarily a part of a market economy, where omul' were exchanged for other food products in the late 18th to early 20th centuries (Levin 1897; Mangutov 1965; Viatkina 1969; Zalkind 1970). Among other Siberian populations such as the Evenki, many people considered themselves hunters, and the role of fish in their diet was seen as supplementary and insignificant. Evenki fishing was undertaken mainly during the summer (Turov 1990; Vasilevich and Smoliak 1956). Therefore, archaeological and ethnographic data both suggest that certain resources, especially fish, became less important elements of subsistence strategies during the Late Holocene, perhaps coincident with the development of pastoral economies.

6.2 Fish exploitation

The behavioral and ecological characteristics of fish species identified at Ityrkhei as well as local fishery data can be helpful in understanding to what extent the ancient inhabitants of Ityrkhei Cove were selective in their choices of fish. These characteristics also shed light on the season of procurement and types of fishing technology used. The modern Little Sea is considered a food-rich area for schools of feeding fish, such as the roach, perch, pike, whitefish and omul' identified at Ityrkhei. Omul', for example, migrate to the Little Sea area in spring and summer, moving closer to the shore in the southern parts of Little Sea (at depths of 30–50 m) during May and June. Whitefish live in the Little Sea for most of the year at depths of 20–120 m, but during autumn they move towards the shores of Mukhor and Kurkut bays to spawn at depths of 2–4 m (Kozhov and Misharin 1958).

The seasonal distribution of whitefish and omul' in the vicinity of the Ityrkhei Cove, in combination with their infrequent occurrence at the site, is informative about season of occupation and fishing technologies employed. Omul' and whitefish are deepwater fishes and are procured by nets in the modern fishery. The rarity of these fish in the assemblage suggests that Coregonidae harvest at Ityrkhei was not a focal activity and their capture was of occasional and incidental character. The shallow water of Kurkut gulf (< 5 m deep) is generally not favorable for these deepwater species, except during their spawning period. Omul' are only present in the deeper regions of the Little Sea from March to July (Figure 6.7), but rarely enter waters shallower than 20 m (Kozhov and Misharin 1958). While a few individuals may have wandered into the Kurkut Gulf, their presence in appreciable numbers would have been restricted to March–July. Whitefish are the only species of Coregonidae that migrate to Mukhor gulf for spawning (Kozhov and Misharin 1958), and therefore also are possibly present in adjacent Kurkut Gulf (Figure 6.8). Their presence in these bays only in October-December suggest that exploitation of these fish (both omul' and whitefish) at Ityrkhei may have been limited to spring through late autumn.

Perch, roach, dace, and pike are year-round inhabitants of Ityrkhei Cove and other shallow bays in the Little Sea, and are caught today using hook and line as well as gillnets through the ice (Losey et al. 2007). Most are caught in spring with nets when the fish congregate to spawn (Kozhov and Misharin 1958). As such, the abundance of these fishes in the site may suggest a spring occupation, but certainly can not be used to eliminate occupation at any other season.

The Ityrkhei faunal assemblage is composed mainly of perch, with fewer roach/dace and trace amounts of pike, and whitefish or omul'. This species composition is quite similar to the ratio of harvested littoral species in modern catches in the Little Sea (see Figures 6.3 and 6.4), which is based on a gill-net fishery. The modern catch composition is also consistent with the ratios of identified species from pits of fish bones found in Ityrkhei cultural layers IV and VIII (Developed Neolithic and Late Mesolithic, respectively). These pits contained mainly perch, roach/dace, and trace amounts of pike and whitefish/omul'. A minimum of 23–24 individuals typically were present, perhaps reflecting a single catch, processing, and discard event. Previously these pits have been interpreted as storage containers for fish preservation (Novikov and Goriunova 2005). If these features were fish storage pits, then the fish remains excavated from them likely do not represent abandoned stored fish – the fish elements were completely disarticulated suggesting the fish were well-processed prior to deposition in the pits.

Pike and perch are the only species among those identified at Ityrkhei that are reportedly suitable for hook and line fishing (Sabaneev 1996). Cyprinidae, particularly roach, are reportedly more difficult to catch with hook and line, since they consistently have a sufficient food supply in the Little Sea, and are considered very inactive (Sabaneev 1996). In addition, their relatively small mouths require very small fish hooks (Sabaneev 1996). Very small hooks are also required for all of the whitefishes, as they also have very small mouths (Losey et al. 2007). In North America, aboriginal groups almost never captured whitefish with hook and line for this reason, preferring instead to fish with nets or traps (Rostlund 1952). Modern net fishery data from the Little Sea indicate that perch are usually caught in conjunction with cyprinids and pike, especially during their spawning periods. Techniques of mass capture, such as nets and traps, also are the most productive methods for harvesting cyprinids, especially during their spawning in May–June (Figure 6.6). As such, it seems that mass harvest technology such as nets or traps could have been used by the inhabitants of Itrykhei for capturing all of the identified fishes.

Needs-Howarth (1999:35) states that, "fish may be found together in [a] deposit because they inhabit the same waters and/or they spawn together and/or they [are] amenable to the same techniques of capture". Similarly, the fish species identified at Ityrkhei are all littoral fishes that inhabit the same waters and spawn roughly at the same time, suggesting they all could have been taken with a single form of technology, perhaps nets or traps. The reconstruction of perch size at Ityrkhei also provides some support for the use of mass harvesting technologies. There seems to have been some selectivity towards the harvest of perch, seemingly more than would be expected through the use of hooks alone (Losey et al. 2007). For example, almost no perch less than about 17 cm in total length were harvested at Itrykhei over the course of its occupation. If hook and line was the sole technology used, some smaller fish would almost certainly be present, as even a relatively large hook can be used to take smaller fish. While very small fish might be absent due to post-depositional taphonomic processes, the near complete absence of fish less than 17 cm in length over several thousand years of relatively intense fishing seems difficult to attribute solely to issues of preservation. Sooner or later it would be expected that elements from a few smaller fish would survive and be recovered. One could argue that smaller fish were simply caught and released, but such a process of selection would have had to have been consistent over thousands of years, which seems highly unlikely. A selective harvesting technology, such as nets or traps, seems the most straightforward explanation for this pattern. Recall too that only one fish hook shank was recovered from all of the deposits at Itrykhei, but multiple notched stones (interpreted as net weights) were present. If hooks were the sole technology used for fishing at Itrykhei, one might expect greater numbers of these tools to be recovered from the site.

