Resilience and the population history of the Kuril Islands, Northwest Pacific: A study in complex human ecodynamics

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Abstract

Living in remote places can strain the adaptive capacities of human settlers. It can also protect communities from external social, political and economic forces. In this paper, we present an archaeological population history of the Kuril Islands. This string of small volcanic islands on the margins of the Northwest Pacific was occupied by maritime hunting, fishing and gathering communities from the mid-Holocene to recent centuries. We bring together (1) 380 new and previously published archaeological radiocarbon dates, (2) a new paleodemographic model based on a radiocarbon-timestamped temporal frequency distribution of archaeological deposits, (3) recently published paleoclimate trends, and (4) recently published archaeological proxy evidence for changes in the extent of social networks. We demonstrate that, over the last two millennia, inhabitants of the Kuril Islands underwent dramatic demographic fluctuations. Explanations of these fluctuations are considered in the context of environmental hazards, social networks and the emergence of an East Asian “World System”, elucidating the tension between local and external adaptive strategies to social and ecological uncertainty. Results suggest that population resilience to local climate and environmental variability was achieved by virtue of social networks that maintained non-local support in times of crisis. Conversely, the expansion of the East Asian political economy into neighboring regions of the southern margin of the Kuril Islands perhaps in conjunction with exposure to epidemic diseases appears to have undermined the adaptive strategies, resulting in an increase in the vulnerability of Kuril populations to environmental fluctuations.

Keyword

Kuril Islands, Archaeology, Social Networks, Resilience, Paleodemography, Climate Change

1. Introduction

As humans we live in a world connected, in which interactions link us to others and to the environment in complex socio-ecological systems. With a case study from island Northeast Asia, this paper examines the interweaving of social and ecological systems and their operation at different spatial and temporal scales. We focus on an archaeological case of long-term persistence punctuated by episodes of population decline. The case is set in the Kuril Islands, a remote chain of volcanic islands in the Northwest Pacific. We provide a model that emphasizes the role of interacting social networks to understand population expansion and contraction in this chain of islands throughout the first and second millennia C.E. The study has implications for the sustainability of human occupation in insular environments and for understanding the benefits as well as vulnerabilities of more or less connected communities and the challenges of mitigating unpredictability in an increasingly complex and interconnected world.

2. Biogeography of the Kuril Islands

Stretching from Hokkaido to the Kamchatka peninsula, the Kuril archipelago contains approximately 32 islands ranging from 5 km² to 3200 km² with many smaller rocky islets and outcrops (see Fig.1). Larger landmasses and a paleogeographic history of connection to temperate ecosystems in Hokkaido in periods of lower sea levels have given the southern islands higher biological diversity than the central and northern islands of the chain (Pietsch et al., 2003). This includes a broad range of trees and shrubs (Anderson et al., 2008), terrestrial mammals (Hoekstra and Fagan, 1998), insects, mollusks and fish (Pietsch et al., 2001; 2003). The remote islands of the Kuril archipelago ("South-Central" and "North-Central" on Fig. 1) are geographically separated from the southern islands by the Bussol Strait, the largest open water strait in the island chain. The Bussol strait represents a significant geographic and climatic barrier to the migration of species from the southern islands to the more remote islands (Pietsch et al. 2003). While smaller and ecologically less diverse, the central and northern islands currently contain high abundances of birds and marine mammal populations, including Steller sea lions (Burkanov and Laughlin, 2005), harbor seals and sea otters.

Weather and climate are among the most significant challenges to life in the Kurils (Fitzhugh, 2012). The weather is strongly influenced by the maritime geography, proximity to strong ocean currents and broad North Pacific atmospheric dynamics (Rodionov et al., 2007). During winter months, the interaction between the Siberian High and Aleutian Low pressure systems forces cold air from the Asian continent over the Kurils producing frequent snowstorms (138 days per year on average) and stable snow cover from November until May (Ganzei et al., 2010; Leonov, 1990; Razjigaeva et al., 2008). During the summer, weather conditions are cool and moist with extensive fog cover (Razjigaeva et al., 2008). The interaction of the cold Oyashio current carrying water from the Bering Sea, the North Pacific and the warm Soya current carrying water

from the Sea of Japan make the Kuril Islands one of foggiest places on earth, averaging nearly 215 fog-days per year on some islands (Bulgakov, 1996; Razjigaeva et al., 2011; Tokinaga and Xie, 2009). While more pronounced in winter, large and violent storms are also common in summer bringing heavy precipitation, strong winds and storm surges (Bulgakov, 1996).

[Insert Figure 1: Kuril Map]

3. Cultural Occupation of the Kuril Islands

The Kuril Islands have been occupied periodically since at least the mid-Holocene—some islands earlier—and archaeologists have studied the culture history of the region for over 100 years (Fitzhugh et al., 2002; Kuzmin et al., 1998, 2012; Ohyi, 1975; Shubin, 1977, 1991; Stashenko and Gladyshev, 1977; Torii, 1919; Vasilevsky and Shubina, 2006; Yamada, 1999; Yamaura, 1998; Yanshina et al., 2009). Aside from the most recent Russian and Japanese settlement of the Kuril Islands, all cultural occupations were based on hunting and gathering of marine mammals, fish, birds, eggs and to a lesser degree shellfish (Fitzhugh et al., 2004). Seaweed, leafy greens, roots, and berries would have also been important despite their poor archaeological preservation (Krashenninikov, 1972). This diet is common to traditional hunter-gatherer cultures around the North Pacific Rim (W. Fitzhugh and Crowell, 1989).

3.1 Jomon and Epi-Jomon

Archaeologists have reported possible Palaeolithic remains from Kunashir, Iturup and Shumshu islands (Nomura and Sugiura, 1995; Tezuka, 2011, p. 170), but according to Kuzmin et al. (2012, p. 239) no Paleolithic “artifacts from undisturbed contexts have yet been recorded”. The earliest confirmed occupation of the Kurils is found on Iturup Island and dates between 7500-8000 cal BP (Yankito 1 and 2: Yanshina and Kuzmin 2010). This occupation is culturally associated with the late Initial/Early Jomon phase of Hokkaido (Yanshina and Kuzmin, 2010). Available evidence indicates that subsequent Early and Middle Jomon occupation was limited to the southernmost islands close to eastern Hokkaido. The sparseness of archaeological materials from those early, southern occupations suggests low populations densities. Because these islands have higher terrestrial mammal abundance and diversity compared to the islands farther north, we suspect that the earliest Jomon inhabitants maintained a more terrestrial orientation compared to later occupants who expanded into the central and northern islands by 3500 cal BP (below). The first prolonged occupation of islands northeast of the Bussol Strait occurred during the Late/Final Jomon period and persisted through the Epi-Jomon phase. The Epi-Jomon was an extension of the Jomon hunter-gatherer culture found in northern Honshu, Hokkaido and the Kurils at a time of expanding rice agriculture and iron usage in the Japanese mainland. Despite its name, the Epi-Jomon in northern Honshu and Hokkaido developed significant differences in subsistence and settlement patterns compared to the preceding Jomon period. In Hokkaido and the Kurils, coastal Epi-Jomon settlements intensified marine adaptations with improved harpoon technologies (H. Okada, 1998, pp. 336). The increased pursuit of sea mammals has been connected to the movement of Epi-Jomon culture into the

Kuril Islands (W. Fitzhugh and Dubreil, 1999), though we now know that central Kuril settlement started earlier (in the Late/Final Jomon phase), as the dates in this paper demonstrate. Indeed, from the limited evidence so far available, we see very few differences so far between Late Jomon and Epi-Jomon occupations in the Kurils. The earliest access to iron and rice dates to the Epi-Jomon period (Yamaura and Ushiro, 1999, p. 43) and by the mid first millennium (late Epi-Jomon in transition to Satsumon), swords, armor, and other rare goods were obtained by Hokkaido groups, suggesting an expanding interaction sphere reaching as far south as the Kofun state, based in the Osaka/Kyoto region (Yamaura and Ushiro, 1999, p. 43).

3.2 Okhotsk and Satsumon

Okhotsk people moved into the Kurils from Eastern Hokkaido about 1300 cal BP persisting for 500-600 years. In northern and eastern Hokkaido and the Kurils, the Okhotsk Culture is understood as the intrusion of a unique population or populations from the western Sea of Okhotsk who were largely distinct from people of the preceding Epi-Jomon Culture and their Satsumon descendants (Amano, 1979; Amano and Vasilevsky, 2002; Vasilevsky, 2005; Ono and Amano, 2007; Sato, et al. 2007, 2009; Deryugin, 2008). The Okhotsk specialized in marine mammal hunting with the use of complex harpoon technologies like those of contemporaneous cultures of the northern Bering Sea region (Chard, 1961; Befu and Chard, 1964). Okhotsk communities were often extensive with numerous, large houses, and in some areas (but apparently not the remote Kurils), Okhotsk communities built fortified settlements and engaged in intra-cultural warfare (Shubina, 1999; Samarin and Shubina, 2007). While Okhotsk groups eventually settled around the Sea of Okhotsk coast from Sakhalin to the Kurils, the Satsumon descendants of the Epi-Jomon in southern Hokkaido expanded millet cultivation and increased trade with northern Honshu. As a result, during the mid to late first millennium C.E., Hokkaido became divided into two spheres of influence: The Okhotsk shared cultural, ethnic and economic connections to the northwest, while the Satsumon were drawn increasingly, if indirectly, into the sphere of mainland Japan and its expanding political economy.

3.3 Tobinitai and Ainu

The Ainu emerged in the centuries after 1000 C.E. by a process now believed to involve assimilation of eastern Okhotsk populations into the Jomon-descendent Satsumon communities of southern and eastern Hokkaido (Hudson, 1999, 2004). A transitional culture, referred to as Tobinitai, developed in this region bringing together elements of Okhotsk and Satsumon traditions (Onishi, 2003; Vasilevsky and Shubina, 2006). In Hokkaido and southern Sakhalin, Ainu communities abandoned semi-subterranean pit dwellings for rectangular, above-ground structures, gave up pottery for ironware and made more of their tools from metal rather than stone. In the Kuril Islands and southern Kamchatka, Ainu groups retained the use of pit dwellings and pottery in a form emulating iron cookware used by Ainu elsewhere (Torii, 1919; Dikov, 2004; Takase, 2013), while using a greater range of iron implements than their predecessors. Ainu patterns of life and culture are more clearly influenced by contact with outside traders than were any prior groups in Hokkaido or the Kurils.

The Ainu and their ancestors had been mentioned in Japanese documents since the 8th century, but the first Russian records appear only in the early 18th century (from initial contact in the Northern Kurils) (Krasheninnikov, 1972). Ethnohistoric accounts describe a hunting, fishing and gathering culture with deep spiritual connection to the natural world (Bachelor, 1901; Etter, 1949). North of Urup Island, the Ainu in the Kurils are described as having a unique subculture with distinct dialect and practices (Snow 1897; Krasheninnikov, 1972; W. Fitzhugh 1999; Tamura 1999). From the 18th century, the Kuril Ainu were increasingly impacted by the expansion of Japanese and Russian competition, settlement and control of the Kuril chain (Walker, 2001; Tezuka, 2009). By the time of initial contact with Russians, Kuril Ainu were living in the northern and central archipelago and had influenced the material culture of the Pacific coast of Kamchatka from the southern tip at Cape Lopatka to Nalychevo Lake, 50 km north of Avacha Bay (Dikov, 2004). Dikov (2004) attributes the material culture from Ainu sites in this region to the later Ainu period, based on use of interior lugged pottery ("Naiji" ware)—a finding consistent with recent analysis by Takase (2013) and with the paleodemographic patterns from the Kurils reported below. Based on the continuity of lithic forms from prior Kamchatkan traditions, Dikov goes on to suggest these southern Kamchatkan sites may represent marriage of Ainu women into Kamchatkan (Old Itel'men) communities rather than wholesale settlement of Ainu immigrants. In the early 18th century, Krasheninnikov (1972) makes a similar suggestion that Ainu on Shumshu Island were inter-married with Kamchatkans of Itel'men (Kamchadal) ethnicity.

Caught between the expanding empires of Japan and Russia, the traditional culture of the Kuril Ainu had largely disappeared by the late nineteenth century (Stephan, 1974). Without ethnographic descriptions, the little information we have on Kuril Ainu lifeways comes from historical accounts of explorers and from interviews conducted with Ainu elders. Torii (1919) provides the most detailed account based on visits to the islands in the late nineteenth century. In the northern Kurils, Torii (1919, pp. 22-25) describes a system of seasonal migration between permanent villages on Shumshu, Paramushir and Rasshua islands and smaller fishing camps on Onkotan, Kharimkotan, Shiashkotan, Matua and Ushishir.

4. Paleodemography of the Kuril Islands

Archaeological survey and excavations conducted by the International Kuril Biocomplexity Project (IKIP) in 2000 and the Kuril Biocomplexity Project (KBP) between 2006 and 2010 generated a cultural radiocarbon database of 380 archaeological dates, recovered from locations extending across the 1100 km expanse of the chain from the island of Kunashir in the South to the island of Shumshu in the North (Figure 1, Table 1). These projects collectively documented 108 sites on the 16 largest islands throughout the chain. All sites were identified and tested through surface observation and collection, small shovel tests and/or examination of erosion profile exposures. Charcoal, fauna, artifacts and sediment samples (e.g., tephra) were collected from intact deposits from most sites and as many components as were encountered in excavation. Where house pits or other surface expressions were visible, site plans were prepared depending on available time (sketch maps, GPS maps, and transit maps; Fig. 2). At several large sites, stratigraphy was also recorded by means of 2cm diameter soil probes placed both in- and outside of house pit features. Charcoal found in the probes

was sampled from charcoal-rich ‘cultural’ strata, and several of the dates reported here come from these contexts (Table 2 for details). While most sites were documented and tested in less than a day of field research, eight sites were more intensively sampled through large-scale excavations over multiple days, involving crews of 10-15 people. These eight sites were notably large and exhibited numerous semi-subterranean house depressions (e.g., Fig. 2). It is likely that some of these sites are classifiable as “villages,” pending demonstration of the contemporaneity of their features—an issue we hope to address in a future publication. These sites were investigated to provide greater archaeological insights regarding site organization, chronological ranges and occupation intensity of sites ranging from Urup Island in the south to Ekarma Island in the north-central islands. These eight sites—arranged south to north—are Ainu Creek on Urup, Peschanaya Bay 1 on Chirpoi, Vodopadnaya 2 on Simushir, Rasshua 1 on Rasshua, Ainu Bay 1&2 (one site) on Matua, Drobnyye 1 on Shiashkotan, Ekarma 1&3 (one site) and Ekarma 2 on Ekarma. The northern islands of Shumshu and Paramushir and southernmost islands of Kunashir and Iturup were surveyed and several sites identified and tested, but no intensive testing was conducted in these regions by IKIP or KBP.

[Insert Fig. 2: Map of Drobnyye 1 site]

Nine hundred and forty six (946) organic samples were collected for the purpose of radiocarbon dating from 63 out of 108 sites recorded by IKIP and KBP, representing all 16 islands with archaeological discoveries. Three hundred and eighty (380) of these samples—from 57 sites—were submitted to the radiocarbon facilities at the University of Arizona (IKIP’s AA dates) and the Woods Hole Oceanographic Institute (KBP’s OS dates) for dating. Two hundred and twenty six (226) of these dates come from the eight intensively *sampled* sites identified above, the remaining 154 dates coming from the remaining 49 sites. Similarly, 237 dates come from the eight most intensively *dated* sites (these are those sites for which 10 or more dates were assayed, arranged from highest to lowest data frequency: Rasshua 1, Vodopadnaya 1, Drobnyye 1, Ainu Creek 1, Ekarma 1&3, Kama, Peschanaya Bay 1, and Baikova 1). As shown in Table 1, this sampling protocol was intended to balance between spatial coverage (dating the largest number of sites) and chronological depth (maximizing understanding of the occupation history of single sites). These dates were predominantly derived from wood charcoal, and the paleodemographic model presented below is based exclusively on 364 terrestrial wood charcoal samples, omitting two measured on marine mammal bone, three on charcoal indicating post-bomb ages, and eleven on charcoal collected from the Ainu Creek 1 site that are of questionable provenience due to site disturbance.

