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Landscape Agency and Evenki-Iakut Reindeer Husbandry along the Zhuia River, Eastern Siberia

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Abstract:	This interdisciplinary study applies a series of environmental tests developed in Fennoscandia to elaborate the patterns created by contemporary and past reindeer husbandry along the Zhuia River, Bodaibo district, Irkutsk oblast', Russian Federation. The study successfully used pollen and fungal spore analysis to document the long-term use of at least one site by ungulates - although it remains unclear if these animals were 'domestic' reindeer or not. The date of occupation could go as far back as the fourteenth century. The on-site phosphate analysis, itself attempted for the first time in Eastern Siberia, proved a useful tool for locating the sites of animal action although failed to specify the boundaries of that action. It did emphasise the importance of accounting for the agency of wind in ordering reindeer behaviour. Finally, the combined phosphate, botanical, and pollen work documented a history of succession of types of land-use from the hunting of Rangifer, to holding Rangifer, to the maintenance of meadows for horse or cattle, to the formation of cereal crops and vegetable patches. The combined use of these methods, and a discussion of the ambiguities they produced, suggests that they are best employed to find distinctive sites in the landscape which attract both people and animals - an aian in local parlance - and are less effective in documenting a Euro-American vision of trust or domination in human-animal relations.
Response to Reviewers:	Reviewer 1 requested minor changes to figure 16 and to the concept of herd-following (p.4), both of which have been done. Reviewer 3 had a longer list of minor changes, all of which have been incorporated: a)The reviewer asked us to comment on the extent that post 1843 and Soviet-era activities obliterated earlier patterns. This is a clumsy question in the sense that Russian settlement did occur on top of meadows opened first by reindeer. The later occupation obliterated artefacts and plant cover but not the soil record. The point of the

	method is explain these soil markers. We reviewed the article and we think that this is clear, although we added clauses of clarification on pages 18 and 21. b)The section on the problems with phosphate analysis was reworded, but I think as the reviewer accepted, the problems with the method are clear. The one citation he provided (Wells et al) was not added since it refers to the interpretation of middens and not activity areas. c)Figure numbers, names all made consistent. d)Although the term 'environmental archaeology' is widely used in Europe, esp in the Scandinavian languages (miljø arkeologi), it is not the main theme of the article and therefore the term was dropped. e)An addition clarification added about the indirect link of pollen and phosphate tests to human occupation on page 4. f)The paragraph on access to the site deleted. g)The use of aerial photographs in the research was stressed in the original text on page 10 and footnote 2. These were slightly reworded for re-emphasis. These are of higher resolution than the satellite photographs the reviewer suggests. A portion of one is submitted as figure 4. h) We added a short sentence and footnote on the subject of semi-domestication on page 22 (quoting the reviewer).

Landscape Agency and Evenki-Iakut Reindeer Husbandry along the Zhuia River, Eastern Siberia

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Abstract This interdisciplinary study applies a series of environmental tests developed in Fennoscandia to elaborate the patterns created by contemporary and past reindeer husbandry along the Zhuia River, Bodaibo district, Irkutsk *oblast',* Russian Federation. The study successfully used pollen and fungal spore analysis to document the long-term use of at least one site by ungulates – although it remains unclear if these animals were 'domestic' reindeer or not. The date of occupation could go as far back as the fourteenth century. The on-site phosphate analysis, itself attempted for the first time in Eastern Siberia, proved a useful tool for locating the sites of animal action although failed to specify the boundaries of that action. It did emphasise the importance of accounting for the agency of wind in ordering reindeer behaviour. Finally, the combined phosphate, botanical, and pollen work documented a history of succession of types of land-use from the hunting of Rangifer, to holding Rangifer, to the maintenance of meadows for horse or cattle, to the formation of cereal crops and vegetable patches. The combined use of these methods, and a discussion of the ambiguities they produced, suggests that they are best employed to find distinctive sites in the landscape which attract both people and animals – an *aian* in local parlance – and are less effective in documenting a Euro-American vision of trust or domination in human-animal relations.

Keywords: Siberia, Evenki, reindeer, pastoralism, landscape, ethnography, pollen, phosphate, history of science

Introduction

This article reports on the work of an interdisciplinary team trying to understand the history of the unique taiga spaces created by the Zhuia River Evenkis. The methods reported here have been to our knowledge been used for the first time to document the history of land use and occupation in Siberia. Our work yields strong evidence of the way that Evenkis and their reindeer shape the landscape, and thereby create a unique artefact of their history. We further argue that these environmental techniques provide important clues to document Rangifer-associated, and perhaps. anthropogenetic landscapes, and thereby shed light on the nature of human-animal relationships generally.

Evenkis are a widely-dispersed hunting and reindeer herding people who inhabit a range of environments from the tundra treeline in Northern Russia to the Northern taiga of China and Mongolia (Vasilevich 1969; Vasilevich and Smolniak 1965). They are perhaps better known in English by their pre-revolutionary ethnonym 'Tungus' through the work of S.M. Shirogokoroff (1935; 1933) who documented neighbouring populations in what is today Zaibaikal Krai. The Zhuia River Evenki-Iakuts live along a series of tributaries of the Lena River – the Zhuia, Chara, and Khomolkho Rivers – at the Northern edge of the Baikal-Patom plateau. In the 18th Century their documented movements took them up and down the Nechara, Chara and Zhuia River valleys. Their land-use today is confined chiefly to the Northern part of their territory around the community of Perevoz (Figure 1).

The taiga life of the Zhuia River Evenki-Iakuts, as with most Evenkis living along the southern border of what is today the Republic of Sakha (Iakutiia), is distinguished by a semi-sedentary seasonal residential pattern. They follow their reindeer up and down the side tributaries using the headwaters in the winter and moving towards the mouths of the rivers in the summers. Their reindeer to a great extent give clues as to the timing of the seasonal movements. As the reindeer seek out alpine pastures with shallow snow in the winter, their hosts follow them there. In the spring the herds crave the fresh grass which grows first on patches which melt early in the spring along the banks of major rivers. This variant of 'herd-following' (Burch 1991) – where the animals select comfortable sites - challenges standard definitions of 'trust' and 'domination' in the history of animal domestication (Ingold 1994). As with Tuvan Todzha, and many other Southern taiga peoples, Zhuia Evenkis do not track or cajole their reindeer to move from one site to another. Rather, they encourage the reindeer to return to environments that they find attractive (Stépanoff 2012). To this end Evenkis often design early summer camping sites equipped with smoke –smudges, shade-structures (*dugde* –Ev.; *naves* – Ru), and salt troughs protecting their reindeer from insects and heat, and supplementing their diet. The smudges improve upon the already-existing grass meadows, which initially attract the reindeer, to encourage them to remain, returning again and again to the smoky meadows after taking food and water during the night. All herders stress that the option of creating smoky meadows can be used only to encourage small herds - up to fifty head - to remain in the valley bottoms. If one has large herds (from 200 to 600 head) one would have no choice in high summer but to follow the reindeer back to cool, windswept snow-covered mountain plateaus in a more classic instance of the 'herd-following' concept.

The Zhuia Evenkis keep their reindeer both for transport, and for milking. A second set of structures assists them in milking the reindeer cows in the early spring. A milking corral (*kuuruu* – Ev;Ia) is used to separate the cows from their calves for several hours in order to allow them to build up milk reserves for the herders to take. An alternate strategy, not observed in this study, is to use a corral to confine the calves (*kahaa* – Ev; Ia). The adult reindeer are saddled for riding and are chiefly used today to carry goods. They assist the hunters in moving the camp from one site to another, transferring meat after the successful hunt of a moose or wild reindeer, and for many decades have been leased to miners or geologists who required transport in difficult-to-reach mountainous locales (Figure 2).

Although the Zhuia River Evenkis (*zhuintsy)* have a relatively long and distinguished history, there are only two families using the Zhuia river valley today. The rest of the regional taiga population – approximately 12 families - is today concentrated along the Khomolkho tributary of the Zhuia river and based in the taiga village Perevoz. Due to a complex colonial and Soviet history, the Bodaibo Evenkis are often referred to as *iakuty* (a local Russian appellation which seems to carry the meaning of 'reindeer porter', and not ethnicity). Both old and young speak Russian and a version of Sakha mixed with Evenki expressions. Although small in population, and perhaps unfairly dismissed by contemporary ethnographers as being creolised, these taiga-dwellers maintain a rich body of herding skills – including milking and castration – and have avoided being enrolled in collective Soviet agricultural institutions. During the most of the Soviet period, as today, they provide meat and furs as contract hunters to the *koopzveropromkhoz* based in Bodaibo. The available ethnographic and historical literature on the Zhuia River Evenkis, and their yearly round, is summarised in more detail in English in Anderson et al.(2011) and Volzhanina and Anderson (2010) and in several sources in Russian (Samokhin 1929; Mainov 1898; Kropotkin 1873; Dolgikh 1960, 480-82).

The landscape-creating practices of the Zhuia River Evenkis came to our attention during a series of conversations with Swedish landscape archaeologists. Our Swedish colleagues have developed a set of finely-honed techniques to document the history of forest Sámi occupation through the combined use of oral histories and archival material, forest botany, pollen analysis and phosphate analysis (Aronsson 1991; Karlsson 2006, 2004; Östlund, Bergman, and Zackrisson 2004; Östlund et al. 2003). The key to those methods is to identify a physical site where reindeer were once held in relatively large concentrations for a long period of time – such as a milking corral. The large, repeated concentrations of animals at the milking sites leave a strong signature both on the existing plant community and on the composition of the soil in the same manner as grassland watering points (Sternberg 2012) , Faroese steadings (Edwards et al. 2005), or West Greenlandic 'greens' (Fredskild and Holt 1993). Soil composition tests are then used to describe the impact qualitatively, spatially and chronologically. The concentrated presence of animals in a confined area is understood as an indirect marker of the co-presence of human pastoralists, despite the fact that this fact is often difficult to corroborate with more traditional artefacts in these highly acidic taiga-soil areas. By consulting the ethnographic record, and contrasting accounts of how ungulates behave when away from humans, the evidence of compact concentrations are assumed to have been encouraged by people. A signature quality of these studies is the interpretation of a stratified pollen record left in peat mires – a robust technique which often allows very subtle dating of local changes to the plant composition over time. A distinct quality of the Swedish work is that it has been used to document a landscape-altering process – reindeer milking - which has disappeared for almost three generations. By contrast, in many parts of the Siberian taiga (Fondahl 1989), including the Zhuia valley, reindeer are still milked, and to do so, Evenkis construct similar structures as to those of Sámis in Sweden. Our interest therefore was to discover if the Scandinavian techniques could be keyed to the contemporary visible practice of Evenkis, and thereby better inform the literature on the history of taiga reindeer pastoralism generally.