In addition, the few whitefish/omul' recovered might have been taken accidentally by nets or traps during the spawning period of the littoral fish species more abundant in the sample. Given these data, the Ityrkhei assemblage is most consistent with fishing practice that focused on littoral species, and utilized a range of fishing technologies. Net or trap technology may have been used to catch the majority of fish found at Ityrkhei, especially in Late Mesolithic and Neolithic layers (Losey et al. 2007). Individual harvest technologies such as spears and hook and line were probably also used, but perhaps contributed far less to the overall fish assemblage than did the inferred mass harvesting technologies. Notably, the Middle Mesolithic and Bronze Age layers are represented by only a few fish bones of mostly perch and pike that could have been taken by hook and line, or any other individual harvest technologies. The use of mass harvesting technologies during these periods is not directly supported by my data.

6.3 Seal hunting

Phoca sibirica is the most abundant mammal at Ityrkhei in terms of NISP values. Seal remains included 54 specimens from minimum of 11 individuals, and were recovered from Mesolithic through Neolithic layers (9300–4300 BP). The seasonality of seal procurement at Ityrkhei was examined by Weber et al. (1998) as part of a larger study of seal use on Lake Baikal. This involved age determinations on seven Ityrkhei seal canines; one adolescent and six adults aged 9–19 years were identified (Table 6.1). Weber et al. (1998:224) argued that, in the context of the seasonal demographic pattern of seal distribution on the lake, these seal teeth suggest late spring to early summer hunting, mostly from March-April. Generally speaking, the Little Sea is not favorable for seals because of its shallow bays, thinner ice, and reportedly poor forage base. Only a few individuals stay in this region for winter (Pastukhov 1993; Petrov 1997; Weber et al. 1998). Seal mothers and pups concentrate in the east part of Lake Baikal in deep waters, while few sexually inactive males and adolescents of both sexes winter in Little Sea. If seal hunting had only occurred in the area of major seal congregations in the middle part of Lake Baikal, the demographic profile of killed seals at Ityrkhei would be skewed towards younger individuals and especially pups. The demographic data does not support this, because none of the seal bones were assessed as belonging to seal pups. Therefore, based on these data, the seal bones at Ityrkhei might represent occasional hunting of seals in the Little Sea, perhaps in the vicinity of the site.

Seal hunting is still practiced today by Buriats in the Priol'khon'e throughout the year (Zhambalova 1984), and this hunting provides them with meat, furs, and most importantly with fat/blubber (30–40 kg from one animal). Modern seal hunting techniques include clubbing, netting, and harpooning, depending on the season. When they are found in large concentrations during their spring sun basking, seals are clubbed. During the winter, they are speared through their breathing holes with harpoons, or ensnared in nets (Georgi 1777; Pallas 1788; Konopatskii 1982; Zhambalova 1984). All of these techniques are used during the spring, but in modern times seal procurement has concentrated mainly on pups because they are less mobile and cannot escape as quickly as their mothers (Zhambalova 1984). In terms of reconstructing seal hunting in Lake Baikal during the Holocene, harpoons are the only material evidence preserved at archaeological sites. Unfortunately, there is no clear differentiation between harpoons for sealing and those for fishing (Okladnikov and Konopatskii 1974/1975).

6.4 Resource exploitation in the Ityrkhei area

Biogeographic characteristics of animal species identified at Ityrkhei allow us to examine the habitats utilized by ancient inhabitants of the site. Overall, the people inhabiting Ityrkhei Cove exploited a 'standard' variety of species for the Priol'khon'e, relying most heavily on littoral fishes, seal, and deer. These species can be divided into two groups based on their preferred habitats, namely aquatic and terrestrial. The aquatic animals are represented by fish and seals. Fish are available all year in littoral habitats, but most may have been taken from spring through fall. Based on seasonality data, seals were likely hunted in spring and early summer. The trace presence of waterfowl remains at Itrykhei could also be an indicator of a spring through fall occupation, as this is the only time when these birds are available in the region (Skriabin 1971).

With regard to terrestrial mammal habitat preferences, red deer, roe deer and elk are inhabitants of the forest steppe, taiga and mountain taiga (Lavov 1974). Red deer and roe deer are quite widespread in the Primorskii range (the western border of the Priol'khon'e) and formerly inhabited Ol'khon island (Smirnov 1968; Litvinov 1960). Elk also inhabit the Primorskii range, but are currently quite rare (Lavov 1974). Wolverines are also found in the taiga and mountain taiga. Although the ungulates migrate into the valleys in autumn and towards highlands in spring depending on winter snow depth (Smirnov 1968), these animals are considered year-round residents of the area (Liamkin 2002; Shvetsov et al. 1984). Thus, their presence in the Ityrkhei assemblage does not provide a clear indication of the season(s) of occupation. Given that all these species are found in the Little Sea area, their presence might suggest that the inhabitants of Ityrkhei occasionally hunted nearby enough that remains of the animals occasionally were transported to the site and deposited.