[Insert Table 1 here: frequency of dates by region]

One of IKIP-KBP’s chief objectives in compiling this radiocarbon database was to establish an empirical basis for modeling variability in Kuril human settlement intensity over time and space. Such models depend on the assumption that variations in the temporal frequency of archaeological deposits can be used as proxy measures of relative changes in human population size over time, under the simple assumption that

larger populations will tend to deposit a greater abundance of archaeological materials than small ones, all else being equal. This approach to census-taking has become increasingly common following Rick's (1987) study of pre-ceramic Peruvian population dynamics. This is especially true for Europe, North America, and Oceania in papers published over the last 15 years (e.g., Kirch and Rallu, 2007; Peros et al., 2010; Boulanger and Lyman, 2014; Downey et al., 2014; Timpson et al., 2014; Wang et al., 2014; Gayo et al., 2015; Tallavaara et al., 2015; Williams et al., 2015; Zahid et al., 2015; for inventories of the cumulating body of demographic temporal frequency analyses, see Surovell and Brantingham, 2007; Williams, 2012; Brown, 2015; Chaput and Gajewski, in press).

The validity of this approach requires that three conditions be met (Rick, 1987). First, the anthropogenic unit of observation that has been selected for temporal quantification (e.g., the site or site component, domestic feature, quantum of datable organic matter, etc.) must have been deposited at an approximately constant person-year rate over time within the study region, resulting in the formation of a temporal frequency distribution (*tfd*) that is approximately proportional to the region's population over time. Second, while the loss of archaeological deposits to destructive geological forces may be inevitable, those deposits that have survived must have resisted the operation of temporally variable—non-constant—destruction rates such as punctuated episodes of erosion or deep burial. Third, the researcher must collect and establish accurate chronometric control for samples of archaeological deposits in equal proportion to those that exist across the study region.

As fundamental as these three conditions are to the validity of demographic temporal frequency analysis, they are hardly guaranteed. On the contrary, multiple potential sources of error threaten to undermine the validity of such demographic interpretations (Rick, 1987; Brown, 2015: Table 2), particularly those that rely on the strong assumption of proportionality between the shape of the *tfd* and temporal fluctuations in paleopopulation size. The confounders on such analysis, which may be meaningfully divided into three overarching categories, have been widely discussed elsewhere (Rick, 1987; Surovell and Brantingham, 2007: 1869; Shennan et al., 2013: 3; Timpson et al., 2014: 550; Attenbrow and Hiscock, 2015: 32-34; Brown, 2015: Table 2) and need only be summarized here:

- Creation error: population size-independent fluctuations in the intensity of the original archaeological signal, resulting from temporal variability in the person-year rate at which archaeological deposits have been created (e.g., due to changes in mobility rates, aggregation or disaggregation of residential groups, etc.; Rick, 1987; Surovell and Waguespack, 2008; Downey et al., 2014);
- Preservation error: the differential preservation of archaeological deposits resulting from the operation of both random and systematic processes of deposit destruction (Rick, 1987; Surovell and Brantingham, 2007; Surovell and Waguespack, 2008; Surovell et al., 2009; Ballenger and Mabry, 2011);

- Investigation error: a wide variety of disproportionate representation factors intrinsic to the research process itself (Rick, 1987). These factors include the level of research intensity, which influences sample size and consequently the degree of random sampling error characterizing the sample *tfd* (Surovell and Waguespack, 2008; Shennan et al., 2013: 6; Timpson et al., 2014: 550; Brown, 2015: 135-136, 141); discovery or detection bias resulting from the application of particular field data recovery methods that are disproportionately sensitive to deposits of different ages (Ballenger and Mabry, 2011); inclusion or scientific bias resulting from the preferential timestamping of archaeological deposits from particular periods, whether because of the differential intensity at which different sites are dated and/or because sites from particular cultural periods are favored over those from others (Ballenger and Mabry, 2011); age misestimation resulting from the limitations of sample hygiene practices undermining the bridging arguments linking target and dated events (e.g., old wood and marine reservoir offsets; Dean, 1978; Schiffer, 1987; Shott, 1992; Batt and Pollard, 1996; Pettitt et al., 2003; Waters and Stafford, 2007; Kennett et al., 2008; Rieth and Hunt, 2008); and various idiosyncratic errors that characterize particular age estimation methods (e.g., those that uniquely affect ^{14}C -supported *tfd*s, summarized in Brown, 2015).

In light of these potential confounders, efforts to produce valid models of paleopopulation growth processes based on *tfd*s must attempt to prevent or at least mitigate their effects to the greatest degree possible. The following discussion describes the measures we have taken toward such ends.

To minimize the degree of target event-dated event disparities, IKIP-KBP field archaeologists focused on the recovery of datable organics that came from unambiguous anthropogenic deposits. As noted above, all dates included in this analysis are limited to those assayed on terrestrial wood charcoal. The “old wood effect” must be considered as a potential bias for dates run on charcoal, since factors like ocean residence time for driftwood, reuse of structural timbers and long-lived tree species can contribute to the artificial inflation of radiocarbon ages. In the study area, it is probable that island residents harvested driftwood for multiple uses, including fuel, in addition to harvesting locally available standing trees and shrubs. Other northern driftwood studies have indicated that logs rarely survive longer than seventeen months in the ocean (Häggblom 1982:Table 1; see Shaw 2008:80-81 for a summary), and long-term reuse of structural timbers is unlikely in this wet environment. The most significant old wood potential, therefore, stems from the burning of long-lived woody taxa – a problem common to most applications of radiocarbon analysis on tree charcoal.

To mitigate the potential effects of old wood on radiocarbon results, Jennie Shaw (n.d.) conducted a brief taxonomic analysis of charred wood fragments from three KBP sites (Rasshua 1, Vodopadnaya 2, and Ainu Creek; Fig. 3). Her analysis indicated that the central island residents of Rasshua 1 and Vodopadnaya 2 used a diverse mix of fuelwoods, including *Picea* (spruce), *Larix* (larch), *Salix* (willow), *Populus* (poplar), *Alnus*

(alder), and perhaps *Betula* (birch); whereas the more southerly site of Ainu Creek exhibited a reliance on *Pinus* (pine), with limited use of *Salix*. Modern and paleoenvironmental studies by Anderson and colleagues (2007) indicate that *Picea*, *Larix*, and *Populus* grew in the southern islands and likely arrived in the central islands as driftwood, while *Alnus* and *Betula* may have been harvested as local shrubs or as larger driftwood logs transported from the south. At Ainu Creek, the *Pinus* was likely a locally harvested shrub (*Pinus pumila*) and *Salix* may have been harvested in shrub or tree form. The archaeological charcoal likely derived from shrubs and small trees with short to medium lifespans and would be unlikely to introduce more than 100 to 150 years of “old wood bias” to radiocarbon dates. While modest, this potential “old wood” offset needs to factor into the interpretation of the resulting radiocarbon distributions discussed below, and we could expect distributional patterns to be slightly offset by several decades or a century or so older than their corresponding true ages—an issue of important when comparing them to historically recorded events, calibrated radiocarbon dates derived specifically from short lived, terrestrial organisms, or calibrated dates generated by alternative chronometric techniques.

[Insert Fig 3: Charcoal Identification]

As discussed above, disparity exists between the dating intensities of the 8 intensively investigated sites identified above (associated with 226 dates, an average of 28.25 dates per site) and the remaining 49 less intensively tested sites (associated with 154 dates, an average of 3.14 per site). At the same time, these eight sites are noteworthy for their exceptional size, reminding us that some sites do in fact represent a greater number of person years, whether occupied by large resident populations for relatively short periods of time, or small populations over extended periods of time, or especially by large resident populations over extended periods of time. As such, a procedure for deposit enumeration and *tfd* construction was required that balances between the competing needs (1) to capture variability in the person-year weights of different sites and/or at different periods, and (2) to count the proxied person-year no more than once. Toward such ends, we divided each site’s radiocarbon assemblage into spatially concentrated clusters (carbon specimens spaced no more than 5 horizontal meters from each other) to minimize the over-representation of intensively dated sites, while simultaneously allowing our sampling of larger sites to contribute greater weight to the *tfd*. The 5-meter horizontal distance rule was applied specifically so that contemporaneous but spatially separated archaeological deposits would be counted separately, under the related assumptions that closely spaced samples are more likely to derive from the same residential unit (e.g., the household and its immediate surrounding, house pits in the area typically ranging 4-6 meters in diameter), and that more distantly spaced samples more likely derive from different residential units. In any case, while the 5-meter rule is an arbitrary threshold, we urge readers not to fixate on this choice vis-à-vis alternative radii. In fact, contiguous test units excavated during the IKIP-KBP field projects rarely exceeded 5 meters in extent, and at sites with multiple excavations, the distance between them was normally well in excess of 10 meters (see Fig. 2). Within the 5-meter horizontal radius, balance between the two needs discussed above was achieved statistically: within this horizontal proximity, we

identified and pooled clusters of statistically redundant (i.e., insignificantly different) radiocarbon ages, following Ward and Wilson's (1978) method. Ultimately, we take each site's reduced set of radiocarbon age estimates to be broadly representative of the relative temporal frequency of demographic units at that site.

Application of this pooling protocol collapsed 172 individual age estimates into 61 pooled estimates. Consequently, the model presented below is based on a sample of 253 age estimates, including these 61 pooled and the remaining 192 stand-alone dates.

Strategies for identifying and correcting preservation error, and particularly the time-transgressive taphonomic bias addressed by Surovell and colleagues (Surovell and Brantingham, 2007; Surovell et al., 2009), are a matter of ongoing concern for archaeological demographers and critics alike. To date, the best solution to preservation error is to correct *tfd*s for the increasing underrepresentation of successively older deposits by multiplying them by the inverse of model deposit survivorship functions (Surovell et al., 2009; Williams, 2012). While the reliability of this approach has been questioned (Ballenger and Mabry, 2011), the fundamental assumption that sites of younger age are proportionally more likely to be preserved is almost certainly a major contributor to the observed trend toward increasing deposit frequency through time in regional *tfd*s spanning the globe. The Kuril pattern shows a similar overall "growth" trend.

The Kuril landscape is highly dynamic, with volcanic and tectonic processes in particular remodeling and creating new land surfaces. To assess the degree of preservation error that these processes have created, MacInnes and colleagues (2014) compared the geomorphic ages of landscape features (landslides, pyroclastic flows, etc.) against the earliest archaeological dates recorded upon them. They found little difference between the archaeological profiles of Pleistocene- and Holocene-age landforms, concluding that landscape remodeling (depositional processes) has not significantly biased the available settlement chronology. This finding suggests that our efforts to model Kuril paleopopulation dynamics are minimally confounded by the operation of land surface creation. Even so, we do not claim that the general trend of increasing date frequencies with time is entirely free of preservation error. In particular, MacInnes and colleagues' study did not control for erosion, and we readily acknowledge that site loss is likely a contributing factor to the long-term trend toward increasing frequencies of younger dates exhibited by the Kuril *tfd*. Even so, we believe that some proportion of the longer term growth trend is real, as argued below, while the peak and trough structures we describe constitute departures from any long-term, attritional trend and are therefore largely immune to the problem of time-dependent loss of archaeological data.

[Insert Fig. 4: Paleodemographic curve]

Figure 4 presents a *tfd*-based paleopopulation size model for the Kuril Islands based on the IKIP-KBP radiocarbon database. The sample *tfd* (thin line) is a summed probability distribution (*spd*), a category of *tfd* that controls for age estimation imprecision by summing up the probabilistic expression of each timestamp in the sample as these expressions vary along the timeline (Table 2 and Supplement). To

minimize the influence of investigation bias on this model, our sample includes only radiocarbon dates collected as a part of IKIP-KBP fieldwork.

As discussed elsewhere (Brown, 2015, and citations therein), both random and systematic error characterize radiocarbon-supported *spds*, the former resulting from the operation of stochastic processes in the generation of radiocarbon assemblages, the latter from DeVries effects (secular variation on the concentration of atmospheric radiocarbon; Sonett et al., 1990) that have led to a nonlinear relationship between calendric and radiocarbon ages. As a side effect of efforts to control for DeVries effects through calibration, radiocarbon-supported *spds* typically exhibit many artificial short-duration structures (spikes and troughs) whose amplitude is modulated by the varying intensity of the stochastic processes, sample size being particularly influential here (Brown, 2015). To mitigate the presence of these artificial structures, fine-scale variation in the *spd* is smoothed away using kernel density estimation techniques, which in this case is tantamount to the application of a moving, distance-weighted average (for further discussion of kernel density estimation and formal details of its implementation here, see Supplement). The smoothed distribution that results (Fig. 4, heavy black line) is expected to more closely approximate the shape of the population curve underlying the sample *tfd* (in this case, the *spd*) than does the sample *tfd* itself. The reconstruction of the Kuril paleopopulation history presented below is based on this distribution of kernel density estimates (*KDE*), not the raw *spd*.

[Insert Table 2 – radiocarbon data]

4.1. Kuril Population Trends

The presence of diagnostic pottery and a few radiocarbon dates from other projects (not included in Fig. 3 to ensure methodological consistency) indicate that the southernmost Kurils were occupied as early as 8000 cal BP (Yanshina et al., 2009; Yanshina and Kuzmin 2010) during the late Initial Jomon and through the Early and Middle Jomon periods (Samarin and Shubina, 2013). From the evidence reported in Table 2, an earlier—though not as early—occupation also appears likely in the northernmost islands of Shumshu and Paramushir, near Kamchatka. A charcoal sample from intact stratigraphy in the Baikova 1 site dates to ca. 6000 cal BP (5290±35 rcybp, OS-97898; Table 2), though more investigation needed to evaluate the context and cultural association of this date. A Kamchatkan source for this occupation may be indicated by the discovery of stone artifacts common to the Kamchatka Neolithic that we found in 2006 on Paramushir Island, at the Trudnaya 1 site and the Savushkina 2 site (Fig. 5a and 5b). Unfortunately these lithic finds were collected from surface contexts and are undated. It is reasonable to assume that people would have first come to the northern-most and southern-most islands from the adjacent mainland coasts without moving into the more remote islands, an interpretation consistent with the evidence reported here.

[Insert Fig. 5- lithic tools]

As argued above, Figure 4 models changes in occupation intensity in the Kurils following their colonization. Examination of this model suggests five episodes or trends

in the region's population history. The first trend ("1" on Fig. 4) is one of limited growth from earliest settlement to 3500 years ago. In that time, growth concentrated predominantly in the southern islands close to Hokkaido.

The second trend ("2" on Fig. 4) is initiated with the oldest radiocarbon evidence for human presence in the remote (South Central and North Central) Kurils at approximately 3500 cal BP. The earliest archaeological diagnostics in the remote islands are attributed to Late Jomon culture, consistent with these earliest dates. These data suggest a development of more maritime focused lifestyles and a demographic expansion across the Kurils at this time. The timing of this development is consistent with a broader shift towards coastal adaptations around the northern Sea of Okhotsk and Bering Sea (Fitzhugh, in press). This timing also follows a broader pattern found in many parts of eastern Japan wherein site numbers decreased dramatically at the end of the Middle Jomon, then began to increase again in the second half of the Late Jomon phase. On the mainland of eastern Hokkaido, for example, hardly any sites are known from the first half of the Late Jomon (Utagawa, 2008, p. 17). This Middle-Late Jomon population trend is often linked with climatic cooling, although few researchers have discussed how environmental change actually impacted Jomon society (cf. Kawashima, 2013).