The major landscape artefacts sampled in this study are a series of 'meadows' or 'glades' (*poliana* - Ru*)* (Figure 3) which one encounters at unexpected intervals along the Zhuia river interrupted by long expanses of thick larch forest. These forest openings are often named and continue to be important stopping areas. Today, these openings are not associated with the effect of reindeer either by Russians or Evenkis. Most elderly Russian settlers associate them with the work of Soviet-era collective brigades who kept them cleared, sewed exotic grass species, and harvested hay to feed cattle and horses. Evenki taiga-dwellers in their turn speak of 'good places' or 'places that suggest themselves' to keep reindeer, placing the accent on the agency of the place itself (Johnson 2000). The Evenki-Sakha word *aian* refers often a high, rocky and dry ridge (often a former glacial moraine) where it is comfortable to set a tent and to survey the reindeer herd which may feed and water itself on a series of intersecting small rivers below the ridge (Anderson, Ineshin, and Ziker 2011). The fact that the landscape might 'suggests itself' for vastly different types of human horticulture, or for animal action, will be an important aspect in our argument. Indeed within Sápmi , forest historians have noted the repeated use of sites by a series of peoples such that reindeer herders might 'open' the forest thereby creating a meadow which then attracts Swedish settlers who would 're-use' the already-fertilized clearing for other uses (Andersson 2005). In these cases, the different layers of activity are made visible by the soil signatures despite being invisible on the surface.

Although many aspects of the history of people and landscapes along the Zhuia River suggest a strong similarity with Northern Sweden, there is one major ecological difference. This Inner Asian mountainous district is characterized by high-energy rivers which experience great floods in the spring and autumn and which subside significantly in the summer. Further, the region has an extremely cold continental climate, creating zones of intermittent permafrost. Both qualities do not favour the creation of the continuously active peat mires, which are the standard source of evidence in North Atlantic pollen analysis. Nevertheless, either river or human agency creates and maintains clearings in the thick forest creating openings which admit summer sun, eliminating the permafrost. This in turn makes possible the formation of both meadows and mires – often together – creating also an 'opening' for a soil content record. This somewhat more complex context required an experimental revision of the predominantly Scandinavian methods, on which we report here.

The Study-sites and Methods

Our group conducted ethnoarchaeological fieldwork across six sites in the region to the North of Lake Baikal over three years between 2007 and 2009 (Figure 1). Three sites were along the Zhuia river, of which we discuss two here: Ust'-Nechara and Lake Tolondo. Another three sites were located in Severobaikalsk district, Buriatiia, published separately (Bezrukova et al. 2012; Kharinskii 2010; Vin'kovskai͡a 2010; Kharinskii 2012).

Lake Tolondo (58°17'11.73"N 115°47'22.46"E) attracted our attention due to one evocative archival text which suggested a historically documented depth of occupancy at least to the middle of the 19th Century. The 'Lake' itself is an extremely unique landscape feature. At some undefined point in the distant past this melt-water reservoir became connected with the Zhuia river such that the river now, and presumably for a long period of time in the past, deposits fish into the Lake during high water creating a year-round repository of fish (Figure 4). There are no living memories of people keeping reindeer there, however around the lake one can find isolated segments of well-worn reindeer-horse paths and older larch stumps showing signs of Evenki bark-stripping practices. The surrounding hills had been clear-cut early in the 20th century to support the mining operations. They also recently [c1970] suffered a major forest fire.

At Lake Tolondo we set four pits and took phosphate samples from the meadow on the peninsula overlooking the spot where the lake meets the river. Four sediment samples were taken from the Lake itself with a UWITEC corer. Here we report on one pit and the phosphate tests.

Ust'-Nechera (58°35'55.60"N 116°25'36.93"E) refers in our study to a large one-kilometer-long meadow located approximately one half kilometer upstream of the mouth of the Nechera River where it meets the Zhuia. The local toponym Ust'-Nechera, by contrast, refers to an entire zone made up of meadows, uplands, several abandoned named habitation sites, and a chain of carp-bearing taiga lakes (Figures 5). Today, hunters first follow their reindeer to the small lakes in April for calving and to wait for the spring floods to recede. The meadow then attracts the reindeer with its grass in May. The vast open space, located some distance from the river mouth, also helps the hunters to protect the calves from bears.

The meadow at Ust'-Nechera itself has a complex structure of occupation. The oldest monuments and foundations lie at the Eastern, overgrown extent of the meadow. On the characteristic high sandy ridge along the river bank, towards the middle, is the remains of a late 19th century cemetery. The contemporary cabins, located at the Western extreme, are surrounded by sites where spring milking corrals and summer shaded pens were established and abandoned in roughly 5-year cycles.

For this paper we report on two sites within the Western side. Ust' Nechera 1 refers to a milking corral inland, at the southern end of the meadow, that was used from 2003-2008 and a set of shade-providing trees and smudges used as a reindeer marshalling area from 2003-2010 (Figure 6). Ust'-Nechera 2 refers to the barely visible and abandoned reindeer marshalling area and shading structure located up against the bank of the Zhuia river and used intermittently from 1962-1976.

Together with the site at Lake Tolondo, these locations provide a set of historically documented, more-or-less continuous examples reindeer-impacted landscapes in various states of abandonment over eight decades (1927-2009), but likely longer. The prevailing wind at both sites comes from the NW.

Hypotheses Our goal for the research was to document as richly as possible the ecological markers of present and past Evenki taiga usage using the interdisciplinary work of Aronsson (1991) and Karlsson (2006) as a guide. Further, we were particularly interested to see if the analysis of soil strata could specify how and for how long these sites were intensively occupied by reindeer, and by association, people. Our hypotheses were simple. First, we wanted to see if phosphate records could be used to distinguish different types of modern reindeer-holding or reindeer-attracting structures such as corrals, shaded smoke smudges, or salt-troughs. Second, we were interested to see if the shallow pollen record of the past 150 years would show the layered signs of the documented ecological succession from forest, to reindeer-glade, to a form of settler cereal/hay meadow. Third, we wished to see if existing plant communities would reflect the history of documented use over the past eighty years. Finally, we were curious to see if any marker could be used to show the existence of reindeer-mediated subsistence before the mid-19th century.

Ethnographic and Archival Work One of the attractions of this particular region is the depth and detail of the historical record of Evenki and ethnic Iakut occupation. Like in many locations in Siberia, historical records begin with Cossack tribute-takers, who constructed posts at the mouth of the Olekma river in 1643 and the mouth of the Zhuia in 1648 (Dolgikh 1960, 480-82). Due to the relatively early discovery of large placer gold deposits in 1843, the region became a magnet for thousands Tungus and Iakut porters who provisioned reindeer and horses to the miners (Anderson, Ineshin, and Ziker 2011). Early local Tungus entrepeneurs wrote petitions complaining of the occupation of their meadows by settler-miners (NARS 19-1[t1]-9) creating texts that are today be recognizable as early aboriginal claims. Famous Russian liberals such as Ivan Ivanovich Mainov (1898, 1912) and Prince Kropotkin (1873) took up the cause of the disenfranchised Tunguses as an example by which to criticize the Imperial Russian state within a political debate known as the 'indigenous question' (Kovaliashkina 2005). Due to these controversies, the region was subject to special surveys of the living conditions of the indigenous labourers beginning with Levental' (1896) and Mainov (1898), and then a special survey of Tunguses working in the Lena goldfields during the 1926-27 Polar Census. One archival manuscript of that census pointed to the location of a previously unidentified 'indigenous cemetery' on the 'island at Lake Tolondo' (GAIO 1468-1-2: 35v) and documented a family keeping reindeer at the site with a corral.[1]

Oral interviews also documented the Soviet-era colonization of the meadows at both Tolondo and Ust'-Nechera for hay production from the 1930s onward. Part of this colonization involved regular clearing of shrubs and the broadcasting of cereals, some of which found their way into our pollen diagrams. This ecological expansion fell into retreat in the post-Soviet period with the removal of state subsidies on agricultural production and the de-population of taiga settlements like Svetlyi once charged with provisioning the resident mining population. With the lack of support for horse or cattle pastoralism, local farm workers ceased using the meadows spread up and down the Zhuia river and the forest has now began to close in. Aerial photographs from 1985 were used to identify sites and to compare the ingression of the forest from late Soviet to the post-Soviet period (Figure 8 and 10).[2]

[1] It is difficult to interpret the 'island' at Lake Tolondo. One possible interpretation is that in the spring and autumn the river flooded the area around the 5m moraine/terrace making the existing meadow and island (rejoining the 'mainland' in summer). A more likely explanation is that the name was a form of shorthand for the small island that sits at the inlet between the river and the lake (Figure 4)

[2] The aerial photographs were special ordered from the archives Eastern Siberian Aerogeodizicheskoe Predpriatie www.vsagp.ru (no classmark). The VSAGP used the photographs to construct topographical maps. The photographs were used for site surveys and to map the contours of vegetation were incorporated into our site maps. The detail on these photographs far surpasses that available on satellite photographs.

At Ust'-Nechera our work took on a much more detailed quality as we worked with the two families who use the site continuously. Pavel Nikolaevich Feoderov (1946) and Tat'iana Nikolaevna Maksimova live in a log cabin to the southern portion of the meadow near the river (Figure 7). Pavel Nikolaevich helped his parents to colonize what is now the Western edge of the meadow in 1958 to create a base for the family's hunting and reindeer porterage operations. In his words, when the steamship dropped his family at what is now the site of their cabin the brush was so thick that you could not see the river when standing inside it. He and his parents disassembled a cabin from one of the Russian settlements above the mouth and moved it to the site. They cleared the site with axes and fire[3], established a raised garden, and built a storage platform (*labaz* – Ru). Pavel described how he and his parents constructed a series of shaded enclosures for their reindeer consisting of a set of wooden poles supporting a larch-bark roof. These allowed them to encourage their reindeer to stay at the meadow over the entire summer so that they could be leased by geologists into the autumn. He stressed the necessity of moving the shaded marshalling area and the milking corrals every five to six years to avoid hoof disease in the reindeer. The shaded enclosures were surrounded by smoke smudge fires set upwind to keep the shaded area free of insects while the reindeer rested during the day. He had built or participated in building three sets of shaded enclosures and corrals (Figure 8). We chose to do a phosphate analysis of an intermediate site in the series used intermittently between roughly 1962 and 1976 when Pavel Nikolaevich was working actively for geological expeditions.[4] Of that ensemble, only the space occupied by the enclosure was accessible. The space where the reindeer milking corral had stood serves as one of the potato patches. An earlier shaded marshalling area directly on the bank was eroded and served as a region for discarding rubbish and human waste.

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[3] It remained a little unclear in his account if the site was 'virgin' forest or had become overgrown. He used the term *otchistit'* [cleansing, clearing] which suggests removing shrubs rather than felling trees. The term *otchistit'* can sometimes refer to burning and Pavel Nikolaevich described what we would call 'burning' the meadow every spring.

[4] Pavel Nikolaevich did not have a continuous overview of the site. He arrived at the site in 1958 with his parents when he was 12. He then served in the army roughly from 1962-1965. He lived at the site again until 1968 when he chose to spend two years in the village returning roughly in 1972. When he returned he began using the still-standing shaded marshalling area.