The only known factor that might have influenced the availability of different resources in the region is environmental change during the last ~10,000 years. Paleoenvironmental data from the Ityrkhei site (Table 6.2), surrounding regions in Priol'khon'e (Goriunova and Vorob'eva 1986; Vorob'eva et al. 1992; Vorob'eva and Goriunova 1997), and the Lake Baikal region in general (Bezrukova 1999; Karabanov et al. 2000; White 2006) may shed light on the role of Holocene environmental changes in shaping prehistoric subsistence patterns. Briefly, these changes are characterized by a general warming trend beginning during the Middle Holocene (8000–5000 BP), which correlates with Late Mesolithic to Neolithic layers at Ityrkhei (Table 6.2). The only observed 'instability' involves a change of cold and warm phases, and the subsequent aridization of the region during the end of the Middle Holocene to the beginning of the Late Holocene (4000–2800 BP) (Bezrukova 1999; Vorob'eva et al. 1992; Vorob'eva and Goriunova 1997).

Based on the paleoenvironment data, Bezrukova (1999) suggested vegetation complexes in the Prio'lkhon'e did not undergo major changes during the Holocene. The aridity of this region likely remained relatively constant throughout the Holocene. The only minor change in vegetation involved the spread of the forest on the bays' slopes, especially from ~6800–4500 BP (Bezrukova 1999:106–108). The general warming in the Middle Holocene that resulted in the expansion of the forests nearer to the lake's slopes (Bezrukova 1999) might have provided additional habitat for ungulates, which perhaps would have flourished in this patchwork vegetation. This might be reflected in the increase of terrestrial mammal species at the site during the Neolithic (~6800–4500 BP). Overall though, it seems that environmental changes in the region do not seem to correlate directly with any major shifts in the exploitation of terrestrial fauna at Itrykhei. Clearly, however, the chronological resolution of the site deposits limits such inferences.

On the other hand, subtle changes in the environment might have had a more significant effect on aquatic resources, particularly fish behavior and ecology (see White 2006 and references therein). In general, however, the Ityrkhei fish sample does not provide any supporting data for such changes, other than perhaps at the transition from the Middle to Late Mesolithic, and again with the onset of the Bronze and Iron Ages. These changes in fishing intensity and species composition could be attributed to a number of cultural and historical processes as well. Without additional dating of the site deposits, correlating environmental and cultural changes at Itrykhei will remain difficult.

6.5 Conclusion

In general, there is sufficient information to suggest that inhabitants of Ityrkhei exploited local habitats, probably those of the immediate site vicinity. The site appears to have been a seasonal habitation from which a number of resources were procured, in particular littoral fishes, seal and deer. It seems that hunting of the last two animals was more of an opportunistic affair, and that at least from the Late Mesolithic through the Neolithic, Itrykhei was primarily used as a base for intensive fishing. While the season(s) of occupation are not known with certainty, some data suggest occupation may have spanned from spring through fall. As was proposed earlier by Goriunova and Vorob'eva (1986), environmental changes appear to have had little effect on subsistence practices at the site, perhaps due to the stable food base provided by Lake Baikal. The Late Holocene changes in resource exploitation observed at Ityrkhei are most likely evidence of less frequent or less intensive site occupation due to the introduction of new subsistence strategies, particularly pastoralism.

Although most of the issues discussed in this chapter are conjectural to some degree due to the small sample size of the Ityrkhei faunal assemblage and the lack of comparative faunal assemblages from the area, the patterns of prehistoric subsistence discussed should prove useful in future analyses in the region. To investigate further prehistoric subsistence practices in the region, additional data on the temporal and spatial variability of faunal exploitation are needed. Directions for future work are addressed in the following chapter.

Table 6.1. Age and season of death determination for *Phoca sibirica* canines from Ityrkhei (after Weber et al. 1998).

Layer	Period	Age	Season
II	Developed Neolithic	09+	?
III	Developed Neolithic	19	March-April
IV	Developed Neolithic	01	May-June
V	Early Neolithic	16	June-July
VI	Early Neolithic	15+	?
VIII	Late Mesolithic	13+	?
VIII	Late Mesolithic	12+	?

Table 6.2. Paleoenvironmental reconstruction at Ityrkhei (after Goriunova and Vorob'eva 1986; Vorob'eva et al. 1992; Vorob'eva and Goriunova 1997).

Layer	Period	Deposits	Climate		Landscape/vegetation
			Thermal conditions	Moisture	
0	Iron Age	aeolian sands, dune	significant temperature decrease	aridization	cold, dry steppe, wormwood and lycopodium
I	Early Bronze Age	sandy loams with different degrees of humus content	interchange of cold and warm phases		meadow and wormwood steppe
II-IV	Developed Neolithic	Heavy humus sandy loams and loams	significant warming	gradual decrease of precipitation	meadow steppe and insular forests, maximum forest development (pine, Siberian pine, spruce)
V-VI	Early Neolithic				
VII-VIII	Late Mesolithic	Humus sandy loams and loams	warming		predominance of steppe and meadow steppe, appearance of insular light-conifers forests
IX	Middle Mesolithic	Middle humus sandy loams and loams	reduced temperature		predominance of open landscape with cold steppe, dwarf birch, wormwood and lycopodium

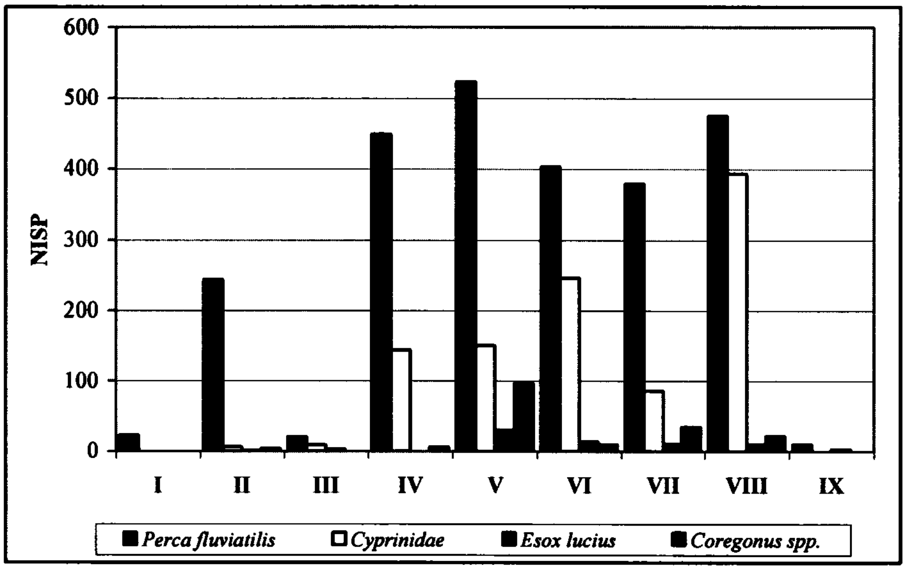


Figure 6.1: Comparison of fish composition by cultural layers.