Our radiocarbon data suggest accelerating and increasingly consistent growth following population movement into the remote islands (ca. 3500-1900 cal BP), spanning the Late and Final Jomon and early Epi-Jomon periods. Growth between 2500 and 2000 cal BP, in particular, appears to have occurred at a rapid rate of approximately 0.2% per year (see Supplement for details regarding growth rate estimation), then slowing over the next century to 0% annual growth, with the population peaking ca. 1900. It is noteworthy that the high and sustained level of growth observed between 2500 and 2000 lies near the upper limit of intrinsic growth observed among ethnographic hunter-gatherer populations, suggesting that this period of growth was fueled in part by an immigration subsidy (Collard et al., 2010). We found Late Jomon pottery (Fig. 6) as far north as Urup Island and Epi-Jomon pottery throughout the southern and central archipelago north to the Drobnyye 1 site on Shishkotan Island. Valery Shubin (personal communication to B. Fitzhugh) reports seeing Epi-Jomon pottery at the Savushkino 1 site on northern Paramushir in the 1970s. This observation is consistent with the appearance of Kamchatka obsidian in Epi-Jomon assemblages throughout the northern and central Kurils (Phillips, 2011) and indicates that Epi-Jomon culture bearers traded with Kamchatka communities—or, less likely, mined their own Kamchatka obsidian well before 2000 cal BP. Epi-Jomon settlements are ubiquitous throughout the central Kurils, and in many locations their relatively small, single-room house pits are the most prevalent features across large multi-component sites, evident from both diagnostic pottery and radiocarbon dates from soil probe samples in house pits across several sites.

[Insert Fig. 6: pottery photo]

The third notable trend in the paleodemographic model ("3" on Fig. 4) is the decline in population at the end of the Epi-Jomon occupation, starting ca. 1900 cal BP and reaching its nadir by ca. 1400 cal BP, declining by 33% at a relatively gradual average rate of approximately -0.08% per year. Because this decline began hundreds of years before Okhotsk expansion into Hokkaido (ca. 1500 BP: Amano 2003) and the Kurils (ca. 1300 cal BP: Yamaura and Ushiro, 1999), it cannot be attributed to Okhotsk contact. The 1400 cal BP inflection in Fig. 4—though a century earlier than the reported age of Okhotsk expansion—may represent the influx of Okhotsk population if the paleodemographic model is offset by old wood dates, as described above, or if the earliest published dates on Okhotsk expansion in Hokkaido are of limited accuracy. In any case, some Kuril Epi-Jomon communities likely remained to witness the expansion of Okhotsk culture into and through the Kurils, but if so, they were a remnant population. We speculate that Okhotsk colonization was made possible by centuries of prior Epi-Jomon decline. There is no evidence at present to suggest conflict between the groups, despite Okhotsk use of defensive fortifications in the southern islands and on Hokkaido and Sakhalin (Samarin and Shubina, 2007). No such fortifications were identified in the central or northern Kurils. We suggest that the transition from Epi-Jomon to Okhotsk involved minimal population displacement, perhaps because few Epi-Jomon communities remained in the Kurils at this time. Possibly Epi-Jomon and Okhotsk groups co-existed peacefully—at least in the southern region, where after 300 years a syncretic (Tobinitai) culture developed with ties to both ancestral groups.

The fourth and fifth trends are defined respectively by the growth (ca. 1400-900 cal BP) and subsequent decline of population (900-450 cal BP). In this half millennium, the Kuril Okhotsk population grew to rival or exceed the Epi-Jomon population peak a millennium earlier ("4" on Fig. 4), though paradoxically requiring less effort per capita to achieve such size (approximately 0.13% per year). From archaeological evidence, we know that the Okhotsk settled the entire Kuril chain as far as the southern tip of Kamchatka (Dikova, 1983). As shown below, obsidian source studies indicate that most obsidian used by central and northern Okhotsk communities in the Kurils came from Kamchatka. In contrast to the gradual pace of the earlier, Epi-Jomon decline, the Okhotsk population appears to have collapsed precipitously between 900 and 450 cal BP, decreasing by 57% at an average rate of approximately -0.19% per year ("5" on Fig. 4).

Surprisingly to us, Ainu occupation in the Kurils was elusive. We had expected to find Ainu occupation replacing Okhotsk within a short interval, but the dates in Fig. 4, diagnostic artifacts and house features all suggest the islands were largely empty of settlements for two hundred or more years, being re-occupied by Ainu communities within a century or two of direct Russian and Japanese arrival and documentation. When they did settle the islands, Ainu appear to have been more directly engaged in extraction of resources for trade (Fitzhugh, 2012).

5. Explaining Kuril Population Trends

5.1 Environmental Hazards

Environmental variability is often invoked to account for changes in the archaeological trajectories of hunter-gatherers, and we begin our exploration of the possible causes for Kuril population fluctuations with a discussion of the environmental factors that might have negatively (or positively) affected Kuril settlement. The most evident environmental factors include natural hazards such as volcanic eruptions and tsunamis, as well as changes in the climate and marine ecosystem that would have affected mobility and subsistence (Fitzhugh, 2012).

Located on the active Kuril-Kamchatka subduction zone, the Kuril Islands have experienced at least thirty-three volcanic eruptions in the last 300 years, with twenty erupting in the last seventy years alone (Nakagawa et al., 2008; Ishizuka, 2001). Nakagawa and colleagues (2008) report approximately eighty volcanic eruptions across the island chain in the last three millennia, including two caldera eruptions (Medvezhya on Iturup in the southern islands and Ushishir in the central islands) and four large Plinian eruptions (Zavaritsky once and Sarychev twice in the central and Severgina, three times in the northern islands) (see Fig. 4). In addition, Nakagawa and colleagues (2008) identify periods of greater and lesser Kuril volcanic activity throughout the Holocene, with some of the most intense eruptive intervals falling during the Epi-Jomon population explosion.

Despite the occurrence of hazard events during periods of high population density in the Kuril Islands, there is little evidence to suggest these events precipitated population decline. As highlighted in Fig. 4, major eruptions in the Kuril archipelago occur at various phases of population growth and decline. The caldera-forming Medvezhya (ca. 2400 cal BP) and Ushishir (ca. 2200 cal BP) eruptions occurred during episodes of population growth, which appear to have continued unabated despite these eruptions. Most eruptions, including many of the large ones, would have had only local impacts, leaving the majority of the Kuril population unaffected, perhaps requiring only adjacent communities to move away temporarily. It is fair to speculate, however, that the impact of eruptions may occasionally have been extensive enough to precipitate changes in the course of population growth, so it may not be a coincidence that either the Epi-Jomon or the Okhotsk population decline (or both) initiated soon after major eruptions. Conversely, the reoccupation of the Rasshua 1 site immediately atop the thick Ushishir tephra soon after that caldera eruption suggests a relatively benign impact (Fitzhugh, 2012).

The tectonic environment of the Kuril archipelago also generates numerous earthquakes and related tsunami events. Geological data collected over the last sixty years demonstrates the occurrence of at least thirty-four earthquakes and related tsunami events within the Kuril archipelago (NGDC, 2013). Analysis of paleo-tsunami deposits indicates that similar events likely occurred in this region throughout the Middle and Late Holocene (MacInnes et al., 2009). Colleagues continue to work on the quantification of earthquake and tsunami frequency and intensity from field studies. Preliminary indications are that major tsunami events recur at any given location (but especially on the Pacific side and near passes) every 100-200 years. Considered as a whole, the archipelago might see a major tsunami somewhere along its extent every several decades. If past residents of the archipelago were in contact with each other, as we expect they were, it is likely that they were aware of the risk of tsunami events and

consequently took efforts to protect themselves and their critical infrastructures (boats and houses). As noted elsewhere, the placement of settlements on elevated terraces suggests effort to avoid direct tsunami impacts (Fitzhugh, 2012). Damage to marine ecosystems from tsunamis may have been fairly temporary and most often isolated to the Pacific sides of the islands. Thus, opportunities would normally exist to move to the Okhotsk Sea side to find unaffected resource zones, though increased human competition for those remaining resource patches might be an expected outcome if the islands were heavily settled.

5.2 Climate Change

Fluctuations in climate could have had direct or indirect effects on the dynamic population history of the Kuril Islands. Boat travel—a necessity for foraging and connecting with neighbors—would have been more risky in stormier periods, and a range of climate variables could change the ecological character and productivity of nearshore marine ecosystems. Research is still needed to meaningfully characterize the mechanisms linking climate trends and their implications for travel and subsistence during the mid to late Holocene. Here we report the more general climate patterns revealed by paleoclimate research conducted under the umbrella of the Kuril Biocomplexity Project.

Paleoclimatological proxy data from a number of sources on or near the Kurils point to major fluctuations in temperature and aridity through the Holocene. Pollen analysis from peat excavations and lake cores in the Kurils show major changes from the early to late Holocene, with sea level highstand marking the Holocene Optimum between 7500 and 6600 cal BP (Lozhkin et al., 2010; Razjigaeva et al., 2013). The late Holocene was generally cooler and stormier than the early Holocene, with a more active and variable Aleutian Low pressure system dominating winter weather in the North Pacific. This pattern resulted in more intense cold and dry winds off the Siberian mainland, a frozen Sea of Okhotsk in winter, and generally more stormy conditions overall. At the same time, warm tropical waters could be pushed north along the Pacific coast of Japan—sometimes reaching the southern Kurils—creating more mild conditions in that region (Razjigaeva et al., 2013, pp. 135).

Expansion of human settlements into the central Kurils follows mid to late Holocene “Neoglacial” cooling trends, while the most extreme cold intervals coincide with declines in population (Fig. 4). Razjigaeva and colleagues (2013) report the following mid to late Holocene trends, which we compare to the paleodemographic observations reported above:

- After the Holocene Optimum, a brief cooling is evident from 5400-5000 cal BP (4700-4500 ¹⁴C BP). This cooling was most prominent in the central Kurils, while temperatures remained relatively warm in the South Kurils.
- From 5100-3400 cal BP (4500-3200 ¹⁴C BP), the Kurils warmed again, especially in the southern islands, and precipitation increased. Jomon expansion into the central islands occurred toward the end of this phase, though human population numbers remained low.

- From 3400 to 2400 cal BP (3200-2400 ^{14}C BP), the Kurils cooled by as much as 2-3 degrees C, and precipitation resulted in heavy winter snow cover. Stronger than previous southerly spring and summer winds are indicated by the presence of windblown pollen from 2750 years ago to present. During this period, the pace of Epi-Jomon population growth appears to have gradually increased from near-zero values, to approximately 0.2% between 2500 and 2000 cal BP. However, it is also worth noting that population growth gave way to decline after ca. 1900 as this cooling trend continued.
- The cooling trend intensified to its maximum during the interval 1650-1200 cal BP (1760-1270 ^{14}C bp). Over this period, conditions were not only cold but also drier than previously, suggesting a southerly extension of the cold Oyashio current and dry, cold winds off the frozen Sea of Okhotsk in winter. The end of the Epi-Jomon decline and the subsequent initiation of the Okhotsk growth occurred during this interval.
- From 1200-670 cal BP (1270-700 ^{14}C BP), a warm trend prevailed, especially on the continent, while the Kurils experienced mild warming to just slightly above late 20th century/early 21st century (“modern”) averages. The Okhotsk expansion into and throughout the Kurils continued during this period, but also the warm trend persisted through the onset of the archipelago’s most dramatic period of population decline.
- Cold winters, cool summers and high precipitation dominated the interval from 670 to 100 years ago or so. Temperatures declined 1-2 degrees C and the cold Oyashio once again appears to have pushed south, though high precipitation indicates prevailing winds coming from open water. Mild regression of the sea level once again exposed unconsolidated sand, and dunes were built in the southern Kurils. The rapid and dramatic population decline that had initiated at the end of the previous warm interval continued for another two centuries as the weather turned cold, accompanied by the disappearance of the Okhotsk culture from the Kurils. Conversely, the end of population decline and the arrival of the Ainu into the Kurils likewise transpired before the climate had yet rebounded. This late population appears to have persisted at a modest but stable size up to the period of contact with Russia.

It is tempting to see a relationship between late Holocene climate and population trends in the Kurils. While the remote islands were only significantly occupied after the end of the Holocene Climatic Optimum, possibly hinting at poor conditions associated with extreme warming, human populations appear to have achieved peak sizes during the moderately cool periods that characterized the late Holocene’s Neoglacial period, and may have declined or completely abandoned the remote islands in the coldest periods (Fig. 4). These relationships could be clarified with higher resolution climate data and better understanding of the mechanistic links between climate and maritime hunter-gatherer welfare in the region.

Recent research in Pacific oceanography suggests that colder temperatures around the North Pacific Rim (especially the Gulf of Alaska and eastern Aleutians) may lead to enhanced marine productivity through production of fattier planktons and more

robust forage fish stocks (Trites et al., 2007). Other data suggests that some taxa (such as cod, pollock, and anchovies) do better—in some areas at least—with warmer waters and stronger Aleutian Low pressure conditions (Chavez et al., 2003). Overall, it is likely that environmental factors played an important role in the settlement, habitation and abandonment of the Kuril Islands but these factors require more study. We believe the environmental variables are important but incomplete aspects of the human settlement story. Hunter-gatherers are known to have a number of strategies available to mitigate environmental variability and uncertainty (Fitzhugh et al., 2011; Halstead and O'Shea, 1989; Wiessner, 1977). We think the story is more complicated, specifically because it also involves social dynamics in play at various spatial scales.

5.2 A Network Approach

Islands are especially difficult places for hunter-gatherers to settle and most islands were in fact first colonized by agricultural populations (Cherry, 1981; Takamiya et al., 2015). The Kurils are one important exception to this generalization. To make better sense of the Kuril settlement history, we propose the following framework to explore the Kuril population trends identified above. Specifically, we suggest that the formation of and reliance on social networks played a key role in both stabilizing populations during moderate environmental turbulence at one spatio-temporal scale while increasing vulnerability to environmental and socio-economic fluctuations at larger spatial scales. Drawing from an information-networks model presented by Fitzhugh and colleagues (2011), we propose that during periods of expansion and colonization of novel landscapes, extensive social networks are likely to be in demand as they provide access to regional information, marriage partners and resources that are crucial when uncertainty about the new environment is at its highest and populations low. In the Kuril Islands, this would occur when populations first expand into the more remote central islands during the early portion of the Epi-Jomon and the early half of the Kuril Okhotsk occupation (which coincides with the Middle Okhotsk in Hokkaido). However, after the period of initial colonization and 'settling in,' environmental uncertainty should decrease through individual learning and collective experience within the new environment (accumulation of local and traditional knowledge). At this point, social networks might either be maintained or reduced. Despite the high costs of extensive social networks, they should be maintained for communities living in sparse and highly unpredictable and hazardous environments (Fitzhugh et al., 2011). Network contraction is expected under most other conditions, where network costs are reduced by trimming the most expensive connections in proportion to greater understanding of and local adaptation to environmental variability (development of local knowledge systems). We expect that partners living farthest away are most likely to drop out of such contracting networks first.

Our initial prediction is that the networks of the Jomon/Epi-Jomon and Okhotsk would have become smaller and more isolated over time as growing experience with the landscape lowered the perceived value of social contacts from beyond the local area. This would be true *unless* the Kurils were chronically vulnerable so that networks remained essential for dealing with occasional local insufficiencies. In this case, the increased security of the extensive social network could be counter-balanced by unintended consequences of being dependent on that larger network. These

unintended implications include susceptibility to external forces or hazards, such as diseases (McGovern et al., 1988), changes in the economic and political dynamics affecting other parts of the network, and the potential loss of self-sufficiency due to an increased reliance on non-local materials. In fact, in some cases trade and information once integral to expansion or population growth could later become significant hazards in their own right. In essence, island-living could put remote communities into a precarious balance between managing local environmental hazards and non-local social hazards.