The herder that used Ust' Nechera, Vasilii Nikolaevich Maksimov (1977-2010), had been keeping his animals here in the late spring and early summer since 2002 (Figure 9). He had come to the site following his military service to 'join his relatives'[5]. He also moved two abandoned log cabins to the site, established the active milking corrals, and took advantage of the high trees to construct the marshalling area and smudge site that is visible today. However in that short time he had also moved his herding structures many times. His initial marshalling area, in 2002 was located directly on the riverbank at the site where Pavel Nikolaevich had first set his. The initial, associated milking corral was behind his cabin in the spot that is today used as a vegetable patch. In 2003 he moved the corral to a site next to the forest and established the present marshalling area in use at the time of our visit. That corral was used for five years until 2008, before a new one was set up in the spring of 2009. The corrals served a population of roughly 22 reindeer cows, of whom four or five would be sequestered at one time. Each new corral was moved laterally about 60m from the last.

<u>Pollen, Fungal and Charcoal Analysis</u> The classic Fennoscandian strategy of taking closed cores from mires had to be altered for practical reasons. Aside from the difficulty of finding a mire that was not permanently frozen, our previous experience in Severobaikalsk district proved that some samples can be distorted by cryogenitic spikes which are not visible when a closed core is taken. To control for this, we took monolith tins from an exposed wall of humified peat and mineralized soil which could be visually inspected. Sampling was done over two seasons at both sites. During the first season test samples were extracted from each visible strata for preliminary dating and to test for a pollen signature. During the second season a full monolith tin taken from each trench (50cm long, 10cm deep, 10cm wide).

[5] His kinship relation to the site is a beautiful yet tragic illustration of bilateral kinship solidarity. Pavel Nikolaevich, a Iakut, took Tat'ina Nikolaevna, an Evenkiika, as his wife following the tragic death of her first husband who came from the Orkanov family. The Orkanov name is one of the oldest Zhuia river Tungus surnames found well documented in the archives. Vasilii married Nina Orkanova, Tat'iana's daughter, after Nina's first husband (who was Vasilii's older brother) died tragically. Vasilii's father was also Pavel Nikolaevich's maternal uncle making the two herders cousins (FZS) with different nationalities. Tamara Nikolaevna's maiden surname is Maksinova related also in a distant and unspecified way to Vasilii. The 'claim' to the meadow at Ust'-Nechera of both male herders is thus founded on a history of very old Evenki occupation through both women at the site.

Our sampling began at Lake Tolondo. Although the archival documents did not specify the location of the milking corral, both the existing vegetation and the narrow topography suggested that the corral stood inland from the foundation of an old log cabin. The mires surrounding the site remained frozen below 10cm of free-standing water. We identified a spot free of permafrost close to the embankment which showed good stratification and was undisturbed aside from a recent strong fire event at the very top part of the sample (5.5-7cm) [19^{th}-20^{th} Century] (Figure S4) which may have been caused by a reindeer smudge fire. Although exposed and dry today, with the percentage of organic matter ranging between 7 and 12%, the soil was initially formed as a peatbog in the past. Trench 2 was within 10m of where we assumed the corral to stand (Figure 10).

At Ust'-Nechera we were fortunate to discover an unfrozen humified peat bog five meters from the still-standing milking corral and 8 meters from the shaded reindeer marshalling area from which a 50 cm monolith in was taken (Figure 8: pit 3). The percentage of organic matter in these samples ranged between 7 and 14% in the upper layer.

The two monoliths were sampled at the pollen lab at the Institute of the Earth's Crust in Irkutsk – a lab with a long history of using pollen records to track climate change from deep sediments from Lake Baikal. The monolith from Lake Tolondo was sampled at 0.5cm intervals up to 34cm depth and thereafter every 1cm to 54cm.The monolith from Ust'-Nechera was sampled at 0.5cm to 31.5cm and then every 1cm to 61.5cm.

Each soil sample, along with two tablets of Lycopodium markers, were treated using a standard Russian procedure of HCl, KOH, CdI+KI, HF, and an H_3BO_3 bath (Chigurı͡aeva, Koloskova, and Daĭkovskiĭ 1975). The slides were glycerine mounted. For each sample a minimum of 1000 terrestrial pollen was counted. If the terrestrial pollen sum did not reach 1000 units then counting continued until 1000 units of Lycopodium were recorded. The identification of fungal spores was done using the images supplied by van Geel (2002). The counts results were graphed using TILIA (Grimm 1991) with 5x exaggeration of grass pollen and displaying both absolute and relative results. Percentage calculations were then based on the full terrestrial pollen sum. The pollen zones are set statistically by the software. The concentration of microcharcoal fragments was estimated using the point-count method of Clarke (1982). Loss-on-ignition analysis followed Heiri et al. (2001). Both results, and the full pollen diagrams, are reported as supplementary material.

AMS Dating AMS testing was conducted at the Angström Lab at Uppsala University. Bulk sediment dates were first conducted from significant horizons to establish a time frame. Later, more specific dates were requested on samples of charcoal or preserved but unidentified plant matter picked out from small samples within the core. It was particularly difficult to find organic material within the soil to date the top of the starkly different lower layer at Tolondo. The sparse flecks of charcoal were picked out by the specialists at the Environmental Archaeology Laboratory at Umeå University.

The dates for both sites are reported in Table 1. An age-depth model was extrapolated for Lake Tolondo by using the INTECAL09 curve and plotting the expected variance of each AMS date by using BACON software (Figure S3). The pollen diagram for Lake Tolondo displays the most probable calibrated dates. The two post-1950 dates on the pollen diagram for Ust'-Nechera were left uncalibrated

Phosphate Analysis The literature on phosphate analysis in archaeology is large, and somewhat controversial (Bjelajac, Luby, and Ray 1996; Holliday and Gartner 2007). Our interest was simply to locate phosphate anomalies in order to pinpoint the sites of former activities, and not to use statistics to try to associate specific fractions with discrete activities over time. The phosphate work also played an important role in the botanical analysis by helping to characterise the boundaries of visible plant communities.

At the time of our fieldwork there were many unknowns about the composition of Eastern Siberian soils. We found that in these permafrost-affected taiga soils that the darker, reddish soil of the 'B Horizon' was visible and that samples could be taken with a hand auger. In dry areas it was found between 14 and 20cm. In damper areas it could be as deep as 60cm. In trying to establish a control signature, we discovered that the sandy soils immediately in the frozen forested zone gave either extremely high or extremely low signatures. A reasonable signature only existed in the exposed areas free of permafrost.

The results were analysed onsite using a portable Merck Reflectoquant colormetric phosphate test designed by Kjell Persson (1997). The portable unit allowed us to adjust the location of grids on-site and to resample some points. The results of the portable test were duplicated with the phosphate lab at Helsinki University and revealed a similar patterning (although different intensities of phosphate). The diagrams showing statistical estimates of phosphate concentration over space were constructed with the programme MapInfo v.8.0.

Botanical Indicators of Human and Reindeer Action Our botanical work followed the Russian geobotanical tradition of analysing grass and shrub communities a markers of past human/animal use[6]. As with the pollen work, this work also was developed over two field seasons with considerable effort put into modelling the plant communities in a relatively undocumented corner of Siberia. We began our work with 1m test-plots transecting each site. When anomalous areas were discovered, sampling was done within visible boundaries, such as a still-standing corral or geometric patches. Plants were classified according the standard reference work for Irkutsk *oblast'* (Malysheva 2008) and for Ust'Nechera were quantified as the percentage of the territory of each area they occupied.

Across all six sites surveyed, we developed a single system of classifying anthropogenetic functional zones. Plant communities in Phytozone I are associated with the heavily trampled areas around human dwellings or the remains of them. Phytozone II is associated with heavily populated but open areas which attract reindeer such as shaded smoke-smudge areas, or salt troughs. Phytozone III was assigned to the plants growing within heavily trampled closed areas such as milking

[6] Russian geobotanists and vegetation historians document local techniques of creating pastures and other economically useful glades out of forests (Borinevich et al. 1963; Il'minskikh 1993; Korobeĭnikova 2002). The tradition enjoys a long history to imperial times when agronomists would study the traditional agricultural techniques of rural peoples. One interesting technique used by both Iakuts and Buriats was the deliberate tying of domestic animals in certain places over the winter in order to create fertilised meadows (Iokhel'son 1895)

corrals. All three zones were present in both sites. The full results are presented in supplementary tables S1 through S6.

Presentation of Results

The presentation of our results will start from the most recent sites at Ust'-Nechera and then turn to consider each of the older sites in turn.

Ust'-Nechera Through the cycle of interviewing, phosphate testing and botanical analysis, the entire edge of the Western side of the meadow revealed itself to have been impacted, if not created, in order to attract and hold reindeer in the spring and early summer. Both the current reindeer marshalling area, situated under a grove of spruce trees, the current milking corral, as well as the corral which had been abandoned one year ago, were heavily trampled and well covered with reindeer dung and hair.

According to our model, the recently abandoned reindeer corral and the shaded marshalling area were classified as Phytozone III and Phytozone II. Both, however, showed similar plant communities. The corral hosted ten plant species of which Shepherd's Purse Mustard *Capsélla búrsa-pastóri* and Pigweed *Polýgonum aviculáre* covered close to 60% of the territory (Table S1). The heavily used, yet physically unbounded, space around the well-fertilized spruce trees was also populated by the same although their relative weight (45%) was reduced by a larger variety of plants. Of these Meadow Grass *Póa angustifólia*, Clover *Amória répens,* and Dandelions *Taráxacum officinále* occupied 17% of the area, while an additional seven species were represented in small numbers (Table S2).

The phosphate diagram of this well-used ensemble is presented in Figure 11. The phosphate patterning does not directly represent reindeer agency but must be interpreted with respect to the the joint action of animals and wind. The highest anomalies sit at the perimeter of the site. This corresponds to the fact that reindeer stand pointing their heads in the direction of the prevailing wind, which in this case also carries the smoke from the smudge fires set upwind. The large white anomaly to the east of the trampled site can be associated with a recent innonvation in how smudge fires are kept. Since 2002, Vasilii used the remains of abandoned metal fuel barrels which could be moved to take advantage of the direction of the wind. Since the reindeer do not stand in the fire, the shifting smudge-barrels create an upwind zone seemingly empty of activity. The portrait of the milking corral, by contrast, is disappointing, with the strongest anomaly being only the blank hole where the smudge barrel sat.[7]

The phosphate map of the abandoned marshalling site – Ust'-Nechera 2 – provides a much clearer picture (Figure 12). To understand the strip of anomalies on the western side one has to imagine the bark covered roof supported by the seven posts shading reindeer who would be standing into the prevailing wind. The two spots empty of phosphate no doubt reflect the positioning of smudge fires of the traditional, static type.

An interesting phenomena associated with this site was the height and quality of the vegetation. Unlike the phosphate signatures, the plants grew in a marked rectangular pattern and were noticeably higher (up to 20cm) and denser (up to 50cm) in the area of the marshalling area (Figure 13). The geometric pattern seems to have been caused by the shade of the rectangular structure rather than the deposition of manure. The predominate species was Couch Grass *Elytrígia répens* (70%) with Plantain *Plantágo sp* (10%), Vetch *Vícia crácca* (5%), Dandelion *Taráxacum officinále* (5%), and Grass *Póa angustifólia* (5%). The remaining nine species include Geranium and Artemisia (Table S3). The richness of the plant species here, when compared to the existing marshalling area, point towards a possible model of plant succession after 20 years. Among the later arrivals are plants which show up more reliably in pollen diagrams (*Poaceae, Plantago, Tanaceum*).