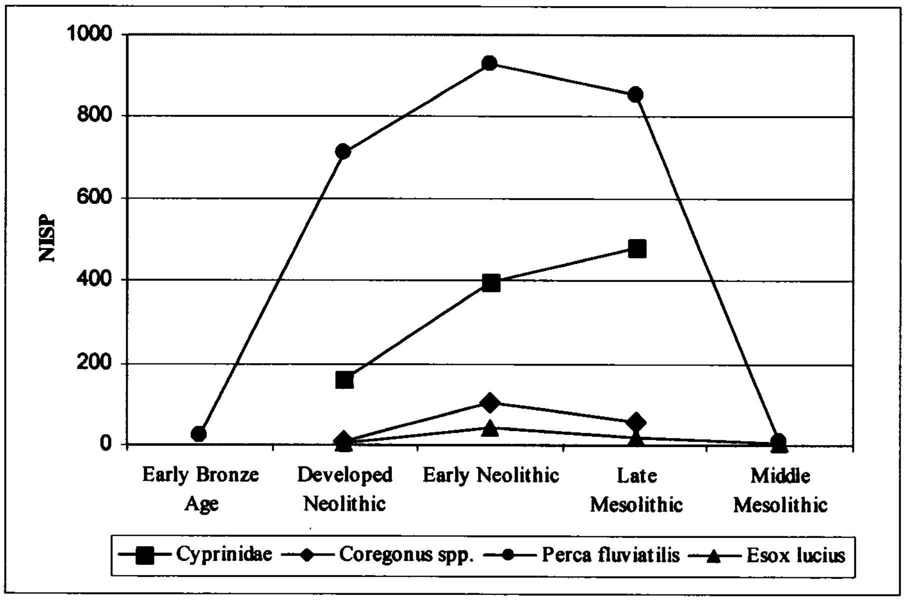


Figure 6.2: Comparison of fish composition by chronological periods.

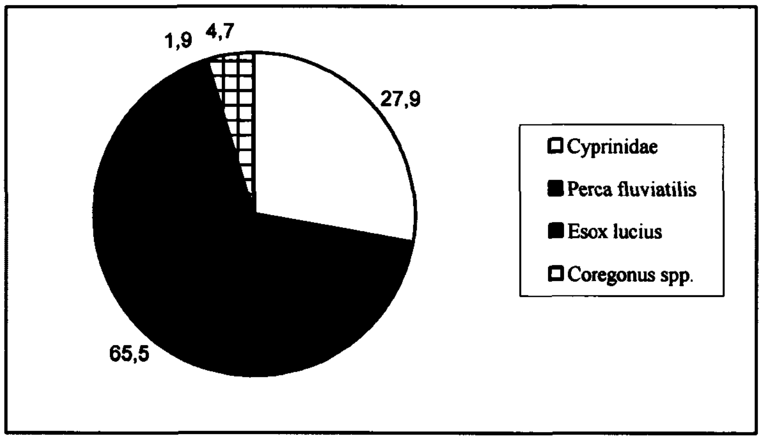


Figure 6.3: Ratio of total identified fish species at Ityrkhei, 1970s and 2005 sample combined.

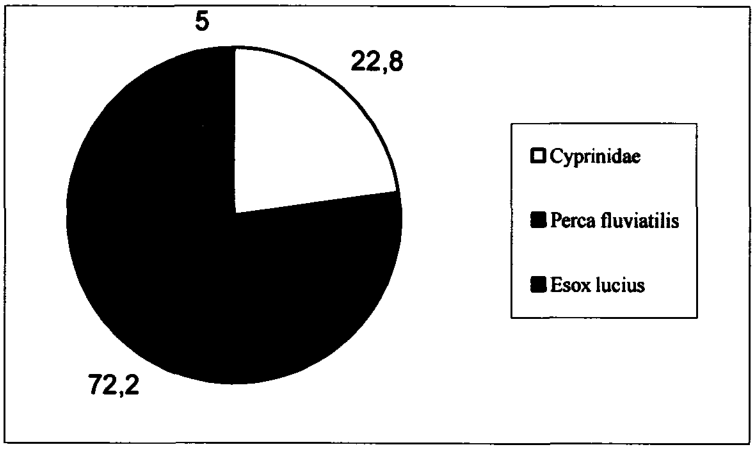


Figure 6.4: Ratio of annual fish catch in Little Sea (after Kozhov and Misharin 1958).

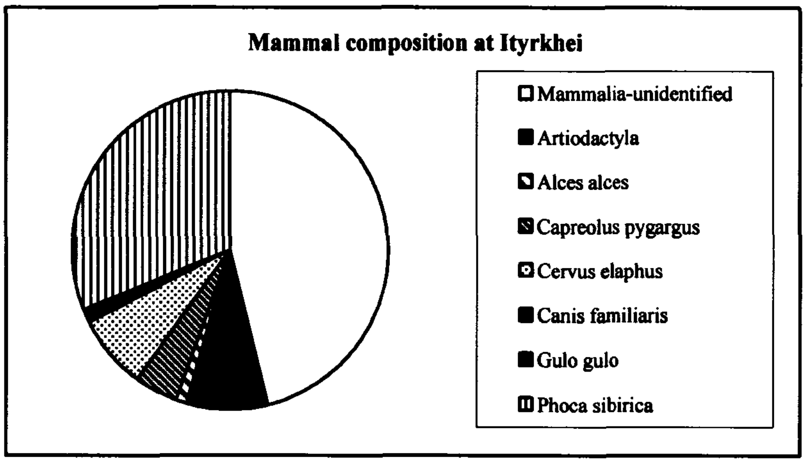


Figure 6.5: Relative abundance of mammal bones at Ityrkhei (NISP=198 specimens).