5.3 A Tale of Two Networks

Based on archaeological and historical evidence, we argue that the Epi-Jomon and Okhotsk occupations of the remote Kuril Islands developed two somewhat different social network strategies that contributed to their different population histories (Gjesfjeld, 2014). Throughout the Epi-Jomon—well after ancestral Jomon settlements were established in the islands—networks appear to have had limited extent. These networks nevertheless served to insulate Epi-Jomon communities from short-term impacts. For the Okhotsk, by contrast, regional networks were more extensive, and continued well after colonization—potentially for economic benefits—in ways that may have led to an over-dependence on non-local assistance in times of local crisis. While neither strategy prevented decline, the rate of population loss was significantly different in each case, with the Epi-Jomon experiencing a gradual population decline over 300-400 years while the Okhotsk disappeared completely in less than 100 years.

As detailed elsewhere (Phillips and Speakman, 2009; Phillips, 2011; Gjesfjeld and Phillips, 2013; Gjesfjeld, 2015), evidence for changes in Epi-Jomon and Okhotsk network structures are based on a series of geochemical sourcing studies using both obsidian and pottery. The use of multiple material types is advantageous in this research as they highlight exchange patterns of differing intensities at different spatial scales. Because obsidian is not found locally in the island chain but can be acquired nearby in Hokkaido or Kamchatka, the sourcing of obsidian throughout the islands is informative of exchange and connections to regions beyond. In contrast, raw clay deposits needed for making pottery are found throughout the central islands with geochemical differences that discriminate clay sources from different regions of the archipelago (Gjesfjeld, 2014). As a result, pottery sourcing studies are more indicative of connections over local or regional scales. These sources, when taken in tandem, allow us to draw conclusions about the scale and intensity of social networking within and beyond the island chain.

Our interpretation of Epi-Jomon network contraction in the central islands is based on this combination of pottery and obsidian evidence. The geochemical sourcing of pottery from the central islands suggests a highly localized network structure. At the site of Rasshua 1, located on the central island of Rasshua, 25 sherds classified as Epi-Jomon (based on presence of cord-marking and consistent with radiocarbon dates) were analyzed for trace elements. A high proportion of sherds (88.5%) had significantly similar geochemical signatures. Using the criterion of abundance postulate (Bishop et al., 1982), we interpret these results to indicate that most ceramic artifacts were locally produced. The remaining sherds (11.5%) are considered non-local or imported to the

site. It is intriguing to note that two thirds of the non-local sherds from Rasshua 1 originate from the lowest levels of the site (Level 7C and 8) suggesting an importation of pottery to the site during its initial settlement.

Lithic analysis of obsidian recovered from Epi-Jomon contexts in the central islands (including Rasshua) also indicates a very low usage of (non-local) obsidian (0.6% of total by mass) compared to the overall lithic assemblage, which is dominated by local basalts (59.3%) and cherts (28.5%). Based on results from the geochemical sourcing analysis of obsidian artifacts, during the Epi-Jomon period central island inhabitants equally procured obsidian from both Hokkaido (52%) and Kamchatka (48%) sources. Unfortunately, based on the resolution of the data we are unable to determine whether procurement networks to both Hokkaido and Kamchatka were in use at the same time or whether Epi-Jomon inhabitants changed their procurement networks while occupying the central region. The finding that northern island obsidian comes predominantly from Kamchatka and southern island obsidian from Hokkaido does imply that the overlap in the central islands was connected and concurrent with the larger pattern.

Compared to the low level of Epi-Jomon interaction, exchange during the Okhotsk occupation tends to be less localized. Results of pottery sourcing at the site of Vodopodnaya 2, on the island of Simushir, suggest that more Okhotsk pottery was non-locally produced than that of Rasshua 1's Epi-Jomon deposit. Based on geochemical analysis of 25 sherds (all identified as Okhotsk), only 24% of sherds demonstrated similar geochemical signatures that could be interpreted as locally produced pottery, with 76% of pottery potentially manufactured non-locally. Overall elemental variability in clay is higher at the site of Vodopodnaya than Rasshua, but not high enough to account for the difference in pottery assigned to a local group, suggesting these differences are indicative of more imported pottery (Gjesfjeld, 2014).

Obsidian in the central islands is also found in higher relative abundance during the Okhotsk period, with a small but higher proportion (1.9%) of the total lithic assemblage. However, even though Okhotsk culture originates in northern Hokkaido and southern Sakhalin, almost all obsidian raw material in the central islands comes from Kamchatka during this period. While this finding does not rule out exchange relationships with Hokkaido populations—and our sample of Okhotsk materials from the southern islands appears to be artificially low—it does suggest exchange relationships with Kamchatka may be more important on average in this period. In sum, Okhotsk populations appear to have been dependent on non-local contacts in terms of their overall use of pottery and non-local raw material. The northerly focused obsidian trade may be indicative of a loss of social network support to the south—a development that may have ultimately led to the collapse of the occupation even while possibly insulating it from some threats to the south.

6 Discussion--Social Dependency in Relative Isolation

Our research indicates that people colonized all of the Kuril Islands by no later than 3500 years ago, expanding in population more or less continuously for the next 1500 years during the Late/Final Jomon and Epi-Jomon periods. During this expansion,

long-distance social networks were established and maintained with both Hokkaido and Kamchatka neighbors, as indicated by obsidian raw materials sourced to both regions. Nevertheless, these communities maintained largely self-sufficient lifestyles and the predominant scale of interaction/mobility was with neighboring islands, indicated by the more local scale for pottery source catchments and the social interactions that would flow across them. Interestingly, the dominant source areas of obsidian appear to have been the ones in closest proximity (Kamchatka or Hokkaido). We see this as a reflection of the high cost of travel and tendency to look for the closest sources of raw materials.

These data suggest a healthy balance of local adaptation and the ability to deal with seasonal to inter-annual, localized resource variability. This is expected for self-sufficient populations with established local and traditional knowledge about their place, who nevertheless rely on larger social networks for occasional trade and maintenance of social contacts. Living above the reach of most tsunamis, moving periodically to avoid local resource failures or volcanic eruptions, and developing traditional knowledge about how to find food in difficult times may have limited the necessity of more regularized, long-distance interactions. The combination worked for millennia.

The decline of Epi-Jomon settlements was gradual (-0.08% per year), transpiring over the half-millennium from ca. 1900 to about 1400 cal BP. This decline cannot be attributed to conflict with Okhotsk people who showed up in Eastern Hokkaido and then the Kurils, centuries after the onset of Epi-Jomon decline. The gradual pace of population loss also implies that the cause was not a catastrophic event such as a major tsunami or short term ecosystem crash of the sort that could be mitigated through the temporary reliance on distant exchange partners. We conclude that the low level, long-distance social networking inferred from the obsidian distributions was effective in allowing for such mitigation. The decline of the Epi-Jomon may instead relate to deterioration of living conditions in the Kurils of the sort that could emerge from a sustained change in ecological productivity due to climate change, or alternatively, people may have been lured away by the development of new opportunities in Hokkaido associated with trade opportunities through Hokkaido and Honshu or the development of minor food production economies (millet and barley) to the south. In either case, possible causal mechanism/s for this decline are not easily identified beyond the simple correlation of population decline and the onset of cold conditions in the late Epi-Jomon.

While the subsequent expansion of the Okhotsk cultural group into the Kurils (ca. 1400-900 cal BP) appears rapid in Figure 4, the growth unfolded at a more gradual rate (0.13%) than seen in Final Jomon/Epi-Jomon expansion 1000 years earlier. The estimated Epi-Jomon growth rate of approximately 0.2% per year falls near the upper boundary of growth rates exhibited by ethnographically known hunter-gatherer populations and suggests a supplement of immigrants (Collard et al., 2010), while the Okhotsk rate falls much more comfortably within the hunter-gatherer range and could have been sustained intrinsically. We do not believe this was intrinsic growth, in fact, because other archaeological data strongly supports a replacement of Epi-Jomon with culturally unique Okhotsk material culture and population. In any case, the rate of loss at the end of the Okhotsk settlement was quite rapid (-0.19% between ca. 900 and 450 cal BP), resulting in an approximately 57% population reduction over this 450-year interval.

To further explore possible causes for the Okhotsk collapse, we need to introduce the concept of the expanding “East Asian World System,” of which the Okhotsk cultural phenomenon sat on the margins (Hudson, 2004). First, we think it likely that the galvanization of the Okhotsk ‘culture’ in the western Sea of Okhotsk region was stimulated—at least indirectly—by political-economic developments in adjacent regions of mainland East Asia. In particular, emerging polities of Manchuria (Heishui or Black Water Mohe) and Bohai (Parhae) kingdoms sought to profit as intermediaries in commodities markets linking wild products from the Sea of Okhotsk and elite markets of more densely settled (and commodities hungry) Korea and China. Demand for trade in exotic commodities was growing and hunter-gatherers of the Sea of Okhotsk were in a position to supply products in return for access to exotic goods including ironware, rice, cloth, alcohol, and weapons (Amano et al. 2013; Smale 2014; Yamaura 1998).

The first millennium C.E. in the western Sea of Okhotsk area is characterized by predominant population movements from north to south as peripheral groups expanded in search of iron and agricultural products. The formation and expansion into Hokkaido of the Okhotsk culture can probably be connected with this trend. However, while their contemporaries, the late Epi-Jomon and Satsumon cultures were increasingly influenced by goods and practices imported from Japanese society to the south, the Okhotsk appear to have been much less engaged in the trade for distant goods (Hudson, 2004). It is unclear whether Okhotsk families who reached Hokkaido and the Kurils were seeking uncontrolled territory to procure trade items, or else were trying to escape the heavy hand of domineering chiefs, whose control of hunting grounds and trade routes and whose pursuit of power made life hard for subordinates. In any case, relatively few durable trade goods from political centers of Japan and East Asia are found in Okhotsk sites in Hokkaido and the Kurils. Despite this, Segawa (2005) has argued that trade was the original motivation for Okhotsk migrations south into Hokkaido. Several early Okhotsk culture sites, such as Aonae on Okushiri Island, are found down the Japan Sea side of Hokkaido, a coast which was always the center of premodern trade between Japan and the north. That these Okhotsk people may have explored as far south as Sado Island is suggested by the following entry in the *Nihon Shoki* for the year 544: “*At Cape Minabe, on the northern side of the Island of Sado, there arrived men of Su-shen in a boat, and staid there. During the spring and summer they caught fish, which they used for food. The men of that island said they were not human beings. They also called them devils, and did not dare to go near them*” (Aston, 1972, II, p. 58). Although in early Chinese texts, the term “Su-shen” usually refers to a Tungusic people living in Manchuria, later entries in the *Nihon Shoki* use this name for a people living in Hokkaido who were attacked by the Japanese state in the 7th century and many scholars link these Su-shen with the Okhotsk culture (Segawa, 2011, p.49-81).

By the 8th century, the Okhotsk expansion south along the Japan Sea coast had come to an end as groups of Japanese farmers moved from the northern part of Honshu into the Ishikari plains of southern Hokkaido. Mixing with the Epi-Jomon, these groups formed the Satsumon culture. Segawa (2005, p. 55) argues that this Satsumon expansion made it difficult for the Okhotsk people to continue their previous activities in western Hokkaido and that consequently their area of settlement became limited to the Sea of Okhotsk coasts of eastern Hokkaido. Okhotsk communities continued to have

some access to commodities traded out of centralized Japan, accounting for the use of Honshu iron in Late Okhotsk smelting (Amano et al., 2013). But obsidian and other lithic resources were still widely used to make tools in the Late Okhotsk whereas the Satsumon culture had completely shifted to the use of iron by that time. The greater access to distant markets possessed by the Satsumon people would without doubt have had significant impacts on the Okhotsk culture, potentially insulating or excluding the latter from economic developments in the broader World System. However, it is not clear whether the vibrant maritime adaptations developed by Okhotsk groups who migrated east and settled the regions around the Shiretoko and Nemuro Peninsulas and who—presumably—seeded and later networked with the populations that soon after filled the Kurils were looking for new sources of exploitable trade items or just a place to escape exploitative market demands in less insular places.

Based on our evidence, once in the Kurils the Okhotsk pursued more social interaction over distance than their Jomon/Epi-Jomon predecessors. Our data are incomplete on this count because our samples do not include Okhotsk materials from the southern islands, but we believe that Okhotsk settlement in the Kurils likely retained strong connections with kindred communities in Eastern Hokkaido for several centuries. Okhotsk settlements are known from the southern islands based on surface collections of diagnostic pottery and limited excavations. In any case between about 1000 and 700 years ago, something disrupted these connections, whatever they were, something that rendered the occupants of the remote and northern Kurils especially vulnerable.

We consider two alternative scenarios. First, the remote islanders could have been abandoned in their trade networks by neighbors in the southern Kurils and Hokkaido. Between 1000 and 700 years ago, Okhotsk occupants in these more southerly regions became increasingly incorporated into interior-focused Satsumon traditions (Tobinitai phase: Hudson, 1999; Onishi, 2003). Since Satsumon communities were much more engaged in commodities trading with mainland Japan, their expansion into Eastern Hokkaido and incorporation of Okhotsk communities there would have been accompanied by increased opportunities to participate in that trade. Since Japanese markets of the day were particularly focused on interior forest and stream products, and not marine goods, the absorption of southern Okhotsk communities could have decreased the need or interest for those communities to engage in reciprocal social and trade networks with remote Kuril groups. Segawa (2012, p. 83) has argued that from the tenth century, Satsumon groups began to move into eastern Hokkaido in search of eagle feathers that were traded for fletching arrows. After the development of the hybrid Satsumon-Okhotsk culture known archaeologically as the Tobinitai, people living in the remote and environmentally tenuous central and northern Kurils may have found themselves cut-off from trade networks linked to eastern Hokkaido to the south. This reduction in access to social networks would have rendered Kuril communities especially vulnerable just as colder climate triggered changes in the frequency and intensity of ecological crises. Newly formed social networks with Kamchatkan neighbors to the north (presumably the ancestors of the Itel'men/Kamchadals) may not have been sufficient to weather these crises.

A second scenario—equally plausible, not mutually exclusive, and harder to evaluate—relates to the increased probability of exposure to communicable diseases

when engaged in more extensive social networks. The Great Smallpox Epidemic of 735-737 C.E. ravaged western Japan, perhaps killing 25-35 percent of the total population, with mortality in some regions exceeding 60 or 70 percent (Farris, 1985; Suzuki, 2011). By the medieval era, smallpox became less virulent in urban Japan, but would have remained lethal to small populations in remote locations, once contacted. The first recorded smallpox epidemic in Hokkaido is not until 1624 (Walker, 2001, p. 181). However, given that regular contact had been occurring between mainland Japan and Hokkaido from much earlier times, it is possible that there were medieval epidemics that went unrecorded by Japanese authorities. Thus, it may not be a coincidence that the Kuril Okhotsk population collapsed catastrophically, just as their neighbors to the south were becoming more engaged in trade and social networks oriented to Japan.

We do not know for certain how Okhotsk and Kamchatkan communities got along, but the loss of networks to the south may have increased the pressure to engage with Kamchatkan groups when natural hazards or ecological downturns affected life in the remote Kurils. It is also possible that Kamchatka served as a refuge to those forced to leave the remote islands, though no Okhotsk settlements have been found along the coasts of Kamchatka. We suspect that the decline in social connections to the south and tenuous connections to the north made persisting in the Kurils particularly precarious for Okhotsk occupants after 700 years ago when Little Ice Age cooling increased the probability of severe bad years.