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[7] There are a large number of reasons that could be used to explain the lack of a strong signature here. First this corral sits very close to damp and permanantly frozen periphery of the site which may prevent phosphates from binding. Second, the four or five cows held here for a few hours a day, three to four weeks a year, perhaps have not contributed enough manure to make a strong signature.

The pollen diagram shows weak signs of a taiga forest plant community in transition to a meadow community impacted by reindeer (Figure 14). The border of pollen zone 3 and 4 is defined by a sharp rise in the quantities of the families *Cyperacea, Ericales, and Poaceae* which have been linked to anthropogenetic disturbance in other studies (Aronsson 1991; Hicks 1993). Mosses decline during this period. There is a suggestive presence of a fungal spore associated with animal dung – *Sordaria* – towards the top of the column – perhaps the most authoritative, but weak, marker. The data on microscopic charcoal are inconclusive but show one weak spike at the boundary of Nech-4 which corresponds with the first formation of the peat layer. The dates from the column are disappointing. The extremely old dates towards the bottom of the core suggest that the terrace had been washed over in glacial conditions, and that the soil formation process had started quite recently. The extremely modern dates in the top layers may be the result of contamination from Iris roots, but more likely than not the dates reflect the fact that the local site was carved from the forest after 1950.

Despite the complexity of the activity observed at Ust'-Nechara, none of the methods used provided a single unambiguous marker which could describe the use of the site. However the combination of methods does provide a useful portrait. The botanical and ethnographic work yielded the clearest picture of the activity, but without the specificity to localise the activity. The phosphate tests provided key anomalies, which in fact were useful in eliciting further oral histories. They also pointed to the important agency of wind in shaping the sites. The fungal spores and the grass markers do suggest a legacy of pastoralism at the site, if only a shallow one. The diffuse results in this case seem to be directly related to the gaping openness of the meadow and the local practice of regularly shifting the location of marshalling areas by 50-60m every few years.

<u>Lake Tolondo.</u> In comparison to Ust'-Nechera, the meadow at Lake Tolondo is a much more dramatic site. Located upstream on the same river, Tolondo sits as a gateway to several highland areas in the interior of the Baikal-Patom plateau where one can use reindeer to hunt moose and wild reindeer, or

to prospect for minerals. The 8 ha wedge-shaped site, poised in between the Zhuia river and the Lake is further confined by a large wetland inland. This narrow site would seem to serve to concentrate activity much more intensely than at Nechera. It also seems to have been spared intensive settlement by miners and foresters and thus preserves the markers of older pre-Russian activity.

The four phosphate transects yielded a relatively weak picture of possible activity areas (Figure 15). There were five relatively large anomalies as well as an interesting elevation in phosphate towards the end of transect 'C'. The lack of a pattern is most likely due to the great distance between the samples. However the phosphate exercise directed our attention to an interesting botanical pattern.

At the mid-point of transect 'D' and towards the end there are two rectangular-shaped plantations of Meadow Windflower *Anemóne dichotóma* (80%) growing in a geometric pattern of roughly 10 square meters which by the flora could represent a marker of a former corral (Phytozone III) or by the patterning as a shaded marsalling area (Phytozone II) (Table S6). This remarkable plant was followed by some similar 'succession' plants as were found at Nechera 2 such as Couch Grass *Elytrígia répens* (10%), sedge *Cárex*(5%), Meadow Grass *Póa pratensis* (2%) as well as a mixture of five other species (Table S6). The gradually elevating phosphate levels at the end of transect C might point to the former location of a corral or marshalling area. With the exception of the ingression of shrubs, the majority of the plants here were sedges *Cárex cespitósa L*.(70%) followed by the now familiar pattern of *Geranium, Elytrigia,* and *Vicia* (Table S5).

The area at the apex of the site surrounding the foundation of the abandoned cabin can be easily characterized as Phytozone I – an area marked by extreme trampling (Table S4). The dominant species is Couch Grass *Elytrigia repens* (80%) followed by textbook communities which are tolerant of human and animal agency (*Vicia cracca* (10%) , *Geránium pretense* (3%) and *Achillea asiatica* (1%))

Scattered markers of cereal agriculture were also found growing here in the form of Flax *Linum perenne* Land Clover *Trifolium arvense*.

The monolith tin from Lake Tolondo (Figures 16, S2, S4) is the most interesting artefact from the site, although it too is complex. It is immediately obvious from looking at the core that the terrace is divided into two halves (TOL1, TOL2). The lower half is suggests a colder, damper and very much older alluvial environment much like at Nechera, and undoubtedly present along the entire valley. This glacial environment is characterised by low depositions of pollen and burgeoning populations of mosses (TOL1). The picture radically changes to that of a humified peat soil after a distinct alluvial layer at 28cm. The shift may have been caused a giant flood event which perhaps removed a slice of the terrace.[8] In its aftermath, the flood may have also created the conditions for a peat mire and later a meadow. In the upper half of the diagram are suddenly some clear markers of the effects of animal agency such as *Polygonom aviculare, Chenopodiacaee,* and *Poaceae*. More importantly, there is a strong signature of coprophilous fungi which start almost immediately after the hiatus. As many commentators have noted, the presence of these fungi provide some of the strongest markers of the presence of tight, compact groups of ungulates (Baker, Bhagwat, and Willis 2013; Räsänen, Froyd, and Goslar 2007). There is one suggestive peak at 22cm (15th Century) associated with the maximal production of the *Polygonum aviculare* and a drop in other families sensitive to trampling which we associate with a period of maximum animal use of the area. The same region also corresponds to one of the highest spikes of microscopic charcoal in the chart (excepting the major fire event). This suggests the process of clearing that Pavel Nikolevich described at Ust'-Nechara. Fire continues to be part of the life of this site throughout the upper portion of the column, but especially at levels 16-19cm (17th-19th Century) and above 5cm (20th Century) (Figure S4). From 12cm upwards (18th Century) shows markers of a hay-meadow perhaps best illustrated by the unexpected appearance of *Fabaceae*.

[8] In addition to the monolith tins we took four sediment samples from the North arm of Lake Tolondo, which are not analysed here (Vologina et al. 2007). Aside from confirming the regional pollen signature the cores document occasional turbulence and one large flood event in the Lake over the past 360 years.

There is an unfamiliar effect in this diagram of the parallel increases of dry-loving and damp-loving species. This effect contradicts standard conceptions of how a landscape moves from being a bog to being a meadow wherein a bog is thought to gradually desiccate into a meadow. In this diagram, damp-loving types such as *Ericales, Spagnum, Lycopodium, Polypodiaceae, Ranunculaceae, Polygonum amphibium,* and *Onagracea* prosper at the same time as dry-loving types such as *Betula Nanae, Chenopodiaceae, Polygonom aviculare, Poacea,* and *Caryophyllaceae.* We documented this phenomena in the other reindeer-herding districts of Severobaikalsk district and partially at Ust'-Nechara 2. To explain this we propose the following ecological model which is different from that one might expect in Fennoscandia. Unlike cattle, or horses, which often have forage brought to them, reindeer browse widely creating a well-spread impact over high and low parts of a permafrost site. In the words of Pavel Nikolaevich, who witnessed this process in action, the reindeer *otbyvaiut* [beat-away] moss by trampling and grazing. When reindeer begin gather in a recent taiga clearing they can have the effect of breaking the moss cover, exposing the permafrost, and thus causing melting and the formation of small lenses of water. At the same time, their action and their manure also – at the same time - encourages grass species which dry the area and begin to create soils. They thus create a unique, contradictory 'wet and dry' set of plant communities which might serve as a marker of East Siberian Rangifer agency.

Discussion and Conclusion

The goals of this study were to apply a series of environmental tests developed in Fennoscandia to elaborate the patterns created by contemporary and past reindeer husbandry in Eastern Siberia. Although neither the phosphate nor pollen studies produced unambiguous signatures of reindeer pastoralism, when combined together with oral history and botanical analysis a number of interesting results were documented. First, the signatures of coprophilous fungi here, as elsewhere, seem to be the strongest marker of unnaturally large concentrations of ungulates. This study is of interest due to the extreme paucity of studies of this type in Siberia, for that matter, in the circumpolar Arctic (Baker, Bhagwat, and Willis 2013). Second, we recorded both botanically and in pollen diagrams a 'wet-dry' plant community which may serve as a signature of Rangifer trampling in permafrost locations. Third, we adapted the standard Fennoscandian methods to match the high-energy environment of the Eastern Siberia taiga. In this study the rapidly changing hydrology of the rivers, and the agency of the wind, served to be important factors for understanding the possibilities of the site. Fourth, the analysis of the botanical indicators, and in particular a set of three plant communities associated with animal agency, was shown to provide perhaps the most evocative picture of Rangifer impacts over the short term. Fifth, the historic and ethnographic documentation of meadow-maintenance give a subtle picture of how reindeer-harbouring architecture is created, rotated, and maintained. Finally, the results taken suggest that some form of Rangifer-agency on one site can be documented for at least seven hundred years.

This study proposed a 'pragmatic' alteration of what have become standard methods in North Atlantic palynology (Bunting, Schofield, and Edwards 2013) by taking analysing sediment samples rather than those from closed mires. It is clear that the monolith tins at best give a less-than-optimal impression of the vegetation history. We argue that the short Rangifer-genetic layer at Lake Tolondo beginning at 27cm gives an account of six hundred years of history – which is an extremely compressed artefact with an error margin of several centuries. Although the record presented may be inexact, the alternative of confining our work to the peat mires much more readily found in the North Atlantic region would leave a major region of reindeer husbandry completely undocumented.

The strongest marker of the presence of ungulates in this study is the long-term signature of fungal coprophilous spores at Lake Tolondo. However to what degree can we be confident that these come from domestic reindeer? Since the mid-19th century this region has a documented history of mixed horse and cattle pastoralism. Indeed in much of Eurasia horse, cattle and reindeer are used in complex teams of animal alliances – a fact not well reported in the ethnographic literature. Theoretically horses and cattle could produce the same fungal signatures (although, doubtfully, the same 'wet-dry' pollen and plant signature). Given that the history of horse pastoralism is connected with provisioning the placer gold operations of the mid-19th century, it would not seem reasonable to expect large aggregations of horses before that time, let alone since the fifteenth century. However, small herds of domestic reindeer would have been useful for Evenkis offering furs to Cossacks, or to Chinese traders before them. Therefore it is reasonable to expect to find large concentrations of reindeer at sites that are comfortable to both animals and people.

However this leads to a further problem. Is it reasonable that Evenkis, or someone else, created smudge structures and corrals to keep large concentrations of reindeer at such an early date? It is clear that reindeer could have been kept to facilitate taiga life well into the past, but why would one want to encourage reindeer to stay in the deep forest over the summer for many months before the arrival of Russians? To solve this question, we would like to cite the local cosmology of useful, 'good' landscapes. The most parsimonious interpretation of the evidence for both Lake Tolondo and Ust'Nechera is that these are simply 'good places' to meet Rangifer, both wild and tame.