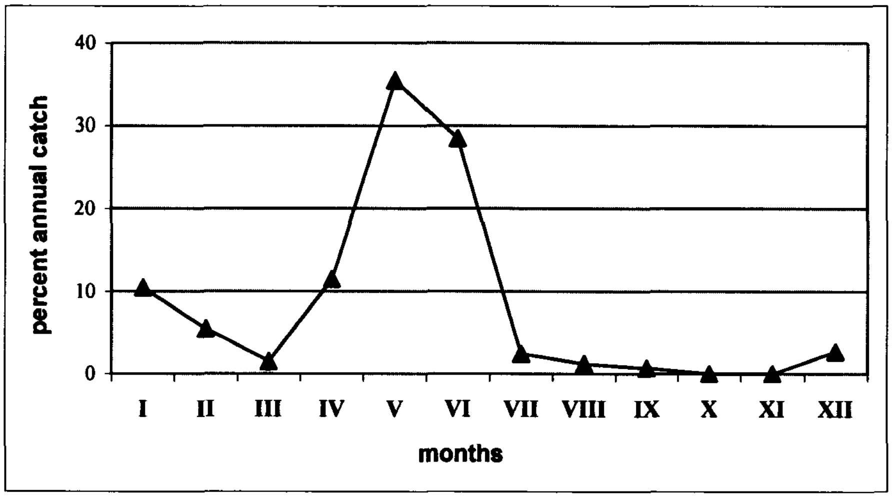


Figure 6.6: Roach catch in Little Sea region by month (after Kozhov and Misharin 1958).

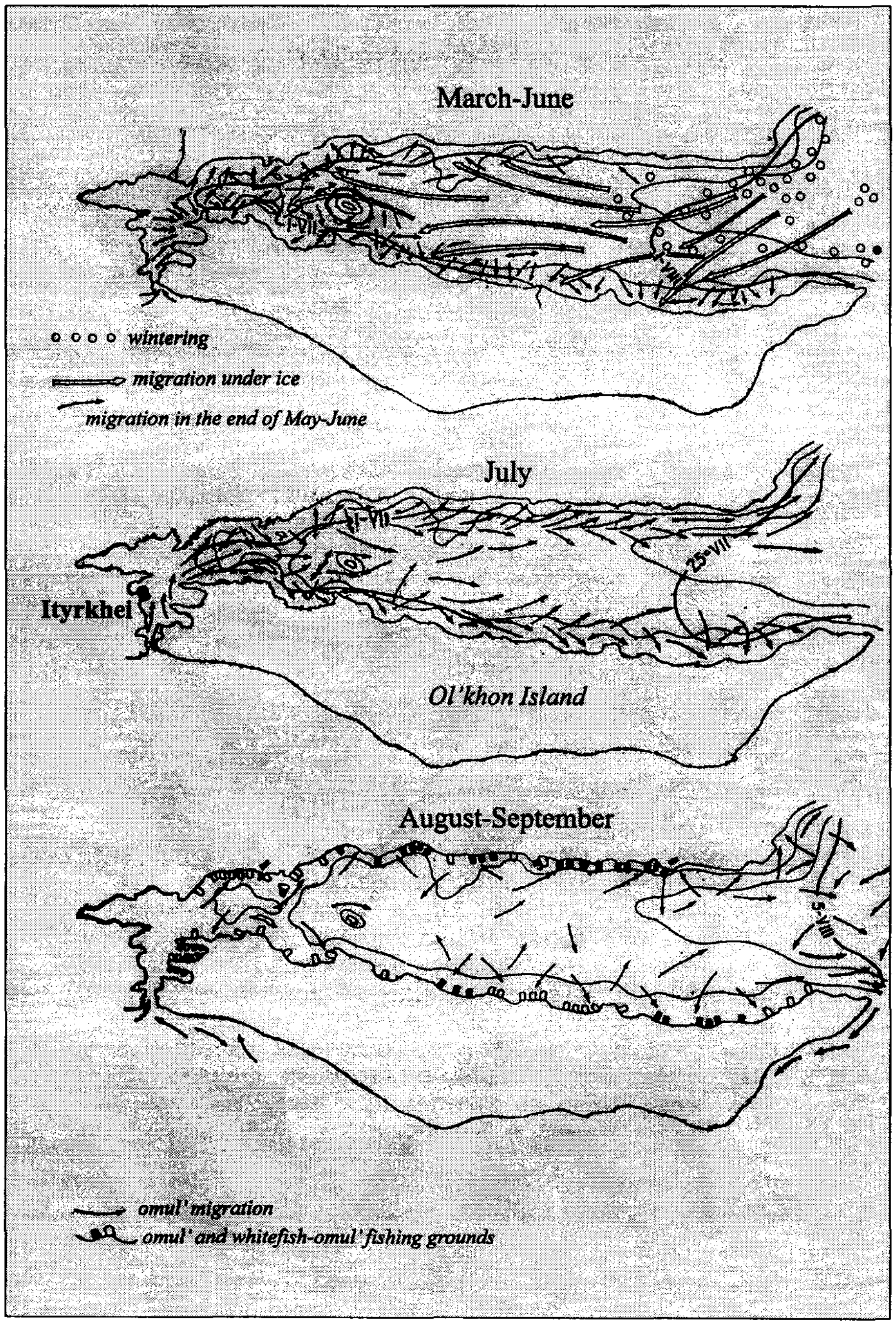


Figure 6.7: Seasonal omul' distribution in the Little Sea (after Kozhov and Misharin 1958).