In sum, we propose that the Kuril Okhotsk were made increasingly isolated in the 13th century C.E. in way that made them more vulnerable to environmental hazards that they could no longer mitigate successfully with help from social networks. This could have occurred because southern neighbors lost an economic incentive to support their northern neighbors and/or because epidemic diseases wiped out southern trading partners or Kuril Okhotsk communities themselves. Cut off from southern contacts and lacking the bonds of common culture or kinship with Kamchatkan populations, social safety networks along with their complementary ecological benefits deteriorated, leaving the Kuril Okhotsk more vulnerable to natural hazards and years of resource failure or storminess. In this scenario, rapid cooling (experienced as an increase in the frequency of particularly cold years) would have been disproportionately hard on Kuril Okhotsk communities and a combination of catastrophic mortality, poor subsistence returns and hunger, increased inter-group conflict (though evidence for warfare is absent in most of the Kurils), and emigration could have led to the rapid depopulation our paleodemography data reveal.

7. Conclusion.

In this paper we have explored an empirical model of Kuril Island demographic history based on archaeological radiocarbon frequencies. The data support a mid Holocene expansion into the remote central islands, followed by two periods of sustained growth punctuated by significant population declines. Successful settlement of and persistence in the remote islands would have required a combination of adept maritime technologies and skills as well as social networks at various scales. Those networks were needed for materials not locally available, marriage partners, information about natural and social resources and hazards, and friends to call on when conditions

failed at home. We presented data that reveal different patterns of social networking in the Epi-Jomon and Okhotsk periods, along with environmental data on the effects of climate on local temperatures and precipitation.

While the data suggest that human populations responded in some degree to climate change, at least in the last 2000 years, we have argued that the human response to climate change was indirect at best. We believe that understanding the population variability in the Kurils demands an approach that considers the intersection of social and natural variables that together affect the vulnerability of small human populations. We suggest that the Jomon/Epi-Jomon emphasis on local adaptation and weak connections to the outside provided a remarkably successful strategy. They persisted in the archipelago for 3000 or more years. Their decline was gradual, probably related to a general decrease in the overall productivity of the Kuril ecosystem. We also argue that the Okhotsk—one way or another—were victims of the expanding East Asian World System that, while they did not directly depend on it, undermined the robustness of their more regional trade network. During the periods considered in this paper, the Kuril Islands probably remained outside most major World System interactions, but the growing incorporation of Hokkaido into that World System eroded the stability of network links between the Kurils and Hokkaido. These considerations raise the question of whether the settlement of the Kuril Islands by hunter-gatherers was ever possible without social links to Hokkaido and Kamchatka. Finally, although not discussed in this paper, the full incorporation of the Kuril Islands into the global World System with the rise of the sea otter trade in the eighteenth century and subsequent territorial competition between Japanese and Russian states completely transformed and ultimately ended the Ainu occupation of the Kurils (Walker, 2001).

We believe that there are lessons in this history for contemporary society. The hyper-connected world we live in today comes with its own advantages and vulnerabilities. Being connected gives us nearly instant access to information. Like the ancient settlers of the Kurils, this information helps us to navigate our world and avoid some pitfalls (or to deal with them, when we have to). By the same token, we are so deeply dependent on our complex and interconnected networks, that any loss of connectivity can create chaos and panic. The people who are most vulnerable are those with unequal or unreciprocated dependence on their network partners. The Jomon/Epi-Jomon appear to have interacted with more or less co-equal partners at low levels of intensity. Their exchange was based on reciprocity and minimal interdependence. The Okhotsk, by contrast were influenced by a growing economic World System that encouraged asymmetric relationships and created unprecedented vulnerability to the fluctuations of environment as well as the whims of markets, social developments, and epidemics beyond their control or even awareness. Chances for sustainability are improved—but not ensured over long enough time periods—with a healthy balance of self-sufficiency and a modest social network, with limited interdependence.

Acknowledgments

The research reported here was financially supported by the U.S. National Science Foundation (0508109; 1202879). Project administrative support came from the UW Center for Studies in Demography and Ecology (CSDE), with funding from a Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) research infrastructure grant, R24 HD042828. Additional support was provided by the University of Washington, Seattle, WA, USA; the Hokkaido University Museum (Sapporo, Japan); the Historical Museum of Hokkaido (Sapporo, Japan); the Sakhalin Regional Museum (Yuzhno-Sakhalinsk, Russia), and the Far East Branch of the Russian Academy of Sciences (IMGG: Yuzhno-Sakhalinsk, IVS: Petropavlovsk-Kamchatskiy, NEISRI: Magadan, TIG: Vladivostok). This paper is the product of extensive and ongoing discussion with many people, and we especially wish to thank our international collaborators on the Kuril Biocomplexity Project and many others who provided insightful feedback and analytical support through the process, including the guest editors, Andrzej Weber and Peter Jordan and a very helpful anonymous reviewer. While we take full credit for any errors or omissions, we gratefully acknowledge a much larger team effort.

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List of Figures

Fig. 1: Map of Kuril Islands showing major islands and selected archaeological sites discussed in the text. Dashed lines indicate location of major straits that divide the islands into four biogeographic and analytical regions. The inset shows the location of the Kuril Islands in the Northeast Asia and Northwest Pacific. (Redrawn from a base-map by Adam Freeburg.)

Fig. 2: Map of the Drobnye 1 archaeological site on Shishkotan Island, showing house pits recorded and test units excavated in 2006 and 2007 by the Kuril Biocomplexity Project team.

Fig. 3: Summary of taxonomic identification of archaeological charcoal from Rasshua 1, Vodopadnaya 2, and Ainu Creek archaeological sites (n=116). See text and Shaw (n.d.).

Fig. 4: A temporal frequency distribution (tfd) of summed archaeological radiocarbon probabilities from 364 Kuril archaeological dates. The summed probability distribution (*spd*; thin line) is derived from 253 independent records in which non-unique radiocarbon dates from the 364 have been pooled. A kernel density estimate (KDE; thick line) is plotted that smooths out calibration interference and random sampling error (See Supplementary materials). The top bar indicates relative temperature change based on palynological evidence (Razjigaeva et al. 2013). The bottom bar shows cultural historical period designation (Omoto et al., 2010). Large asterisks indicate caldera forming eruptions and small asterisks indicate major non-caldera eruptions. The first known time of occupation in each region is indicated on the graph by “S” (first occupation in the south), “C” (central, including both south-central and north central regions on the Fig. 1 map) and “N” (north). See Fig. 1 for regional divisions. Numbers on the graph correspond to major demographic trends enumerated in the text.

Fig. 5: (a) Microblades from Trudnaya 1 site on southern Paramushir; (b) obsidian biface from Savushkino 2 site on northern Paramushir.

Fig. 6: Select sherds representing diagnostic pottery decoration for the (a) Early Epi-Jomon from Rasshua (FS#3990, SRM#8077-41), (b) the Late Epi-Jomon from Iturup (FS#47, SRM#7867-167) and the (c) Middle or Late Okhotsk from Kharimkotan (FS#776). All sherds are currently curated at the Sakhalin Regional Museum (SRM).

List of Tables:

Table 1: Distribution of radiocarbon dates from through Kuril Islands. Dominant sources refer to sites receiving more extensive archaeological sampling and disproportionate dating. The southern and northernmost islands have the least coverage in the KBP radiocarbon database because of the decision to focus efforts in the more remote, central sections, where less archaeological attention had been directed by previous research efforts.

Table 2: Radiocarbon dates from the Kuril Biocomplexity Project (KBP) and International Kuril Island Project (IKIP). Table includes all dates used in the paleodemography model plus a small number of additional dates that were excluded from that analysis (see text for reasons).

Supplement: Summed probability distribution and kernel density estimate calculation.

Table 1:

Kuril Islands	Date Frequency	Dominant sources
South	89	
Chirpoi	13	
Iturup	14	
Kunashir	4	
Urup	58	Ainu Creek 1
South Center	143	
Matua	7	
Rasshua	66	Rasshua 1
Simushir	58	Vodopadnaya 2
Ushishir	12	
North Central	116	
Chirinkotan	5	
Ekarma	27	Ekarma 1 and 2
Kharimkotan	5	
Makanrushi	12	
Onekotan	11	
Shiashkotan	56	Drobnyye 1
North Kurils	32	
Paramushir	14	
Shumshu	18	
Grand Total	380	

Table 2: [See separate file]

Figure 1

Figure 2

Figure 3

Figure 4-bw

Figure 4-clr

Figure 5-bw

Figure 5-clr

Figure 6-bw

a

b

c

Figure 6-clr

a

b

c

Table 2: Radiocarbon dates from the Kuril Biocomplexity Project (KBP) and International Kuril Island Project (IKIP). Table includes all dates used in the paleodemography model plus a small number of additional dates that were excluded from that analysis (see text for reasons).

Island number	Section	Island	Site Name	Context ²	Material ³	Catalog #	Lab #	14C age	"95.4% Credible Interval	
(cal BP) ⁴ "	Primary IKIP/KBP source ⁶									
1	A-South	Kunashir	Rikorda 1	Test Pit 1, Level 1, 0 - 28cmbs	Ch	KBP 0107	OS-58975	2250±25	2341-2158	C
1	A-South	Kunashir	Rikorda 1	Test Pit 1, Level 2	Ch	KBP 0115	OS-58967	2210±30	2320-2148	D
1	A-South	Kunashir	Serebryanoe 2	Erosion face: 35cmbs, 5 cm below Okhotsk pottery, 15 cm above Epi-Jomon pottery. Kun07-2 (Shubina and Samarin Survey)	Ch	KBP 2635	OS-67411	2440±30	2700-2357	E
1	A-South	Kunashir	Serebryanoe 2	Erosion face: 50-60cmbs, associated with Epi-Jomon pottery. Kun07-1 (Shubina and Samarin Survey)	Ch	KBP 2634	OS-67403	>Modern	n/a	E
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 1, Level 2, hearth feature	Ch	KBP 0059	OS-93589	3290±25	3572-3456	E
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 2, Level 11, charcoal sample #4, from south end of level	Ch	KBP 0083	OS-58748	2300±30	2356-2183	C
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 2, 10 cm above hearth, charcoal sample #5	Ch	KBP 0084	OS-93593	2110±25	2146-2003	E
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 2, Level 9A, charcoal sample	Ch	KBP 0082	OS-93592	2080±35	2144-1950	E

				#3, from north end of level						
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 2, 30-40 cm above hearth, charcoal sample #1	Ch	KBP 0080	OS-93590	2070±30	2123-1950	E
2	A-South	Iturup	Berezovka 1	Erosion face, Profile 2, Level 9B, charcoal sample #2, north end of level	Ch	KBP 0081	OS-93591	2030±30	2105-1898	E
2	A-South	Iturup	Glush	Test Pit 1 (erosion section), cultural layer, 56-80 cmbs - two layers mixed	Ch	KBP 0595	OS-93602	3640±25	4079-3875	E
2	A-South	Iturup	Kasatka Bay 1	Erosion face, 50-60 cm, associated with Middle Jomon pottery, basalt and obsidian: Itur07-2 (Shubina and Samarin Survey)	Ch	KBP 2637	OS-67417	3880±30	4416-4185	C
2	A-South	Iturup	Olya 1	Test Pit 2, 94 cmbs	Ch	KBP 0143	OS-93595	3820±25	4350-4096	E
2	A-South	Iturup	Olya 1	Test Pit 4, bottom cultural layer, Epi-Jomon	Ch	KBP 0139	OS-93594	2990±30	3323-3067	E
2	A-South	Iturup	Olya 1	Test Pit 3, Level 5	Ch	KBP 0152	OS-93597	1170±35	1180-981	E
2	A-South	Iturup	Olya 1	Test Pit 4, 10 cmbs, in root matt with Okhotsk pottery	Ch	KBP 0144	OS-93596	1000±25	964-802	E
2	A-South	Iturup	Rybaki 1	Modern trench exposure: from cultural zone 40-90 cmbs, with Middle Jomon pot sherd at 40cmbs: Itur07-1 (Shubina and Samarin Survey)	Ch	KBP 2636	OS-67412	3930±30	4507-4249	C
2	A-South	Iturup	Tikhaya 1	"Test Pit 2", bark sample from 80cmbs	WB	KBP 0172	OS-93598	1170±25	1179-999	C
3	A-South	Urup	Ainu Creek 1	Test Pit 4, Level 6, 110 - 128cm	Ch	KBP 0386	OS-59522	3230±30	3557-3381	C
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, 210-	Ch	KBP	OS-	2610±25	2765-	E

				220 cmbs		0538	59345		2725	
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, charcoal and bone layer, 242-250 cmbs	Ch	KBP 0510	OS-59344	2550±25	2750-2504	E
3	A-South	Urup	Ainu Creek 1	Test Pit 2, Level 3, 52cmbs, 36E 35N	Ch	KBP 0323	OS-59348	2540±30	2748-2496	D
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 3, 85 cmbd	Ch*	KBP 2361	OS-67620	2540±30	2748-2496	D
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 3, Epi-Jomon level	Ch*	KBP 2584c	OS-67623	2510±30	2740-2489	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, 200 cmbs	Ch	KBP 0531	OS-95615	2490±35	2737-2435	E
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 3, Epi-Jomon level	Ch*	KBP 2584b	OS-67644	2490±35	2737-2435	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, +/-205 cmbs, Epi-Jomon layer	Ch	KBP 0534	OS-98017	2460±25	2705-2379	E
3	A-South	Urup	Ainu Creek 1	Unit A3, Level 2, 45 cmbd	Ch*	KBP 2046	OS-98019	2440±20	2697-2358	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, 260-270 cmbs, basal black layer	Ch	KBP 0507	OS-59376	2430±30	2699-2354	E
3	A-South	Urup	Ainu Creek 1	Unit B3, Level 3, 60 cmbd, near A3 in west section of B3	Ch*	KBP 2281	OS-98021	2430±30	2699-2354	E
3	A-South	Urup	Ainu Creek 1	Test Pit 4, Level 7, 133cmbs	Ch	KBP 0391	OS-59342	2410±30	2688-2350	D
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 3, 65 cmbd	Ch*	KBP 2663	OS-67630	2390±35	2683-2343	E
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 2, directly on top of Level 3	Ch*	KBP 2286	OS-67627	2350±30	2464-2324	E
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 3, Epi-Jomon level	Ch*	KBP 2584a	OS-67643	2310±30	2360-2184	E
3	A-South	Urup	Ainu Creek 1	Unit A1, Level 2, from under dolphin skull	Ch*	KBP 2285	OS-67619	2300±30	2356-2183	E
3	A-South	Urup	Ainu Creek 1	Unit B1, Level 2, 18-20	Ch*	KBP	OS-	2290±30	2354-	E

				cmbd, fire pit area		2359a	98020		2180	
3	A-South	Urup	Ainu Creek 1	Unit B2, Level 2, 25 cmbd (with ceramics)	Ch*	KBP 2044	OS-98018	2190±20	2309-2142	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, 192 cmbs, Epi-Jomon layer	Ch	KBP 0537	OS-59377	2170±30	2309-2065	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, 115-125 cmbs, fish bone and charcoal stratum, above 'Okhotsk' layer	Ch	KBP 0444	OS-59375	2050±35	2120-1925	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, Profile 2, 60 - 80cmbs	Ch	KBP 0443	OS-59795	2010±80	2296-1741	E
3	A-South	Urup	Ainu Creek 1	Test Pit 5, 150-160 cmbs, Okhotsk midden	Ch	KBP 0447	OS-59343	1310±25	1293-1183	E
3	A-South	Urup	Ainu Creek 1	Test Pit 1, 62cmbs, 45 cm N	Ch	KBP 0290	OS-59347	1290±30	1286-1180	E
3	A-South	Urup	Ainu Creek 1	Test Pit 4, Level 3, midden	Ch	KBP 0352	OS-98015	1290±25	1285-1181	E
3	A-South	Urup	Ainu Creek 1	Test Pit 1, 127 cmbs	Ch	KBP 0272	OS-59382	1160±25	1176-986	E
3	A-South	Urup	Ainu Creek 1	Test Pit 1; 115 cmbs, 90 cm, N Charcoal Sample	Ch	KBP 0268	OS-59205	1120±25	1167-960	E
3	A-South	Urup	Ainu Creek 1	Test Pit 4, Level 5, 90 - 95cm	Ch	KBP 0368	OS-59374	880±30	908-729	D
3	A-South	Urup	Aleutka Bay	1978 trench- N Profile, lowest CZ, 14C#1	Ch	IKIP 0304	AA-44266	2255±44	2348-2153	A
3	A-South	Urup	Kama	Profile 2, lowest lamina (sample 1)	Ch	IKIP 0326	AA-40950	2157±37	2309-2013	A
3	A-South	Urup	Kama	Profile 2, CZ 4 (sample 2)	Ch	IKIP 0327	AA-41560	2122±43	2304-1990	A
3	A-South	Urup	Kama	Profile 2, CZ 3 floor 3	Ch	IKIP 0331	AA-44272	2039±39	2115-1899	A
3	A-South	Urup	Kama	Profile 1, CZ 5	Ch	IKIP 0317	AA-41559	2002±34	2041-1876	A
3	A-South	Urup	Kama	Profile 2. CZ 3 (sample 4)	Ch	IKIP	AA-	1967±48	2041-	A