The occasional catastrophic flooding at Lake Tolondo perhaps first created a forest opening on the peninsula. The south-facing aspect of the peninsula helped to keep it free of permafrost creating the conditions for grasses to take root. The clearing was a windy place – the type of place which reindeer seek out for relief from insects. Further, clear surroundings helps them monitor the surroundings for predators. In is quite possible that, wild reindeer, or semi-tame reindeer, descended to this site on their own initiative to enjoy one of a very small number of places across the region where grasses would grow. As people grew closer to Rangifer, or Rangifer to people, this "shared common space"[9] may have become more intensively used in one of many types subsistence action.

[9] We would like to thank an anonymous reviewer for suggesting this term. That reviewer also understood the meadows to be a "platform" for semi-domestication of both Rangifer to people and people to Rangifer.

The combined phosphate, botanical, and pollen work does document a history of succession of types of land-use from (perhaps) hunting of Rangifer, to holding Rangifer, to the maintenance of meadows for horse or cattle, to the formation of cereal crops and vegetable patches. In the most recent period, our study also shows a regression of these shared spaces in the post-Soviet period back to forest.

Euroamerican archaeological models have long been focussed on how animals are 'broken' and brought into human spaces. Recent critical research has focussed on the importance of animal agency in creating the domestic relationship (Oma 2010; Haraway 2008). This study points to the role of landscape agency – of the *aian* in local parlance – in attracting both people and animals, each of whom may be recognized by each other to greater and lesser degrees. In this setting, the presence of these 'good places' with their grasses and their winds, may have brought people and Rangifer together for short periods of time in a hunting relationship. With the use of controlled burning, salt, smudges and shade, people may have extended these relationships over greater periods of time by making interesting places even more attractive to Rangifer. While leaving behind ambiguous signatures of the control of people over animals, the botanical, ethnographic, and soil signatures in this study leave a much more evocative record of landscape agency.

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Acknowledgements This article is dedicated to the memory of Vasilii Nikolaeich Maksimov who drowned with his son while crossing the Zhuia River in 2012.

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For this article, DGA was the principal investigator of the two grants, participated in most of the fieldwork, and composed this English text consulting Russian-language drafts prepared by EMI and OPV. EMI organized the fieldwork, conducted dug the trenches, and prepared the map. OPV participated in the fieldwork, collected botanical samples, and participated in the interpretation of the pollen diagrams. ML participated in the fieldwork and conducted the phosphate analysis. The arduous work of identifying and counting the pollen grains, fungal spores and charcoal fragments was done by NVK in her laboratory in Irkutsk.

We are indebted to our colleagues Drs. Ed Schofield and Dmitryi Mauquoy of School of Geosciences at the University of Aberdeen for drafting the pollen diagrams and constructing the age-depth model.

Captions to Tables

Table 1 Calibrated Radiocarbon Dates from the Zhuia River Valley

Captions to Illustrations

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Figure 4: Aerial Photograph of Lake Tolondo, 1984

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Figure 17 Spore, Fungus and Pollen Diagram, Selected Types, Lake Tolondo (diagram by Dr. Ed Schofield)

Captions to Supplementary Tables

Table S1 Phytozone III – Ust'-Nechera 1 – Abandoned Milking Corral 2003-2008

Table S2 Phytozone II – Ust'-Nechera 1 – Active Reindeer Marshalling Area Surrounded by Smudges 2003-2009

Table S3 Phytozone II – Ust'-Nechera 2 – Abandoned Reindeer Marshalling Area 1960-1979

Table S4 Phytozone I – Lake Tolondo – Main Meadow near the abandoned foundation of the cabin

Table S5 Phytozone II – Lake Tolondo – Phosphate Vector 'C' Possible Location of a Reindeer Corral

Table S6 Phytozone II/III – Lake Tolondo – Phosphate Vector 'D' Rectangular Plant Community Nearer the Lake – Possible Location of a Shaded Marshalling Area or a Corral

Captions to Supplementary Figures

Figure S1a Complete Nechera Pollen Chart - Part 1 [Trees, Shrubs, Herbs] (by Dr. Edward Schofield)

Figure S1b Complete Nechera Pollen Chart - Part 2 [cryptogram and spores] (by Dr. Edward Schofield)

Figure S2a Complete Tolondo Pollen Chart - Part 1 [Trees, Shrubs, Herbs] (by Dr. Edward Schofield)

Figure S2b Complete Tolondo Pollen Chart - Part 2 [cryptogram and spores] (by Dr. Edward Schofield)

Figure S3 Complete Age-Depth Model for Lake Tolondo (by Dr. Dmitri Maquoy).
The model presents a graphic representation of the most likely ages for the four AMS dates given the minimum, maximum and error spread given by the INTECAL09 calibration and the most like permutations as calculated by the statistical package 'Bacon' at a 95% confidence level. The curve is calibrated with a standard algorithm for sediments. .

Figure S4 Soil characteristics at Lake Tolondo

figure 1

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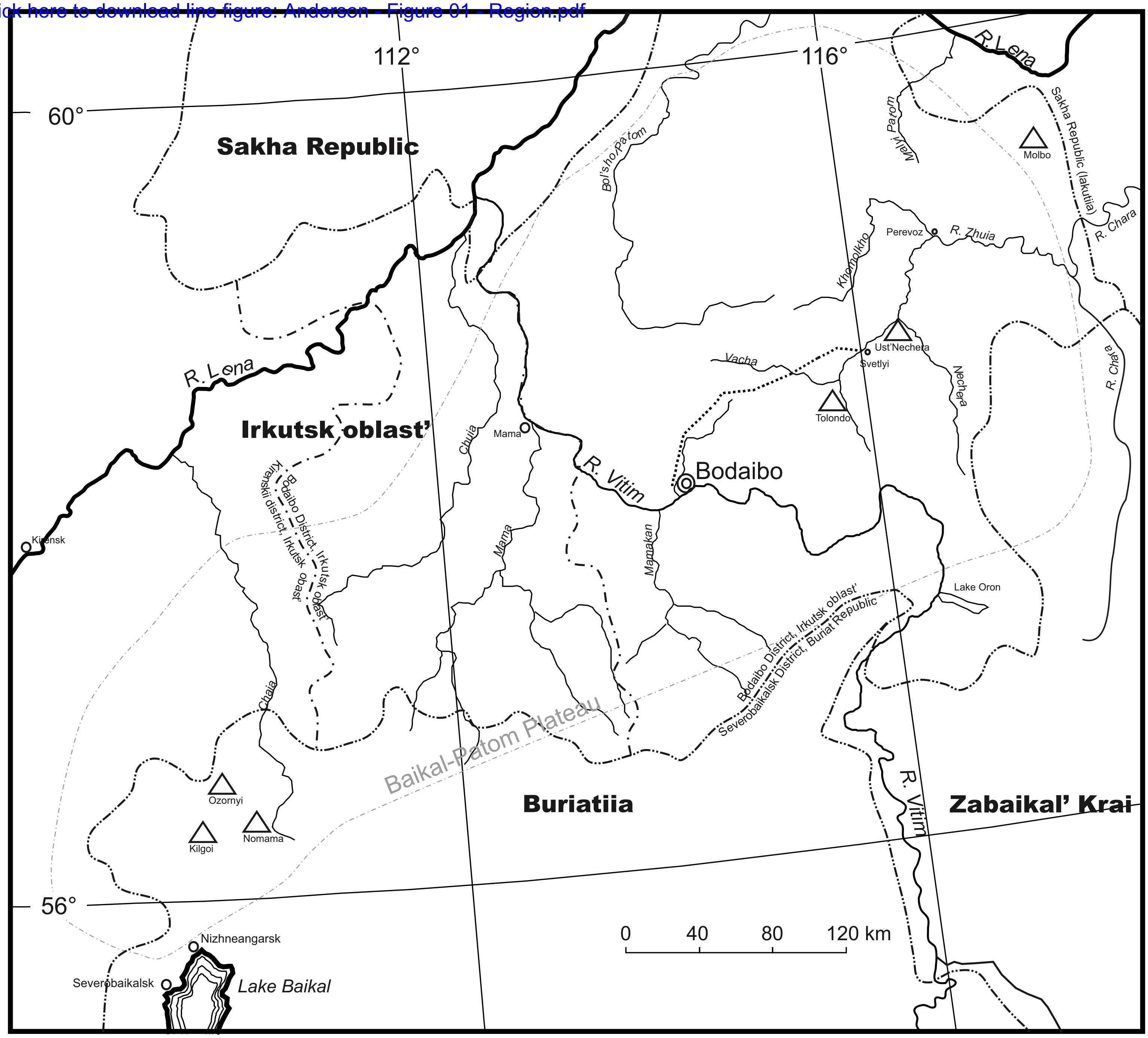

Fig. 1 The Baikal Patom Region showing Bodaibo and Severo-Baikalsk Districts and the Study Sites

figure 2
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figure 3
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figure 4
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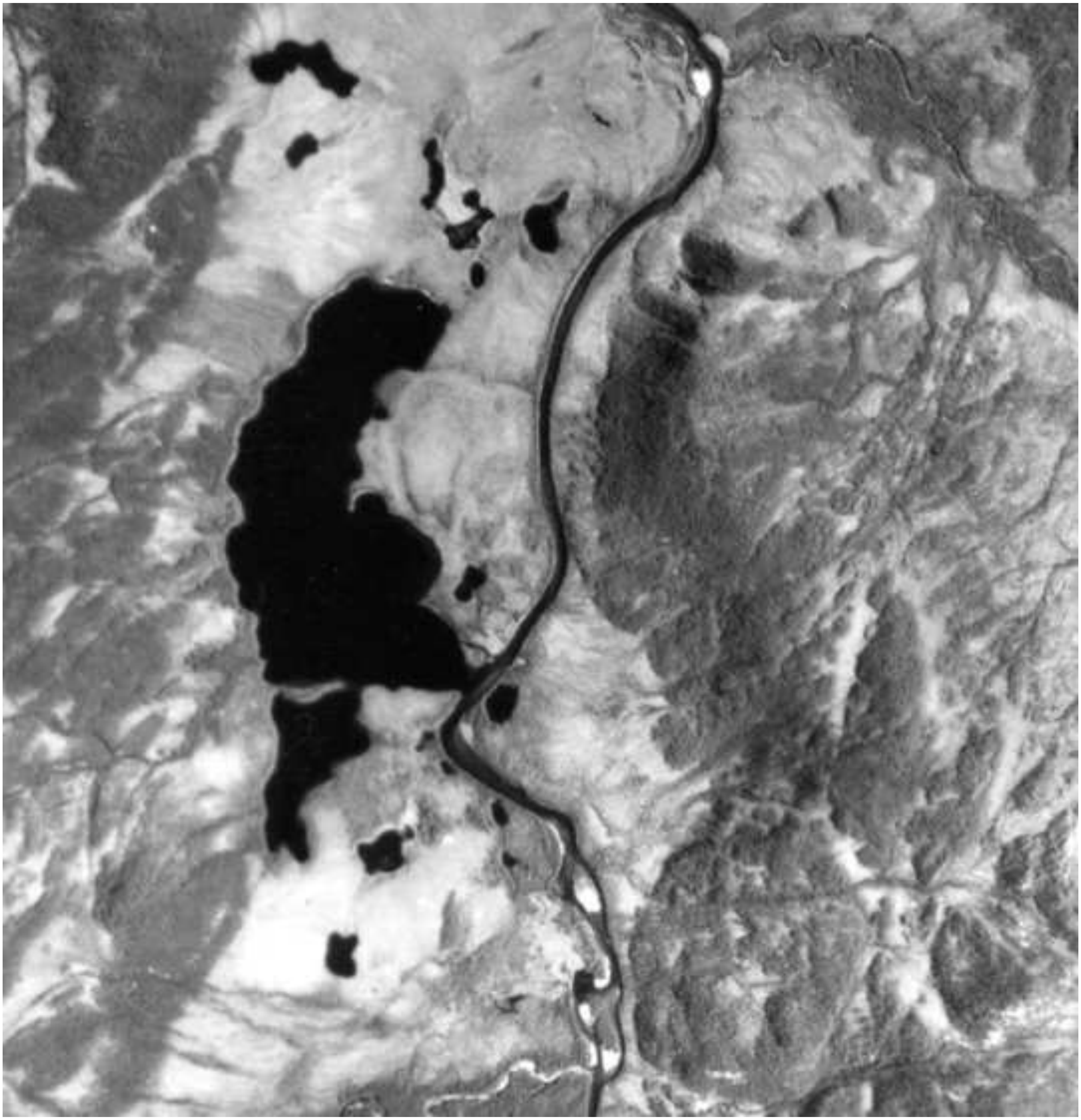