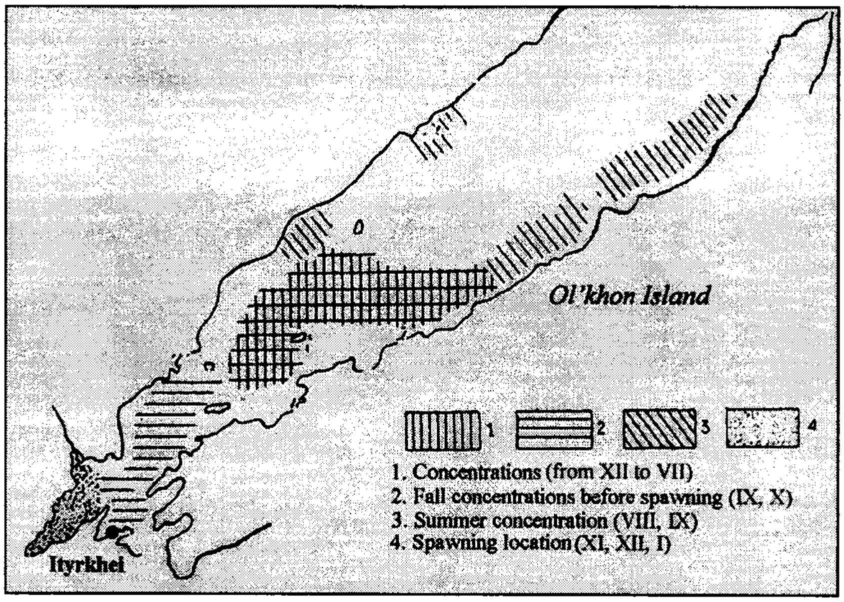


Figure 6.8: Seasonal whitefish distribution in the Little Sea (after Kozhov and Misharin 1958).

Chapter 7
Conclusion

This study has provided new data on the Ityrkhei faunal assemblage to aid in the reconstruction of ancient subsistence patterns in the Priol'khon'e and Lake Baikal regions in general. My research drew upon the analysis of archaeological faunal remains, ecological studies, and ethnographic data to examine subsistence adaptations at Ityrkhei over the past ~10,000 years. Overall, Ityrkhei can be characterized as a site where intense fishing for littoral species occurred, particularly from the Late Mesolithic through Neolithic periods. Fish constituted about 99% of the total assemblage, and the vast majority of the identified fishes were littoral species that today commonly inhabit shallow waters of the Little Sea. The remainder of the faunal specimens at this site is dominated by seal and deer, which are also locally accessible.

The research presented in this thesis contributes to the study of prehistoric subsistence practices in the Baikal area in several ways. It provides the first systematic analysis of faunal remains in the Lake Baikal region and demonstrates the potential of zooarchaeological data for addressing key issues in the region's archaeological history. The specific insights provided by this thesis are summarized below.

7.1 Ityrkhei data and previous research on the prehistoric subsistence practices

One common theme in previous examinations of fishing practices on Lake Baikal was the assumption that omul' were a major resource structuring the seasonal mobility of the Baikal's forager populations (Everstov 1988; Novikov and Goriunova 2005; Svinin 1976). My study revealed that almost all fish remains at Itrykhei were of littoral species available year-round near the site. Even if all Coregonidae elements at Itrykhei are from omul', they clearly are not present in substantial numbers (~5% of the identified specimens). This clearly indicates that fishing at the site did not focuse on these deep water fishes. People were here, at least in part, to fish for littoral species; omul' fishing was not drawing people to Ityrkhei.

Some scholars examined the role of fishing in the subsistence practices of prehistoric groups on the basis of the quantity of fishing gear found in archaeological sites (Everstov 1988; Georgievskaia 1989; Okladnikov 1950, 1955). Whitridge (2001) has suggested that the relative abundance of fishing gear in sites may not be an accurate indication of the overall importance of fishing in subsistence practices. In other words, the occurrence of fishhooks at archaeological sites in the region is not clear evidence of the degree of reliance on fishing among ancient groups. This can be seen at Ityrkhei. The site clearly was used as a base for intensive fishing, but only one fishhook was found at the site.

Among the species identified at Ityrkhei, roach and omul'/whitefish are the least suitable for hook and line fishing (Losey et al. 2007; Rostlund 1952; Sabaneev 1996). Therefore, the presence of bones of these species at archaeological sites is a possible reflection of the use of mass harvesting techniques such as nets and traps, technologies that do not preserve in most archaeological settings. The suggestion that nets were used by ancient Baikal populations is not new (see Petri 1926; Okladnikov 1950, 1955; Goriunova 1974, 1984; Georgievskaia 1989; Novikov and Goriunova 2005), and notched stones have long been used as evidence to argue for the use of nets on the lake. However, our study on harvested perch size at the site (Losey et al. 2007) and some of the data presented in this thesis, provide additional evidence that mass harvesting technologies were most probably used on Lake Baikal. One could also argue that such technologies were clearly needed to produce the high δN^{15} seen in human remains from the Lake Baikal area (Katzenberg and Weber 1999; Lam 1994; Weber et al. 2002).

7.2 Recommendation for future studies

More samples of faunal remains from sites in this region are necessary for a fuller understanding of prehistoric subsistence patterns. There is a need for both inter-site and intra-site faunal data from other sites in the Little Sea area (e.g., Berloga and Ulan-Khada) and elsewhere along the coast of Lake Baikal (e.g., Sagan-Zaba II and Tyshkine II and III) (Figure 1.2). While the available literature on these archaeological sites contains some information on the species present (Goriunova and Yaroslavtseva 1982; Khamzina 1991; Ovodov and Panychev 1982), this information cannot be used for comparative purposes for three main reasons. First, almost none of fish remains recovered from other sites in Priol'khon'e have been identified. Second, the existing faunal identifications need to be reassessed in a systematic and comprehensive way using standard zooarchaeological methods. For example, the preliminary identifications of the 1970s mammal bone sample from Ityrkhei by Khamzina (1990) are significantly different than the identifications reported in this study (comparison of identifications are provided in Tables 4.2 and 5.1–5.2). Therefore, it is important to emphasize again the need for the use of comparative osteological collections and a standardized methodology in zooarchaeological studies. Such collections need to be assembled for use by all scholars doing such work in the Lake Baikal region. Finally, none of the other sites in the region have been excavated and systematically sieved. This almost certainly results in samples that are biased towards large mammals and against small fauna such as fish.