						0329	41561		1818	
3	A-South	Urup	Kama	Profile 2, highest lamina (Sample 3)	Ch	IKIP 0328	AA-44271	1855±38	1879-1708	A
3	A-South	Urup	Kama	Profile 2, CZ 3 floor 2 hearth	Ch	IKIP 0330	AA-41562	1731±47	1780-1537	A
3	A-South	Urup	Kama	Profile 1, CZ 6	Ch	IKIP 0315	AA-44270	1621±37	1604-1410	A
3	A-South	Urup	Kama	Profile 1, level 3B	Ch	IKIP 0311	AA-44267	1364±37	1345-1186	A
3	A-South	Urup	Kama	Profile 1, level 3A	Ch	IKIP 0314	AA-41557	1345±40	1330-1182	A
3	A-South	Urup	Kama	Profile 1, burnt layer	Ch	IKIP 0312	AA-44268	1205±38	1261-1007	A
3	A-South	Urup	Kama	Profile 1, CZ 6	Ch	IKIP 0315	AA-40949	1016±38	1049-798	A
3	A-South	Urup	Kama	Profile 1, CZ 2	Ch	IKIP 0313	AA-44269	916±38	922-745	A
3	A-South	Urup	Kama	Profile 1, CZ 1 (post bomb age)	Ch	IKIP 0316	AA-41558	>Modern	n/a	A
3	A-South	Urup	Kapsul	Test Pit 1, Level 1; Test Pit 1, Level 1,	Ch	KBP 0665	OS-97895	1200±30	1236-1010	E
3	A-South	Urup	Kapsul	Test Pit 4	Ch	KBP 0262	OS-59414	815±25	781-685	E
3	A-South	Urup	Kapsul	Test Pit 3, Level 3	Ch	KBP 0256	OS-59385	135±35	281-6	C
3	A-South	Urup	Kapsul	Test Pit 3, Level 2	Ch	KBP 0255	OS-59497	80±25	259-30	E
3	A-South	Urup	Kapsul	Test Pit 2, Level 2	Ch	KBP 0248	"OS-59383;			
OS-59496"	>Modern	n/a	E							
3	A-South	Urup	Kompaneyski 1	Test Pit 2, n.a., Sample E	Ch	KBP 4316	OS-79912	2100±25	2137-2000	C
3	A-South	Urup	Kompaneyski	Test Pit 2, Level 4C, bulk	Ch	KBP	OS-	2010±30	2041-	E

			1			4308	98006		1885	
3	A-South	Urup	Kompaneyski 1	Test Pit 2, Level 4E	Ch	KBP 4310	OS-98007	2000±20	1994-1897	E
3	A-South	Urup	Kompaneyski 1	Test Pit 2, n.a., Sample F	Ch	KBP 4317	OS-79913	1200±25	1225-1060	E
3	A-South	Urup	Kompaneyski 1	Deflation Basin (NW), below green grey tephra, 2006 exposure cleaning.	Ch	KBP 0421	OS-59415	170±30	291-0	E
3	A-South	Urup	Tokotan 1	Erosion face: creek erosion cut 30m up along creek from M lake; 20-25 cmbs, just below turf level	Ch	KBP 0398	OS-93601	990±25	960-799	E
3	A-South	Urup	Tokotan 4	Test Pit 1, Level 1	Ch	KBP 0418	OS-95613	1320±25	1296-1184	E
3	A-South	Urup	Tokotan 4	Test Pit 1, Level 2	Ch	KBP 0419	OS-95614	1260±35	1283-1083	E
3	A-South	Urup	Vasino 1	Test Pit 2, Level 2, 130 cmbs	Ch	KBP 0230	OS-93600	3510±30	3867-3697	C
3	A-South	Urup	Vasino 1	Test Pit 1, 138 cmbs	Ch	KBP 0200	OS-93599	2080±30	2140-1952	E
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, upper hearth	Ch	IKIP 0291	AA-42208	2435±43	2704-2354	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, scoria layer, 61-63 cmbs.	Ch	IKIP 0283	AA-42205	2290±43	2360-2155	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, fr. White tephra-43 meters fr. North end of profile	Ch	IKIP 0292	AA-42209	2178±42	2320-2060	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, near debitage, stemmed point layer	Ch	IKIP 0293	AA-42210	2088±44	2294-1935	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, Stratwn E, hearth	Ch	IKIP 0288	AA-40947	2080±57	2300-1897	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, north hearth, 3-5 cm above black sand	Ch	IKIP 0284	AA-42206	1959±42	1995-1822	A

4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, hearth #2	Ch	IKIP 0282	AA-42204	1938±43	1994-1742	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, hearth #1	Ch	IKIP 0295	AA-42211	1909±40	1943-1732	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, near Adze	Ch	IKIP 0289	AA-42207	1832±41	1873-1629	A
4	A-South	Chirpoi	Peschanaya Bay 1	Camp Profile, south midden	Ch	IKIP 0263	AA-42203	1272±58	1295-1066	A
4	A-South	Chirpoi	Peschanaya Bay 1	House 31, Unit B3 (outside house wall)	BM	IKIP 0217	AA-40946	825±36	522-382 5	A
4	A-South	Chirpoi	Peschanaya Bay 1	Probe Survey, house pit (GPS 019), 60-75 cm	Ch	KBP 4264	OS-95703	275±20	429-286	E
4	A-South	Chirpoi	Peschanaya Bay 1	House 31, Unit B2 (SE), hearth fill	Ch	IKIP 0215	AA-40945	162±40	289-0	A
5	B-South Center	Simushir	Brotona Bay 2	Erosion face, sample #5	Ch	IKIP 0151	AA-44262	1818±43	1865-1623	A
5	B-South Center	Simushir	Brotona Bay 2	Profile 2, post mold	Ch	IKIP 0154	AA-44264	1732±43	1774-1540	A
5	B-South Center	Simushir	Brotona Bay 2	Profile 2, lower charcoal layer	Ch	IKIP 0153	AA-40944	1695±36	1698-1535	A
5	B-South Center	Simushir	Brotona Bay 2	Erosion face, sample #3	Ch	IKIP 0149	AA-44260	1164±44	1222-970	A
5	B-South Center	Simushir	Brotona Bay 2	Erosion face, sample #2	Ch	IKIP 0148	AA-44259	1121±38	1174-939	A
5	B-South Center	Simushir	Brotona Bay 2	Erosion face, sample #4	Ch	IKIP 0150	AA-44261	1011±40	1048-796	A
5	B-South Center	Simushir	Brotona Bay 2	Erosion face, sample #1	Ch	IKIP 0147	AA-44258	1003±43	982-794	A
5	B-South Center	Simushir	Brotona Bay 2	Profile 2, upper charcoal layer	Ch	IKIP 0152	AA-44263	935±42	930-747	A
5	B-South Center	Simushir	Brotona Bay 2	Profile 2, between upper and lower layers	Ch	IKIP 0155	AA-44265	897±38	914-735	A
5	B-South Center	Simushir	Nakotamori 1	Erosion face, cultural deposit below 1 m. of	Ch	KBP 2153c	OS-67622	140±25	281-6	E

				volcanic overburden, with unburned wood, lithics, bone fragments and cobbles. GPS 117						
5	B-South Center	Simushir	Nakotamori 1	Erosion face, cultural deposit below 1 m. of volcanic overburden, with unburned wood, lithics, bone fragments and cobbles. GPS 117	Ch	KBP 2153b	OS-67618	105±25	268-20	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 16, (GPS 394)	Ch	KBP 1958	OS-95627	2170±30	2309-2065	C
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 25 (GPS 403)	Ch	KBP 1967	OS-95629	2170±30	2309-2065	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 4, 40 cmbs	Ch	KBP 0575	OS-97894	2140±25	2300-2010	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 19 (GPS 397)	Ch	KBP 1954	OS-95626	2080±25	2125-1990	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 1, Level 2, 20-30 cmbs	Ch	KBP 0561	OS-97891	2010±30	2041-1885	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 1, Level 4, 40-50 cmbs	Ch	KBP 0567	OS-97892	2000±25	1998-1891	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 22 (GPS 400)	Ch	KBP 1968	OS-95630	1980±30	1994-1873	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 13 (GPS 391)	Ch	KBP 1952	OS-95625	1970±25	1989-1872	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 2, Level 1, 15-23 cmbs	Ch	KBP 0462	OS-59199	1940±40	1994-1815	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 3 (bottom), North, Strat 1, above tephra, 43-47 cmbs.	Ch	KBP 1825	OS-67470	1930±35	1987-1814	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 5 (base), base of exc., Strat 1	Ch	KBP 1830	OS-67472	1930±30	1946-1820	E
5	B-South	Simushir	Vodopadnaya	Probe Survey, house pit	Ch	KBP	OS-	1920±25	1926-	E

	Center		2	probe 28, (GPS 406)		1951	95624		1820	
5	B-South Center	Simushir	Vodopadnaya 2	house pit Probe 31; GPS point 0409; , house pit Probe 31, GPS point 0409	Ch	KBP 1965	OS-95628	1900±30	1922-1737	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 1, Level 3 from 30-40 cmbs	Ch	KBP 0563	OS-97890	1890±20	1888-1741	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 3 (top), 31-36 cmbs, below coarse cinders, Strat 1	Ch	KBP 1827	OS-67587	1850±30	1865-1715	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 1, Level 1, 0-20 cmbs	Ch	KBP 1013	OS-59204	1820±30	1860-1630	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 5, above sterile	Ch	KBP 1460	OS-97905	1820±25	1824-1639	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 8: 68 cmbd	Ch	KBP 1391	OS-67420	1800±25	1818-1628	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 4, below tephra (?) at 42 cmbs in North wall	Ch	KBP 0576	OS-59346	1740±30	1715-1565	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 1, Level 4C	Ch	KBP 1474	OS-97906	1740±30	1715-1565	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 7	Ch	KBP 0584	OS-59203	1700±30	1697-1544	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 1, Level 7, bottom	Ch	KBP 1536	OS-97997	1700±20	1693-1552	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 13, burned rafter, 85 cmbd	Ch	KBP 1550	OS-67586	1690±30	1694-1534	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 1; North Wall, 62 cmbs, below tephra	Ch	KBP 1831	OS-67492	1650±30	1687-1418	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 6	Ch	KBP 0581	OS-59201	1650±25	1615-1422	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 2, hearth, 45-52 cmbs	Ch	KBP 0474	OS-59197	1600±25	1546-1414	D
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, North 48-49 cmbs, 1 mm below tephra, Strat	Ch	KBP 1824	OS-67617	1570±25	1530-1404	E

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5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 07 (GPS 385)	Ch	KBP 1947	OS-95623	1480±25	1406-1313	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 10, 59 cm	Ch	KBP 1454	OS-67269	1470±30	1405-1305	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 8, bulk	Ch	KBP 1402	OS-97904	1460±30	1398-1302	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 3, above and in midden layers	Ch	KBP 0487	OS-97889	1360±20	1306-1271	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 1, Level 2	Ch	KBP 1231	OS-97900	1310±30	1295-1181	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 4, directly above tephra at 75 cmbs, SE corner	Ch	KBP 0574	OS-97893	1310±25	1293-1183	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 3, inside pot at base of level 3	Ch	KBP 0483	OS-59421	1300±30	1291-1181	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 3, 120 cmbd (bottom cultural level)	Ch	KBP 1329	OS-97903	1300±30	1291-1181	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 1, South Wall, 42 cmbs, below cinders	Ch	KBP 1826	OS-67471	1280±25	1280-1180	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 5	Ch	KBP 0582	OS-59202	1260±30	1282-1086	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 5	Ch	KBP 1565	OS-97998	1110±35	1173-933	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3, Level 2	Ch	KBP 1246	OS-97902	1110±30	1072-937	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 11, 77 cmbd	Ch	KBP 1530	OS-67616	1100±30	1064-937	E
5	B-South Center	Simushir	Vodopadnaya 2	Unit 3 North, Strat 1, 22-25 cmbs cinders	Ch	KBP 1832	OS-67588	1100±30	1064-937	E
5	B-South Center	Simushir	Vodopadnaya 2	Test Pit 3, Level 2	Ch	KBP 0479	OS-59381	1090±25	1058-937	D
5	B-South Center	Simushir	Vodopadnaya 2	Unit 4, Level 10, 60 cmbl, inside house wall	Ch	KBP 1534	OS-97907	1070±25	1054-930	E

5	B-South Center	Simushir	Vodopadnaya 2	Unit 2, Level 2	Ch	KBP 1237	OS-97901	1060±20	1049-928	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 01 (GPS 379)	Ch	KBP 1939	OS-95620	1050±40	1059-914	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 04 (GPS 382)	Ch	KBP 1946	OS-95622	945±25	924-795	E
5	B-South Center	Simushir	Vodopadnaya 2	Probe Survey, house pit probe 10 (GPS 388)	Ch	KBP 1940	OS-95621	430±25	524-342	E
6	B-South Center	Ushishir	Ryponkicha 1	Unit 1, S Trench, 114 cmbl	Ch	KBP 1884	OS-67329	1390±30	1348-1277	C
6	B-South Center	Ushishir	Ryponkicha 1	Test Pit 2, Level 3, 30 - 45cmbs, from bulk midden sample 1/4" fraction	Ch	KBP 0983	OS-59419	1130±25	1173-963	E
6	B-South Center	Ushishir	Ryponkicha 1	Test Pit 2, Level 1, 0-19 cmbs, charcoal	Ch	KBP 0630	OS-59418	1090±30	1058-936	E
6	B-South Center	Ushishir	Ryponkicha 1	Probe Survey, Probe 6, house pit 187, GPS 476, charcoal	Ch	KBP 2118	OS-98002	1000±25	964-802	E
6	B-South Center	Ushishir	Ryponkicha 1	Unit 1, Level 4, bulk	Ch	KBP 1880	OS-98016	975±25	936-796	E
6	B-South Center	Ushishir	Ryponkicha 1	Probe Survey, Probe 2, house pit 185, GPS 472, charcoal above pumice	Ch	KBP 2114	OS-98001	795±25	745-675	E
6	B-South Center	Ushishir	Ryponkicha 2	V131 charcoal	Ch	KBP 4215	OS-95663	1300±25	1289-1182	E
6	B-South Center	Ushishir	Ryponkicha 2	V133 charcoal	Ch	KBP 4214	OS-80150	430±25	524-342	E
6	B-South Center	Ushishir	Ryponkicha South	"JBII" excavation; 84-85 cm	Ch	KBP 0987	OS-80149	615±25	655-550	C
6	B-South Center	Ushishir	Yankicha 1	Test Pit 1, 50-60 cmbs, house pit level	Ch	KBP 0619	OS-59420	100±25	264-23	C
6	B-South Center	Ushishir	Yankicha 2	Probe Survey, house pit 5, below tephra	Ch	KBP 1888	OS-98000	305±25	458-301	C
6	B-South	Ushishir	Yankicha 2	Probe Survey, house pit 3,	Ch	KBP	OS-	35±20	245-35	E