figure 5
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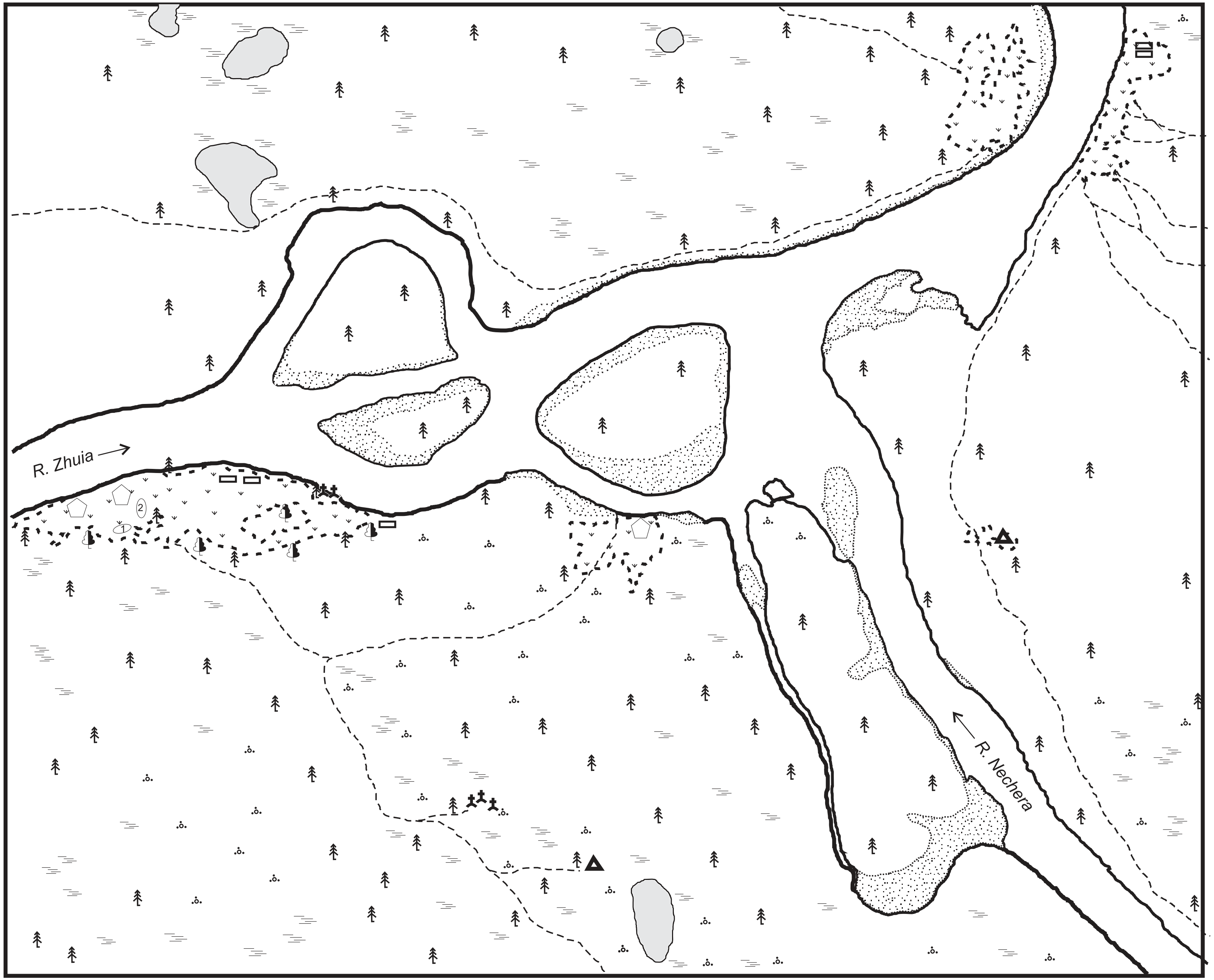

Figure 5: The Mouth of the Nechera River - General View Showing Contemporary and Past Habitation Sites

Larch · Birch · Shrubs · Swamp · Meadow · sand · edge of the forest · path
Ensemble of cabins · abandoned foundation · grave · sites Ust'Nechera 1 & 2 · spring camp

figure 6
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figure 7

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figure 8

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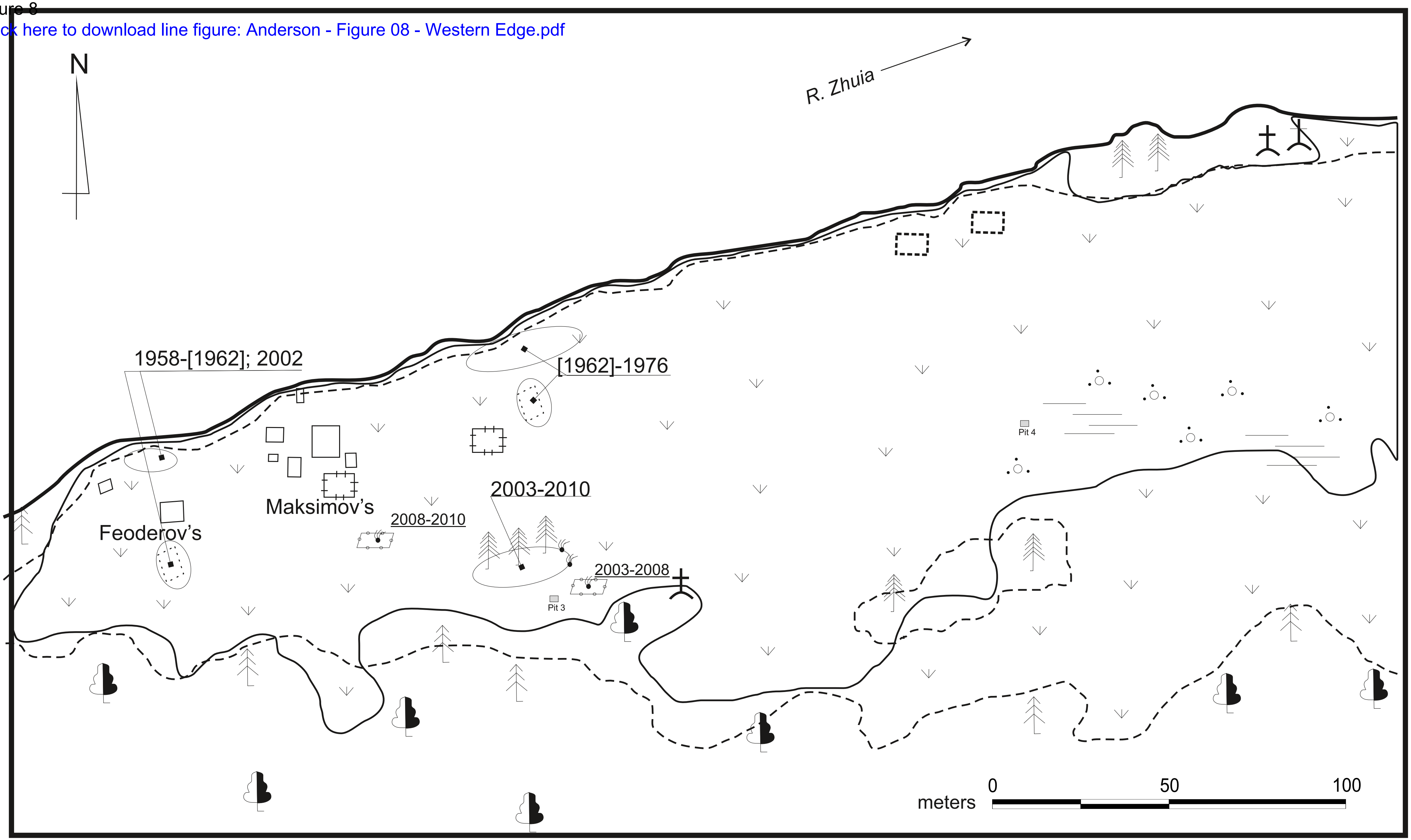

Figure 8: Structures and Plant Cover at the Western Edge of the Meadow at Ust'-Nechera