Seasonality studies are of great importance in the reconstruction of prehistoric subsistence patterns (Casteel 1976; Colley 1990; Monks 1981; Reitz and Wing 1999). A number of attempts have been made to describe the subsistence of prehistoric inhabitants of the Lake Baikal shores. These attempts focused on the integration of animal behaviour characteristics with ethnographic records to develop regional schemes of seasonality and their relationship to proposed ancient foraging strategies (Aseev 2003; Khlobystin 1963; Konopatskii 1982; Okladnikov 1950; Svinin 1976). Despite this long-standing interest in the subject, almost no seasonality studies of faunal remains have been undertaken, with the exception of Weber et al. (1993, 1998) examination of seal canines. As such, there is a need for the application of additional methods for assessing the seasonality of site occupation in Lake Baikal archaeological sites.

Fish remains are potentially valuable sources of seasonal information due to the large number of recovered specimens (particularly scales, but also cranial elements) with incremental growth structures. Among the identified fish species at Ityrkhei, perch and cyprinids meet several important criteria for establishing seasonality. First, these littoral fishes are available throught the year in Lake Baikal. Second, the remains of these species are identifiable, generally well preserved, and could have been procured by ancient peoples throughout the year. The methods for such seasonality studies could be modified from the techniques used to examine seasonality of harvest of freshwater European fish developed by Crass-Hine and Jones (1969), Hofstede (1974), Le Cren (1947) and Steinmentz and Müller (1991).

Some additional work on the Itrykhei site is also necessary, as previously discussed in Chapter 4. First, additional radiocarbon dating is needed for Itrykhei and other habitation sites in the Lake Baikal area. Second, it is important to identify some of the fish remains, particularly the whitefish/omul', for the purposes of reconstructing fishing strategies and seasonality. The identification of these species appears to be very difficult based solely on osteological indicators, and only DNA analyses can potentially solve this problem (Nicholls et al. 2003; Politov et al. 2000; Sukhanova et al. 2004; Yong et al. 2004). Finally, more studies on the size of fish harvested at Itrykhei are needed. These studies have already been undertaken with perch remains at the site (Losey et al. 2007), but cyprinids and pike remains also need to be examined.

7.3 Concluding remarks

The research presented here represents only a small portion of the collaborative work undertaken by the Baikal Archaeological Project. This thesis is envisioned as a starting point for zooarchaeological research in the region. Research on faunal collections from other sites in Priol'khon'e, particularly Berloga and Ulan-Khada (Figure 1.2), began during the 2006 field season and should be completed in 2007. Ultimately, analyses of animal bones recovered from Ityrkhei and other archaeological sites in the area will provide information about diet, subsistence practices, seasonality, and mobility among the lake's inhabitants. Ultimately, this zooarchaeological research hopefully will be fully integrated with data derived from other studies conducted by the Baikal Archaeological Project, especially the stable isotope analyses. Together, these studies should contribute significantly to our understanding of the lives of foraging peoples of the Priol'khon'e and the broader Lake Baikal region.