	Center			20 cmbs		1886	97999			
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #7 shell and charcoal layer	Ch	KBP 4010	OS-79602	3450±30	3829-3637	C
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 8	Ch	KBP 3868	OS-79743	3280±35	3585-3409	E
7	B-South Center	Rasshua	Rasshua 1	Erosion face, Section 1B: immediately above lt. grey fine tephra	Ch	KBP 1900	OS-67143	3260±30	3565-3403	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4104	OS-79665	2860±25	3064-2884	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4106	OS-79667	2660±25	2843-2744	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 8A, charcoal concentration	Ch	KBP 3996	OS-79896	2640±30	2842-2735	E
7	B-South Center	Rasshua	Rasshua 1	Erosion face, Section 1B: Epi-Jomon layer, just below fine lt. grey tephra	Ch	KBP 1901	OS-67330	2570±30	2758-2508	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, excavation profile sample	W	KBP 4136	OS-79604	2490±25	2723-2473	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4105	OS-79666	2480±35	2724-2380	E
7	B-South Center	Rasshua	Rasshua 1	Erosion face, Section 1B: Epi-Jomon cultural layer, ca. 5 cm above lt. grey tephra	Ch	KBP 1899	OS-67086	2430±25	2697-2355	B
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4103	OS-79720	2430±25	2697-2355	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #14	Ch	KBP 4017	OS-79598	2260±30	2346-2158	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 4	Ch	KBP 3650	OS-79863	2250±25	2341-2158	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, level 3J	Ch	KBP 4155	OS-79859	2230±30	2333-2153	E

7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4102	OS-79671	2210±25	2313-2151	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 7B	Ch	KBP 3839	OS-79868	2160±35	2308-2046	E
7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N67 (GPS 258)	Ch	KBP 4044	OS-80017	2130±25	2296-2006	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4100	OS-79670	2110±25	2146-2003	E
7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N67 (GPS 258)	Ch	KBP 4046	OS-80018	2080±25	2125-1990	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4099	OS-79669	2080±25	2125-1990	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 7A	Ch	KBP 3828	OS-79867	2040±30	2111-1904	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 7A	Ch	KBP 3827	OS-79866	2040±25	2109-1926	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 6	Ch	KBP 3820	OS-79865	2020±30	2056-1892	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 5	Ch	KBP 3652	OS-79864	2010±30	2041-1885	E
7	B-South Center	Rasshua	Rasshua 1	Erosion face, Section 1A, 25-30 cm, just above orange f-ms yellow brown tephra	Ch	KBP 1907	OS-67131	1990±30	1998-1878	B
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #10	Ch	KBP 4013	OS-79594	1970±30	1994-1865	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #13	Ch	KBP 4016	OS-79597	1970±25	1989-1872	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, excavation profile	Ch	KBP 4097	OS-79668	1950±25	1970-1825	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #8	Ch	KBP 4011	OS-79603	1940±30	1969-1821	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #2	Ch	KBP 4005	OS-79600	1930±25	1929-1822	E

7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N70 (GPS 248)	Ch	KBP 4030	OS-80016	1920±30	1948-1746	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 3	Ch	KBP 3658	OS-79862	1920±25	1926-1820	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 2, Level 2	Ch	KBP 3580	OS-79861	1860±30	1870-1720	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 5	Ch	KBP 3727	OS-79725	1820±25	1824-1639	E
7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N70 (GPS 248)	Ch	KBP 4029	OS-80015	1810±25	1820-1633	E
7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N40 (GPS 259)	Ch	KBP 4048	OS-80019	1720±25	1699-1562	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 7	Ch	KBP 3844b	OS-79741	1700±35	1699-1540	E
7	B-South Center	Rasshua	Rasshua 1	Probe Survey: house pit N14 (GPS 268)	Ch	KBP 4061	OS-80020	1670±30	1693-1523	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #11	Ch	KBP 4014	OS-79595	1280±25	1280-1180	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #3	Ch	KBP 4006	OS-80139	1120±50	1174-936	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, base of Level 4	Ch	KBP 3761	OS-79723	1100±35	1168-931	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 3, base of midden	Ch	KBP 3507	OS-79722	1000±30	967-799	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile, "npcs" #4	Ch	KBP 4007	OS-79601	1000±25	964-802	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 3B	Ch	KBP 3600	OS-79726	950±25	926-796	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 4 midden	Ch	KBP 3586	OS-79724	935±25	920-793	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 7A	Ch	KBP 3860	OS-79742	925±30	925-768	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 4 midden	Ch	KBP 3681	OS-98011	920±20	912-789	E

7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 3	Ch	KBP 3617	OS-79744	915±30	920-762	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 2, charcoal concentration	Ch	KBP 3497	OS-79721	905±25	913-746	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile: "npcs" #12	Ch	KBP 4015	OS-79596	905±25	913-746	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 4 midden	Ch	KBP 3709	OS-98012	890±25	907-735	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 4B	Ch	KBP 4453	OS-98014	890±20	905-736	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, Level 3	Ch	KBP 4473	OS-98009	860±20	893-726	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1A, excavation profile: "npcs" #14	Ch	KBP 4018	OS-79599	835±30	793-687	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 4	Ch	KBP 4285	OS-79860	830±25	786-691	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 3G	Ch	KBP 3911	OS-79728	315±30	466-302	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 3C	W	KBP 3721	OS-79727	245±25	423-0	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, level 3H, roof structure wood sample #1	W	KBP 3947	OS-79729	225±30	310-0	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, Level 3i	Ch	KBP 3935	OS-79731	215±25	305-0	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, level 3H, roof structure wood sample #4	W	KBP 3943	OS-79730	205±35	309-0	E
7	B-South Center	Rasshua	Rasshua 1	Test Pit 1B, excavation profile sample	W	KBP 4137	OS-79664	170±30	291-0	E
7	B-South Center	Rasshua	Rasshua 1	Erosion face, Section 1B, "Ainu" level	Ch	KBP 1904	OS-67130	30±30	255-31	E
7	B-South Center	Rasshua	Rasshua 2	Probe Survey, Probe 2 (GPS 134): below cinders	Ch	KBP 2128	OS-67134	1720±30	1703-1560	C
7	B-South Center	Rasshua	Rasshua 2	Probe Survey, Probe 3 (GPS 135): below first (top)	Ch	KBP 2130	OS-67136	1190±35	1235-989	E

				tephra						
7	B-South Center	Rasshua	Rasshua 2	Probe Survey, Probe 3 (GPS 135): above first (top) tephra	Ch	KBP 2129	OS-67135	1100±35	1168-931	E
7	B-South Center	Rasshua	Rasshua 2	Probe Survey, Probe 1 (GPS 134) 10-15 cmbs: above cinders	Ch	KBP 2127	OS-67133	130±25	273-10	E
8	B-South Center	Matua	Ainu Bay 1 and 2	Level 14 of Y. Ishizuka's geological column	Ch	IKIP 0113	AA-40943	2345±37	2651-2211	A
8	B-South Center	Matua	Ainu Bay 1 and 2	Erosion face: Marsh Erosional Scarp, sample 5, 1-3 cm below yellow tephra	Ch	KBP 2106	OS-67626	1970±40	1999-1825	C
8	B-South Center	Matua	Ainu Bay 1 and 2	Test Pit 2, cultural level	Ch	IKIP 0129	AA-40942	1604±36	1565-1405	A
8	B-South Center	Matua	Ainu Bay 1 and 2	Test Pit 5, road cut, upper level	Ch	KBP 2089	OS-67589	815±30	782-684	E
8	B-South Center	Matua	Ainu Bay 1 and 2	Geo Survey: (MacInness GPS 91), cultural deposit	Ch	KBP 2617	OS-67621	815±25	781-685	E
8	B-South Center	Matua	Ainu Bay 1 and 2	Erosion face; Marsh Erosional Scarp, sample 4, 1-2 cm below brown tephra	Ch	KBP 2105	OS-67590	295±25	455-296	E
8	B-South Center	Matua	Ikeda Bay	Cliff profile, 45-46 cmbs	Ch	IKIP 0141	AA-42201	66±38	266-22	A
9	C-North Central	Shiashkotan	Bashmak 1	Test Pit 1, 15 cmbs	Ch	KBP 3153	OS-95632	265±35	458-0	E
9	C-North Central	Shiashkotan	Bashmak 2	Probe Survey, house pit 2, 55 cmbs	Ch	KBP 3166	OS-80021	370±30	504-317	C
9	C-North Central	Shiashkotan	Bashmak 2	Test Pit 1, Level 3, from yellow sand (tephra?) lens on north wall profile	Ch	KBP 3164	OS-80023	340±25	478-313	E
9	C-North Central	Shiashkotan	Bashmak 2	Test Pit 1, Level 3, 61 cmbd: (next to artifact #3165)	Ch	KBP 3162 a	OS-80022	280±25	435-158	E
9	C-North Central	Shiashkotan	Bashmak 3	Test Pit 1, 74 cmbs	Ch	KBP 3173	OS-80026	905±25	913-746	C

9	C-North Central	Shiashkotan	Bashmak 3	Test Pit 1, 57 cmbs	Ch	KBP 3169	OS-80025	805±35	783-677	E
9	C-North Central	Shiashkotan	Bashmak 3	Probe Survey, house pit 6 (GPS 475), 40 cmbs	Ch	KBP 3170	OS-80024	260±25	429-151	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 36, house pit ____, GPS 446	Ch	KBP 1673	OS-67483	2990±30	3323-3067	C
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 30, house pit 260, pit next to house, GPS 439	Ch	KBP 1666	OS-67479	2960±40	3235-2980	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 4, Level 4, 37cmbd, within compact sand	Ch	KBP 1715	OS-67469	2920±30	3160-2969	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 29, house pit 260, GPS 438	Ch	KBP 1665	OS-67443	2900±30	3156-2953	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 43, house pit 278, GPS 453	Ch	KBP 1680	OS-67446	2630±25	2779-2738	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 1, Level 4, 119 cm charcoal, pit bottom	Ch	KBP 1798	OS-79900	2440±25	2699-2357	E
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 1, Level 6	Ch	KBP 0770	OS-59195	2130±35	2301-1999	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 2; 82-83 cmbd	Ch	KBP 2672	OS-67419	2080±30	2140-1952	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 2; 57-63 cmbd	Ch	KBP 2671	OS-67418	1960±25	1987-1835	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 7, house pit 231, GPS 417	Ch	KBP 1651	OS-67415	1920±25	1926-1820	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 3, house pit 0235	Ch	KBP 1647	OS-67414	1890±30	1895-1733	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 31 (GPS 440), house pit 264	Ch	KBP 1667	OS-67480	1880±30	1885-1728	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 40 (GPS 450), house pit	Ch	KBP 1677	OS-67487	1800±25	1818-1628	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 12 (GPS 422), house pit 246	Ch	KBP 1655	OS-67423	1790±30	1817-1620	E
9	C-North	Shiashkotan	Drobnyye 1	Unit 3, Level 3, top 5 cm of	Ch	KBP	OS-	1720±35	1709-	E

	Central			level		1602	67304		1554	
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 27 (GPS 436), house pit 257	Ch	KBP 1662	OS- 67441	1700±30	1697- 1544	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 1, Level 4, 108 cmbI	Ch	KBP 1695	OS- 79899	1660±25	1685- 1523	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 18 (GPS 428), house pit 248	Ch	KBP 1658	OS- 67424	1620±30	1569- 1412	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 20 (GPS 430), house pit 238	Ch	KBP 1659	OS- 67425	1610±30	1559- 1412	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 23 (GPS 433), house pit 253	Ch	KBP 1661	OS- 67440	1570±35	1541- 1386	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 1, Level 3, 93 cmbd	Ch	KBP 1610	OS- 79898	1550±25	1525- 1384	E
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 1, Level 5	Ch	KBP 0765	OS- 59107	1470±35	1413- 1299	D
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 1, Level 4	Ch	KBP 0758	OS- 59190	1460±35	1405- 1300	E
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 1, Level 2, 55 cmbd, charcoal sample #2	Ch	KBP 1592	OS- 79897	1290±30	1286- 1180	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 4 (GPS #415), house pit 234	Ch	KBP 1648	OS- 67421	1250±30	1274- 1080	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 27 (GPS 435), house pit 256	Ch	KBP 1663	OS- 67442	1130±35	1174-961	E
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 1, Level 2	Ch	KBP 0715	OS- 59036	1110±25	1064-960	D
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 3, Level 4, 62-63 cmbI	Ch	KBP 1642	OS- 67413	1110±25	1064-960	D
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 2, Level 2, base of level near Epi-Jomon ceramic	Ch	KBP 0723	OS- 58974	960±25	930-796	D
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 54 (GPS 466), house pit 286	Ch	KBP 1684	OS- 67488	950±30	926-795	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 5 (GPS 416), house pit 0233	Ch	KBP 1649	OS- 67422	920±25	920-783	E

9	C-North Central	Shiashkotan	Drobnyye 1	Unit 3, Level 3	Ch	KBP 1603	OS-67406	870±30	905-701	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 42 (GPS 452), house pit 280	Ch	KBP 1679	OS-67445	860±25	898-699	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 6 (GPS 416), house pit 232	Ch	KBP 1650	OS-67584	830±30	790-687	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 39 (GPS 449), house pit 292	Ch	KBP 1676	OS-67585	825±30	787-687	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 38 (GPS 448), house pit 296	Ch	KBP 1675	OS-67444	760±30	731-666	E
9	C-North Central	Shiashkotan	Drobnyye 1	Test Pit 1, Level 3, above Tephra	Ch	KBP 0750	OS-59106	750±30	728-664	D
9	C-North Central	Shiashkotan	Drobnyye 1	Unit 4, Level 3, top of level	Ch	KBP 1634	OS-67407	310±25	459-303	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 32 (GPS 463), house pit	Ch	KBP 1668	OS-67481	150±25	284-0	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 9 (GPS 419), house pit 252	Ch	KBP 1653	OS-67416	130±30	276-9	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 35 (GPS 444), house pit 261	Ch	KBP 1672	OS-67482	130±25	273-10	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 47 (GPS 458)	Ch	KBP 1682	OS-67447	130±25	273-10	E
9	C-North Central	Shiashkotan	Drobnyye 1	Probe Survey, Probe 37 (GPS 447), house pit 295	Ch	KBP 1674	OS-67484	120±30	272-11	E
9	C-North Central	Shiashkotan	Grotovyie 1	Test Pit 2; 31-35 cmbs, bulk	Ch	KBP 0868	OS-95617	880±25	905-730	C
9	C-North Central	Shiashkotan	Grotovyie 1	Test Pit 1, Level 2	Ch	KBP 0858	OS-97899	150±20	284-2	E
9	C-North Central	Shiashkotan	Rebristyy 1	Probe Survey, house pit 96, N48.80418, E154.13298	Ch	KBP 2087	OS-67409	1260±35	1283-1083	C
9	C-North Central	Shiashkotan	Rebristyy 1	Probe Survey, house pit 97, N48.80418, E154.13293	Ch	KBP 2088	OS-67410	680±25	677-563	E
9	C-North Central	Shiashkotan	Rebristyy 1	Probe Survey, house pit 99, N48.80439, E154.13293	Ch	KBP 2086	OS-67402	255±25	427-0	E