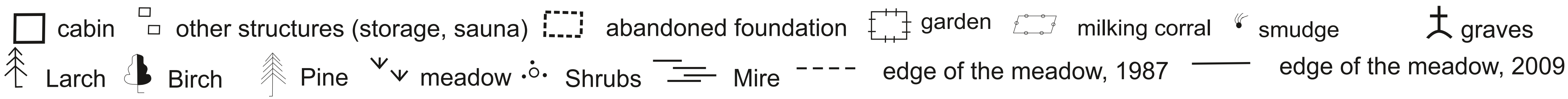

figure 9
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figure 10

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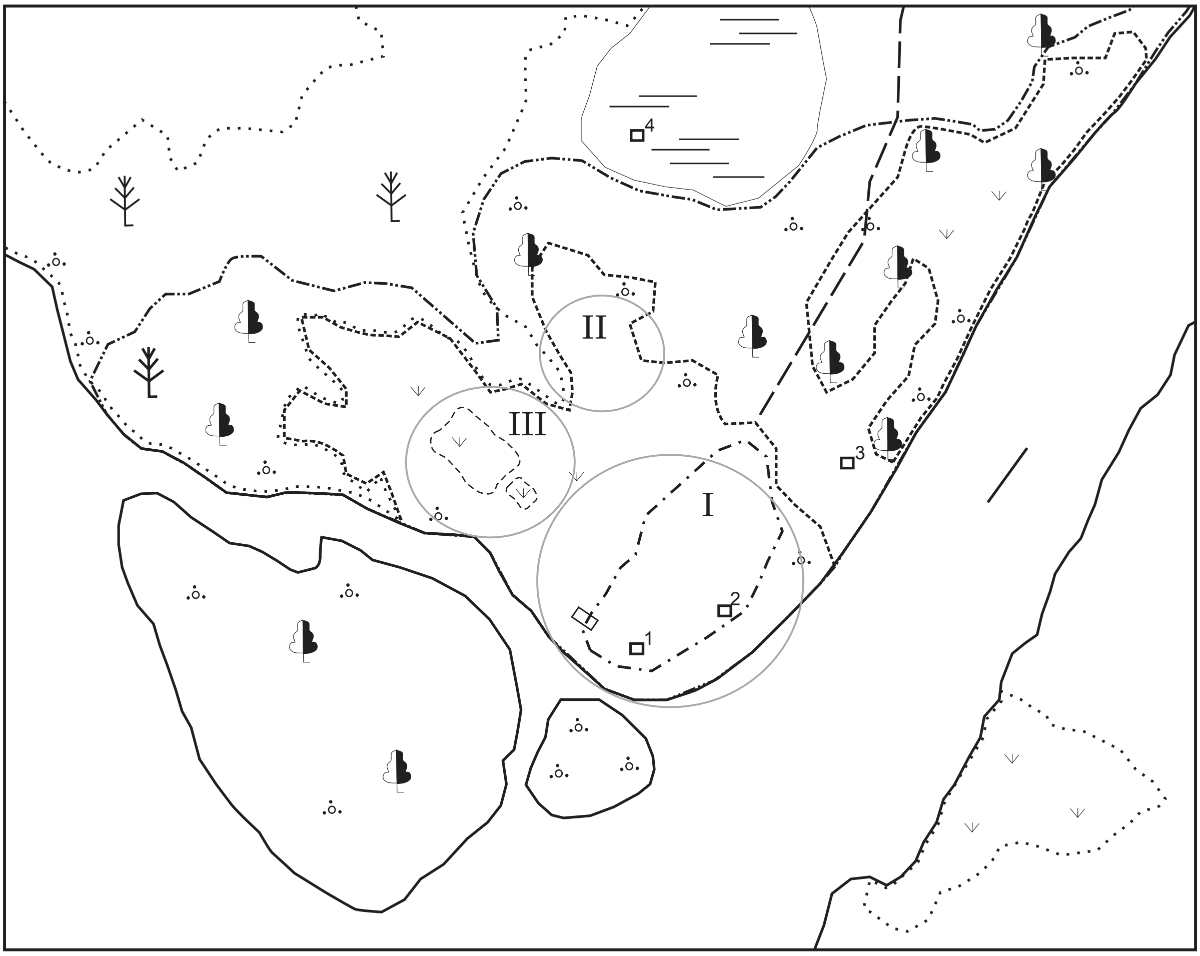

Figure 9: The Meadow at Lake Tolondo

Larch
Birch
Shrubs
Swamp
Meadow
Trenches 1-4
Road
Abandoned cabin foundation
Phytozones I,II,III
Boundaries of forest plant communities
Extent of meadow c.1985 from aerial photograph
Extent of meadow 2008

figure 11

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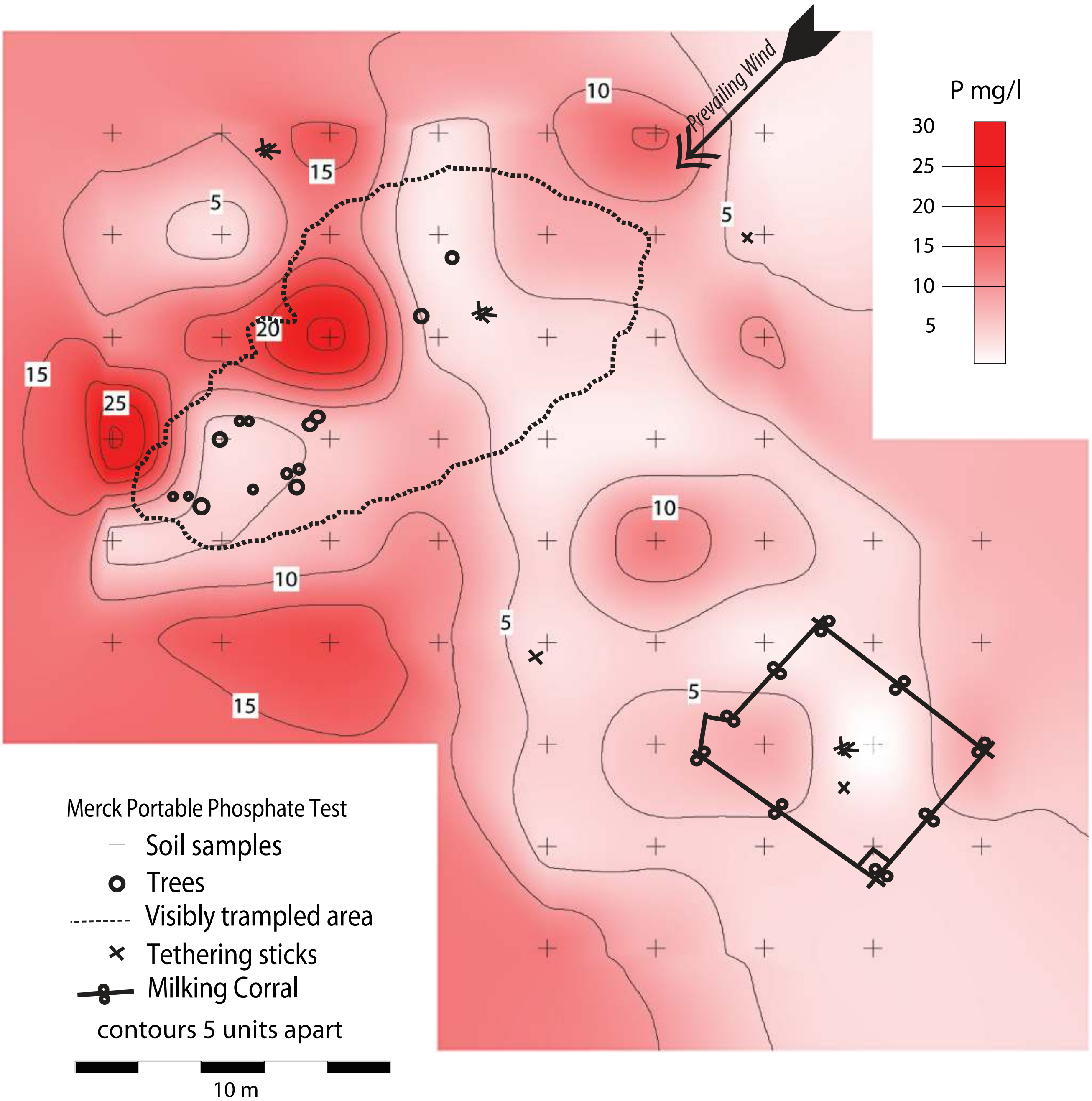

figure 12
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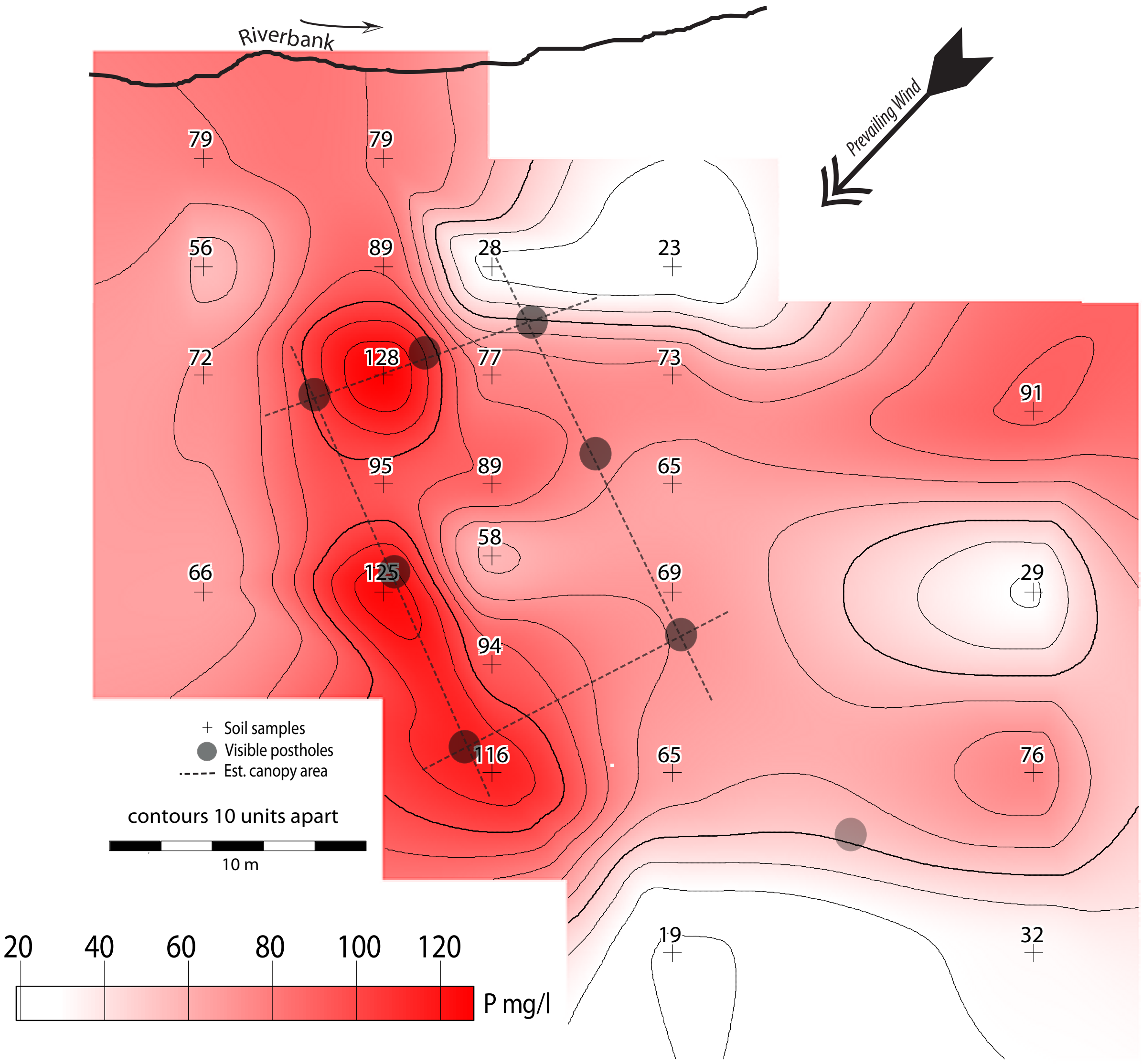