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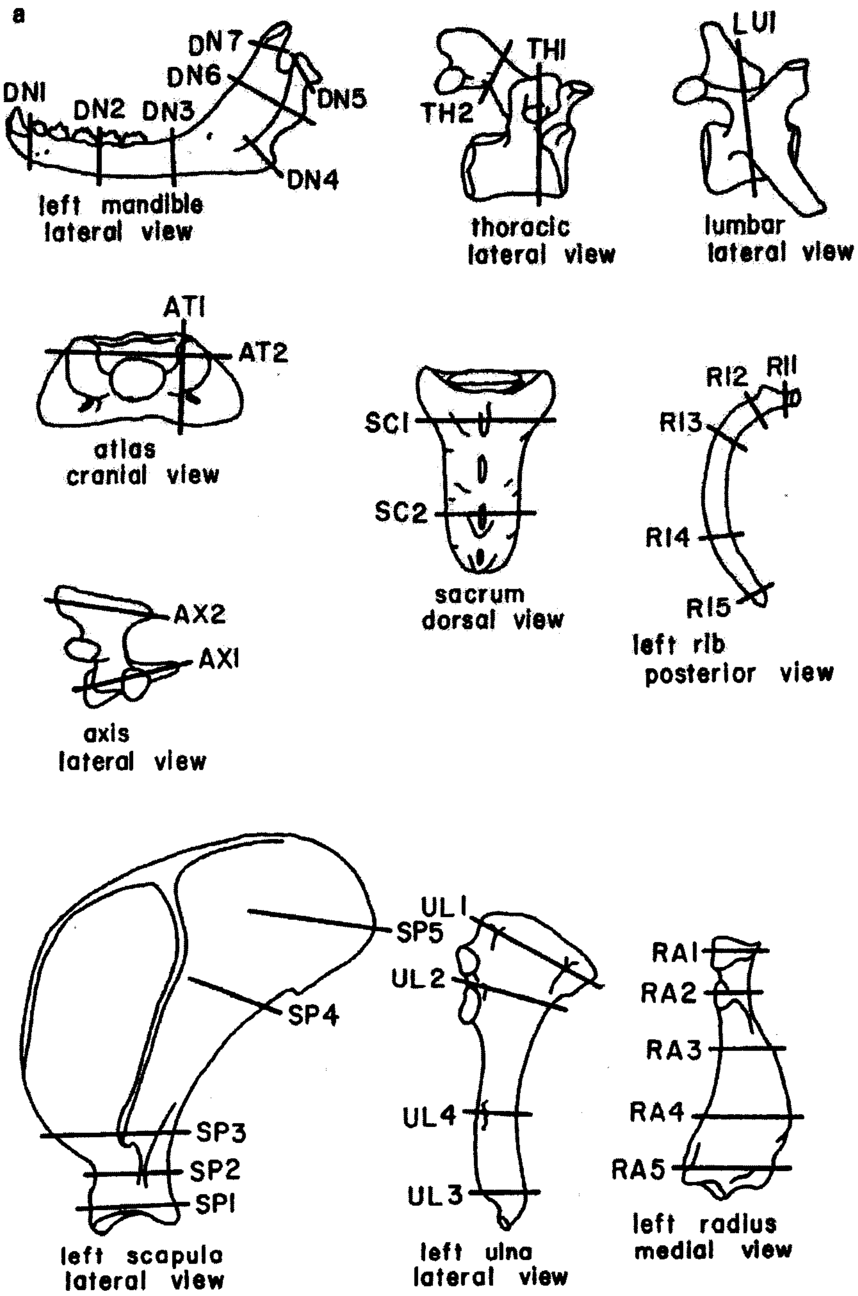
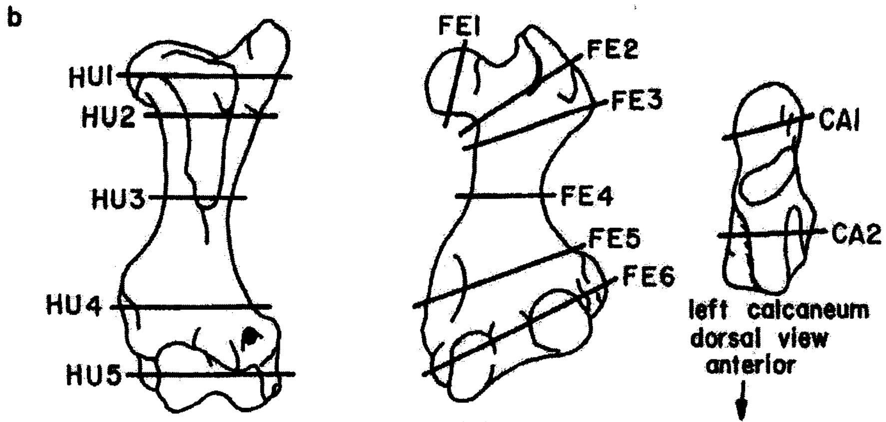
Appendix 1. List of specimens of BAP comparative collection in Irkutsk (2005–2006)

Latin name	**Common name**	**# of specimens**	**skeletal completeness**
Pisces			
Brachymystax lenok Pall.	Lenok	1	complete
Carassius auratus gibelio Bloch	Prussian carp	1	complete
Coregonus autumnalis migratorius Georgi	Baikal omul'	2	complete
Coregonus lavaretus baicalensis Dyb.	Baikal whitefish	1	complete
Esox lucius L.	Northern pike	2	complete
Leuciscus leuciscus baicalensis Dyb.	Siberian dace	1	complete
Lota lota L.	Burbot	1	complete
Perca fluviatilis L.	Freshwater perch	2	complete
Rutilus rutilus lacustris Pall.	Siberian roach	1	complete
Thymallus arcticus baicalensis Dyb.	Baikal black grayling	3	complete
Thymallus arcticus baicalensis brevipinnis Svet.	Baikal white grayling	1	complete
Cottocomephoridae spp.	Baikal sculpins	3	complete
Mammalia			
Phoca sibirica Gmelin	Baikal seal	2	1 complete, 1 skull
Ovis aries Linne	Domesticated sheep	1	complete
Citellus undulatus Pallas	Longtailed ground squirrel	2	1 complete, 1 partial
Microtus oeconomus Pallas	Tundra vole	1	complete
Apodemus peninsula T.	Korean field mouse	1	complete
Aves			
Larno sp.	Seagulls	1	partial

Appendix 2. Bone density scan sites for seal (after Lyman 1994; figure 7.6, 244–245)

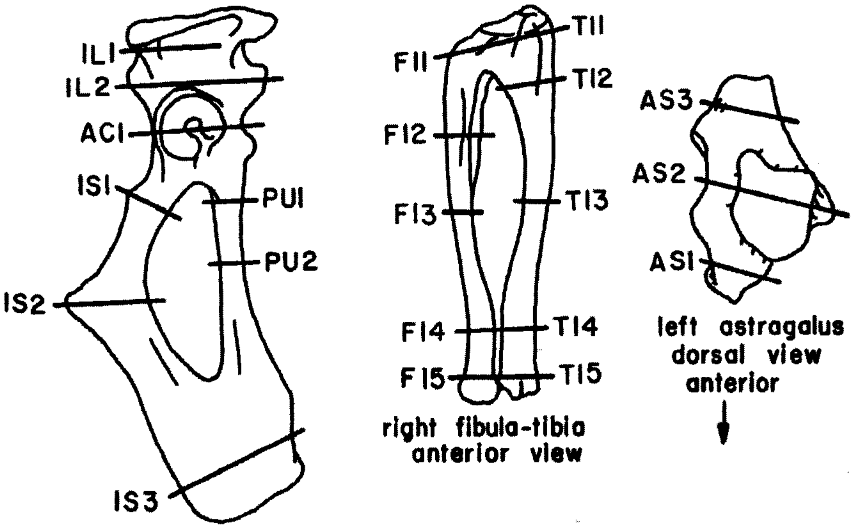




right humerus
anterior view

right femur
posterior view

left calcaneum
dorsal view
anterior



right fibula-tibia
anterior view

left astragalus
dorsal view
anterior

right innominate
lateral view