9	C-North Central	Shiashkotan	Zakatnaya	Test Pit 1, marine mammal bone near surface	BM	IKIP 0117	AA-44273	983±34	636-513 5	A
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 1, 60 cmbs	Ch	KBP 2060	OS-67382	1230±25	1260-1069	C
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 3, SE quad	Ch	KBP 2964	OS-79903	1180±25	1180-1006	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, East Profile, bottom Layer L; charcoal sample #15	Ch	KBP 3125	OS-79910	1100±25	1062-956	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit "7" from probe	Ch	KBP 3143	OS-79937	1070±25	1054-930	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 4	Ch	KBP 3062	OS-98013	1070±20	1050-931	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 4, cultural layer	Ch	KBP 3013	OS-79933	1040±25	1045-921	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 4; lots of charcoal fragments	Ch	KBP 3127	OS-98010	1010±20	965-910	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, East Profile, top of Layer I; charcoal sample #11	Ch	KBP 3132	OS-79908	1000±25	964-802	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 4, SE quad, below tephra	Ch	KBP 3054	OS-79907	955±30	928-795	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 13: below seven tephra	Ch	KBP 3138b	OS-79915	955±25	928-796	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 3E, SW quad	W	KBP 3102	OS-79905	945±25	924-795	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 4; SW corner	W	KBP 3096	OS-79906	930±25	920-790	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, East Profile, Layer K- below tephra: charcoal sample #14	Ch	KBP 3126	OS-79909	910±25	915-764	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 4: charcoal below tephra	Ch	KBP 3146	OS-79934	905±25	913-746	E
10	C-North	Ekarma	Ekarma 1 1	Test Pit 1, East Profile,	Ch	KBP	OS-	900±25	911-741	E

	Central			Layer F: "#7 Charcoal?"		3123	79911			
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 2; lower part of cultural zone	Ch	KBP 3135	OS-79932	900±25	911-741	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 6 probe; lower cultural level	Ch	KBP 3141	OS-79936	900±25	911-741	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit "7" probe	Ch	KBP 3144	OS-79949	845±30	893-689	E
10	C-North Central	Ekarma	Ekarma 1 1	Test Pit 1, Level 1: 30 cmbs	Ch	KBP 2058	OS-67132	835±30	793-687	E
10	C-North Central	Ekarma	Ekarma 1 1	Probe Survey, house pit 6; top cultural level	Ch	KBP 3140	OS-79935	395±25	510-330	E
10	C-North Central	Ekarma	Ekarma 2	Probe Survey, house pit 15, brown cultural layer	Ch	KBP 3069	OS-79931	2000±25	1998-1891	C
10	C-North Central	Ekarma	Ekarma 2	Probe Survey, house pit 1, 34 cmbs	Ch	KBP 3023	OS-79914	1930±25	1929-1822	E
10	C-North Central	Ekarma	Ekarma 2	Probe Survey, house pit 13, cultural layer	Ch	KBP 3068	OS-79916	1900±30	1922-1737	E
10	C-North Central	Ekarma	Ekarma 2	Test Pit 1, Level 3	Ch	KBP 3079	OS-79904	940±30	925-791	E
10	C-North Central	Ekarma	Ekarma 2	Test Pit 1, Level 1	Ch	KBP 3071	OS-79901	925±30	925-768	E
10	C-North Central	Ekarma	Ekarma 2	Test Pit 1, Level 2, below grey tephra	Ch	KBP 3073	OS-79902	845±25	793-694	E
10	C-North Central	Ekarma	Ekarma 2	Probe Survey, house pit 9, 20-28 cmbs	Ch	KBP 3028	OS-80014	695±30	687-563	E
11	C-North Central	Chirinkotan	Chirinkotan 1	Erosion face, Profile 1, 180 cmbs	Ch	KBP 2077	OS-67124	1620±30	1569-1412	E
11	C-North Central	Chirinkotan	Chirinkotan 1	Erosion face, Profile 1, 161 cmbs	Ch	KBP 2076	OS-67090	1610±25	1555-1414	E
11	C-North Central	Chirinkotan	Chirinkotan 1	Erosion face, Profile 1, 110 cmbs	Ch	KBP 2075	OS-67089	1130±25	1173-963	E
11	C-North Central	Chirinkotan	Chirinkotan 1	Erosion face, Profile 1, 83 cmbs	Ch	KBP 2074	OS-67088	970±30	934-796	E
11	C-North	Chirinkotan	Chirinkotan 1	Erosion face, Profile 1, 77	Ch	KBP	OS-	925±25	918-788	E

	Central			cmbs		2073	67087			
12	C-North Central	Kharimkotan	Cape Ankuchi	Fox hole exposure, 60 cmbs.	Ch	KBP 3235	OS- 80118	945±25	924-795	C
12	C-North Central	Kharimkotan	Cape Ankuchi	Probe Survey, point 202, house pit, 40 cmbs	Ch	KBP 3210	OS- 93692	240±30	425-0	E
12	C-North Central	Kharimkotan	Cape Ankuchi	Probe Survey, point 216, house pit, 40 cmbs	Ch	KBP 3224	OS- 80119	85±25	260-26	E
12	C-North Central	Kharimkotan	Kharimkotan 1	Erosion face: 28 - 35cmbs (collected by M.E.Martin)	Ch	KBP 0973	OS- 93672	1370±25	1328- 1269	C
12	C-North Central	Kharimkotan	Lake Lazurnoye	Test Pit 1, directly below thin sand layer, ~ 10 cmbs	Ch	KBP 3199	OS- 98003	1090±25	1058-937	E
13	C-North Central	Onekotan	Cape Gorely'y	Erosional face, 25-38 cmbs	Ch	KBP 3294	OS- 80121	3070±25	3358- 3214	C
13	C-North Central	Onekotan	Cape Gorely'y	Probe Survey, point 8-VG- 01-E; house pit, 70 cmbs	Ch	KBP 3305a	OS- 98005	2900±25	3142- 2957	E
13	C-North Central	Onekotan	Cape Gorely'y	Probe Survey, point 8-VG- 01-B; house pit, 22 cmbs	Ch	KBP 3303	OS- 80120	910±25	915-764	E
13	C-North Central	Onekotan	Cape Lisiy	Probe Survey, point 147; house pit, 90-100 cmbs	Ch	KBP 3285	OS- 80148	1050±25	1049-925	E
13	C-North Central	Onekotan	Cape Lisiy	Probe Survey, point 148; house pit, 35 cmbs	Ch	KBP 3286	OS- 98004	875±20	900-731	E
13	C-North Central	Onekotan	Cape Lisiy	Probe Survey, point 147; house pit, 45 cmbs	Ch	KBP 3284	OS- 80123	150±30	284-0	E
13	C-North Central	Onekotan	Cape Lisiy Bay	Nakagawa Excavation, Level 2	Ch	KBP 3280	OS- 80122	1090±25	1058-937	C
13	C-North Central	Onekotan	Nemo Bay 2	Test Pit: cultural layer at 147-152 cmbs (NGR excavation)	Ch	KBP 3444	OS- 93673	2460±25	2705- 2379	C
13	C-North Central	Onekotan	Yagodnnyy North	Test Pit 1, 30-35 cmbs	Ch	KBP 3254	OS- 80153	1050±25	1049-925	C
13	C-North Central	Onekotan	Yagodnnyy North	Test Pit 1, 17-18 cmbs	Ch	KBP 3245	OS- 80152	1000±30	967-799	E
13	C-North Central	Onekotan	Yagodnnyy North	Probe Survey, house pit # 9; 30-35 cmbs	Ch	KBP 3267	OS- 80151	915±25	919-767	E

14	C-North Central	Makanrushi	Bukhta Vostok	Probe Survey, GPS #174; from old test pit, 20-30 cmbs	Ch	KBP 3427	OS-80028	2250±25	2341-2158	C
14	C-North Central	Makanrushi	Bukhta Vostok	Probe Survey, GPS #197; 20 cmbs (see ID#3435)	Ch	KBP 3436	OS-80029	1020±25	977-835	E
14	C-North Central	Makanrushi	Bukhta Vostok	Probe Survey, GPS #197; house pit, 30-35 cmbs	Ch	KBP 3437	OS-80030	1020±25	977-835	E
14	C-North Central	Makanrushi	Bukhta Vostok	Probe Survey, GPS #165; house pit, 50-60 cmbs.	Ch	KBP 3418	OS-80027	860±30	901-695	E
14	C-North Central	Makanrushi	Bukhta Zakat	Probe Survey, GPS #159, house pit 25 cmbs	Ch	KBP 3405	OS-80112	1090±25	1058-937	C
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, Level 5, 124 cmbd in SE Quad	Ch	KBP 3347a	OS-95662	965±30	932-796	E
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, Level 2, 77 cmbd	Ch	KBP 3339	OS-80115	910±25	915-764	E
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, Level 4, 93 cmbd	Ch	KBP 3342	OS-80117	910±25	915-764	E
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, Level 3, 79 cmbd	Ch	KBP 3341	OS-80116	905±25	913-746	E
14	C-North Central	Makanrushi	Bukhta Zakat	Probe Survey, house pit B, 25-28 cmbs	Ch	KBP 3372	OS-80113	890±25	907-735	E
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, 25 cmbs; upper part of sea urchin layer	Ch	KBP 3333	OS-80114	885±25	906-732	E
14	C-North Central	Makanrushi	Bukhta Zakat	Test Pit 1, Level 2	Ch	KBP 3309	OS-98008	830±20	781-694	E
15	D-North Kurils	Paramushir	Okeanskoye	Test Pit 2, 70 cmbs	Ch	KBP 0965	OS-93610	3780±30	4245-4009	C
15	D-North Kurils	Paramushir	Okeanskoye	Test Pit 1	Ch	KBP 0959	OS-93609	1830±30	1864-1639	E
15	D-North Kurils	Paramushir	Savushkina 1	Test Pit 2, Level 1	Ch	KBP 0803	OS-97896	2100±25	2137-2000	C
15	D-North Kurils	Paramushir	Savushkina 1	Test Pit 1, Level 2	Ch	KBP 0805	OS-67267	1910±30	1929-1741	E
15	D-North	Paramushir	Savushkina 1	Test Pit 1, Level 1	Ch	KBP	OS-	1120±35	1173-955	E

	Kurils					0815	67268			
15	D-North Kurils	Paramushir	Savushkina 2	Erosion face, Road Profile	Ch	KBP 0790	OS-93604	3750±25	4227-3990	C
15	D-North Kurils	Paramushir	Savushkina 2	Test Pit 1, cultural level	Ch	KBP 0794	OS-93605	3740±25	4220-3987	E
15	D-North Kurils	Paramushir	Savushkina 2	Probe Survey: probe sample in big house	Ch	KBP 0795	OS-93606	1740±25	1710-1570	E
15	D-North Kurils	Paramushir	Tukharka River 1	Test Pit 3, Level 1, 70 cm	Ch	KBP 0873	OS-59029	2560±30	2754-2502	C
15	D-North Kurils	Paramushir	Tukharka River 1	Test Pit 1, 40 cmbs	Ch	KBP 0872	OS-59028	60±30	258-31	E
15	D-North Kurils	Paramushir	Zerkalnaya	Erosion profile, above sands	Ch	IKIP 0019	AA-40939	935±38	929-766	A
15	D-North Kurils	Paramushir	Zerkalnaya	Erosion profile, 36 cmbs, just below lower sand lens	Ch	IKIP 0031	AA-40940	892±35	911-733	A
15	D-North Kurils	Paramushir	Zerkalnaya	Center of pit house test	Ch	IKIP 0029	AA-44257	206±35	309-0	A
15	D-North Kurils	Paramushir	Zerkalnaya	Center of pit house test	Ch	IKIP 0029	AA-41556	99±33	269-13	A
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 4, Point B, 120 cmbs	Ch	KBP 0854	OS-97898	5290±35	6184-5948	C
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 3, 79 cmbs	Ch	KBP 0963	OS-59038	2440±30	2700-2357	E
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 1, level 4, 77-93 cmbs	Ch	KBP 0949	OS-59037	2190±30	2310-2127	E
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 2, Level 6	Ch	KBP 0929	OS-95638	2170±55	2325-2008	E
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 1, Level 2, 47-57 cmbs	Ch	KBP 0944	OS-59194	2110±25	2146-2003	E
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 1, level 3, 57-77 cmbs	Ch	KBP 0948	OS-59192	2010±35	2054-1880	D
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 1, Layer 1, 20-47 cmbs	Ch	KBP 0941	OS-59193	1970±35	1995-1830	E
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 2, sod	Ch	KBP	OS-	1370±25	1328-	E

	Kurils					0906	95618		1269	
16	D-North Kurils	Shumshu	Baikova 1	Test pit 1, midden	Ch	IKIP 0067	AA-40941	975±35	953-795	A
16	D-North Kurils	Shumshu	Baikova 1	Test Pit 2, Level 2	Ch	KBP 0921	OS-95982	155±20	284-1	E
16	D-North Kurils	Shumshu	Bol'shoy 1	Test Pit 3, Level 2, Midden B	Ch	KBP 0828	OS-59198	3330±35	3678-3466	C
16	D-North Kurils	Shumshu	Bol'shoy 1	Test Pit 2, Midden A, 77cmbs	Ch	KBP 0824	OS-97897	2220±30	2324-2152	E
16	D-North Kurils	Shumshu	Bol'shoy 1	Test Pit 1, from inside ceramic sherd	Ch	KBP 0833	OS-95616	2010±25	2035-1892	E
16	D-North Kurils	Shumshu	Bol'shoy 1	Test Pit 2, around sea lion skull	Ch	KBP 0831	OS-59349	1180±30	1221-999	E
16	D-North Kurils	Shumshu	Bol'shoy 2	Test Pit 2; 24-40 cmbs	Ch	KBP 0800	OS-93607	1760±25	1735-1571	C
16	D-North Kurils	Shumshu	Bol'shoy 2	Test Pit 2; 50-60 cmbs	Ch	KBP 0801	OS-93608	1620±40	1605-1409	E
16	D-North Kurils	Shumshu	Bol'shoy 2	Test Pit 1, 209 cmbs	Ch	KBP 0782	OS-93603	350±25	492-315	E
16	D-North Kurils	Shumshu	Bol'shoy 2	Test Pit 1, 280 cmbs	Ch	KBP 0785	OS-93690	265±30	434-0	E

1. Site Name: Ekarma 1 site, originally identified in 2006, was later treated as a new site during the 2007 excavations and labelled "Ekarma 3." These are the same site and samples from both years are labeled Ekarma 1 here.
2. Context: Details on excavations and samples can be found in annual reports available through the Digital Archaeological Repository (tDAR): Fitzhugh et al. 2007, Fitzhugh et al. 2009a, and 2009b. See References for access link.
3. Material: BM = marine bone (excluded from analysis); Ch = wood charcoal; Ch* = wood charcoal recovered from Ainu Creek in 2007 post-disturbance, excluded from analysis; W = unburned wood; WB = wood bark.
4. Calibration: Oxcal 4.2, IntCal13, unless otherwise noted
5. Calibration: OxCal 4.2, Marine13
6. References: (A) Fitzhugh et al., 2002; (B) Fitzhugh, 2012; (C) MacInnes et al., 2014; (D) Phillips and Speakman, 2009; (E) this paper