figure 13
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figure 14
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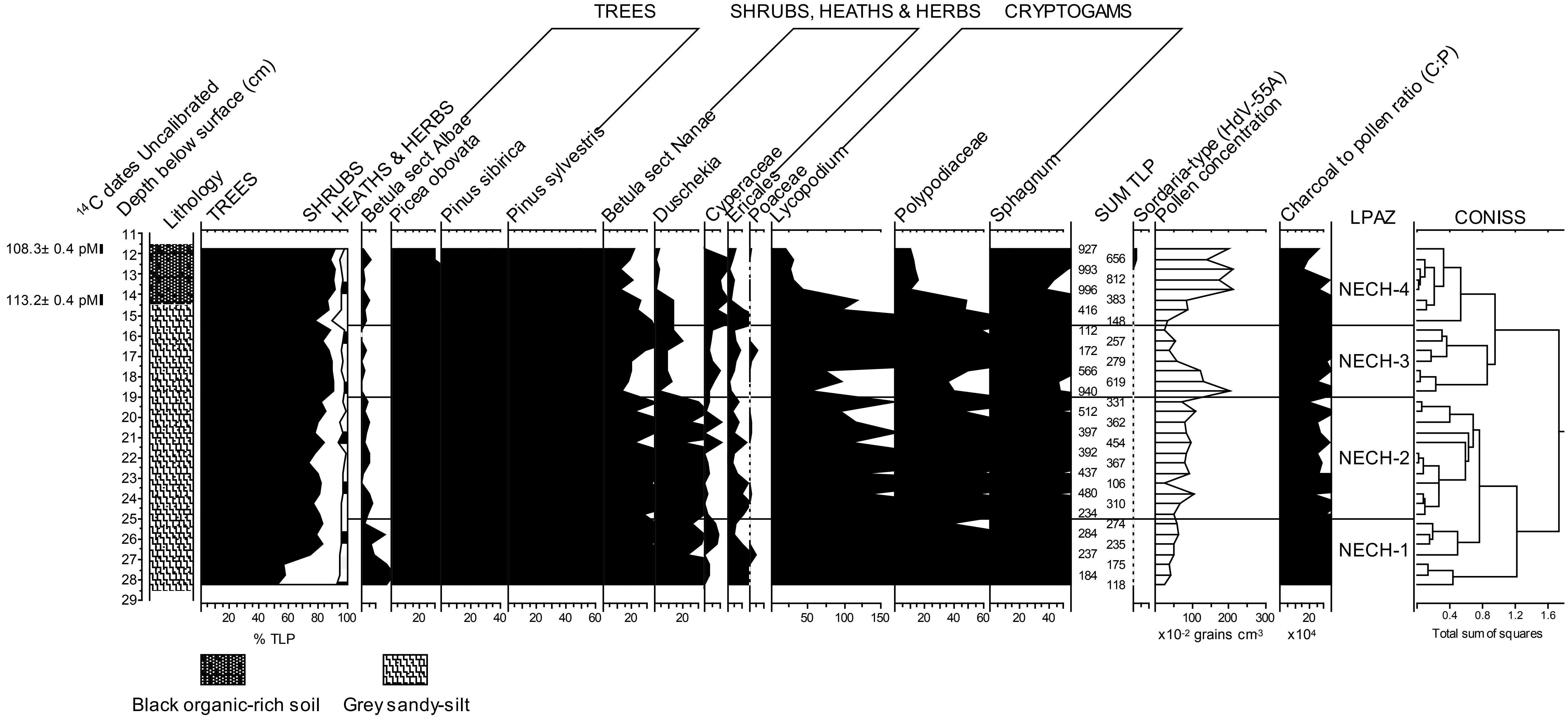

figure 15

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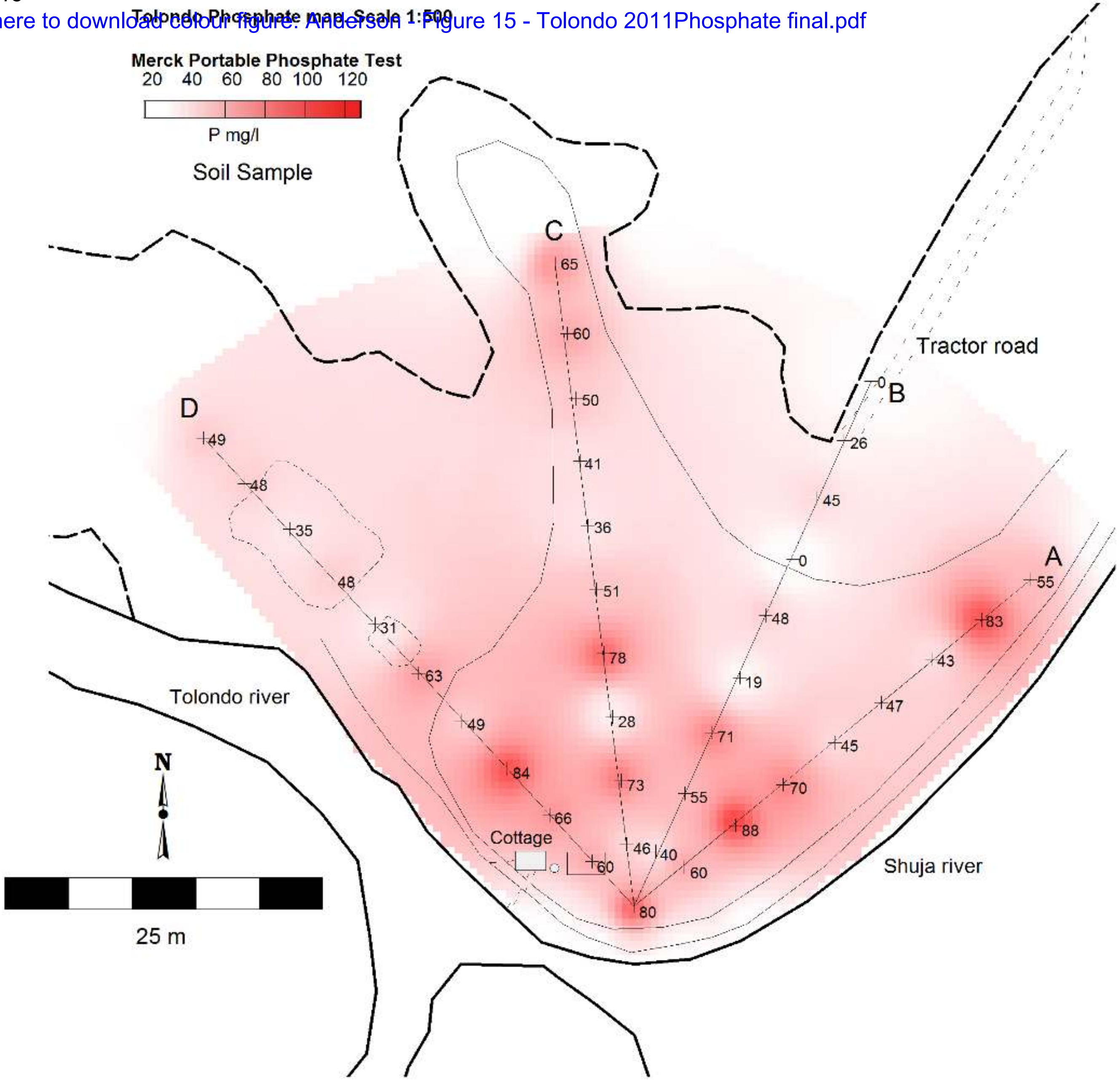

Area examined
Base map scale 1:2000

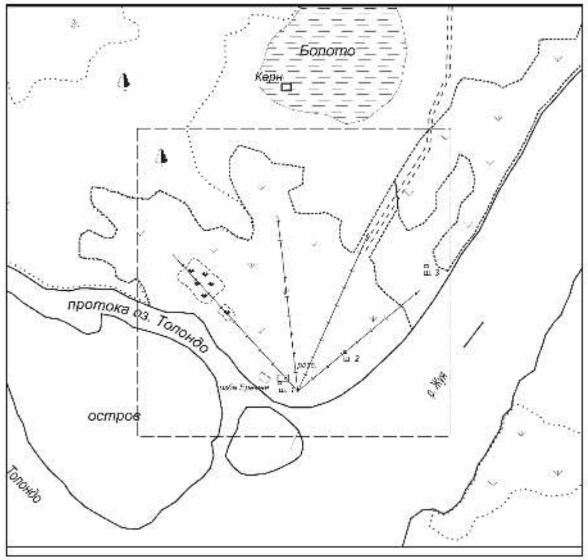

figure 16

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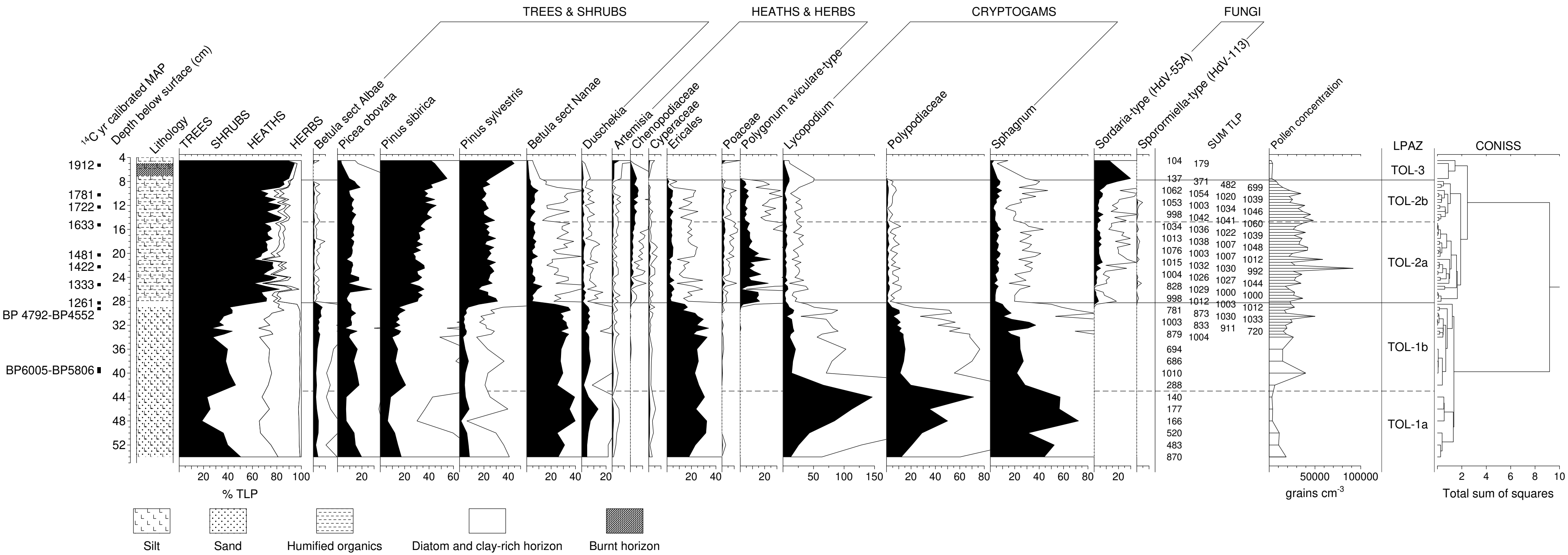

figure S1a

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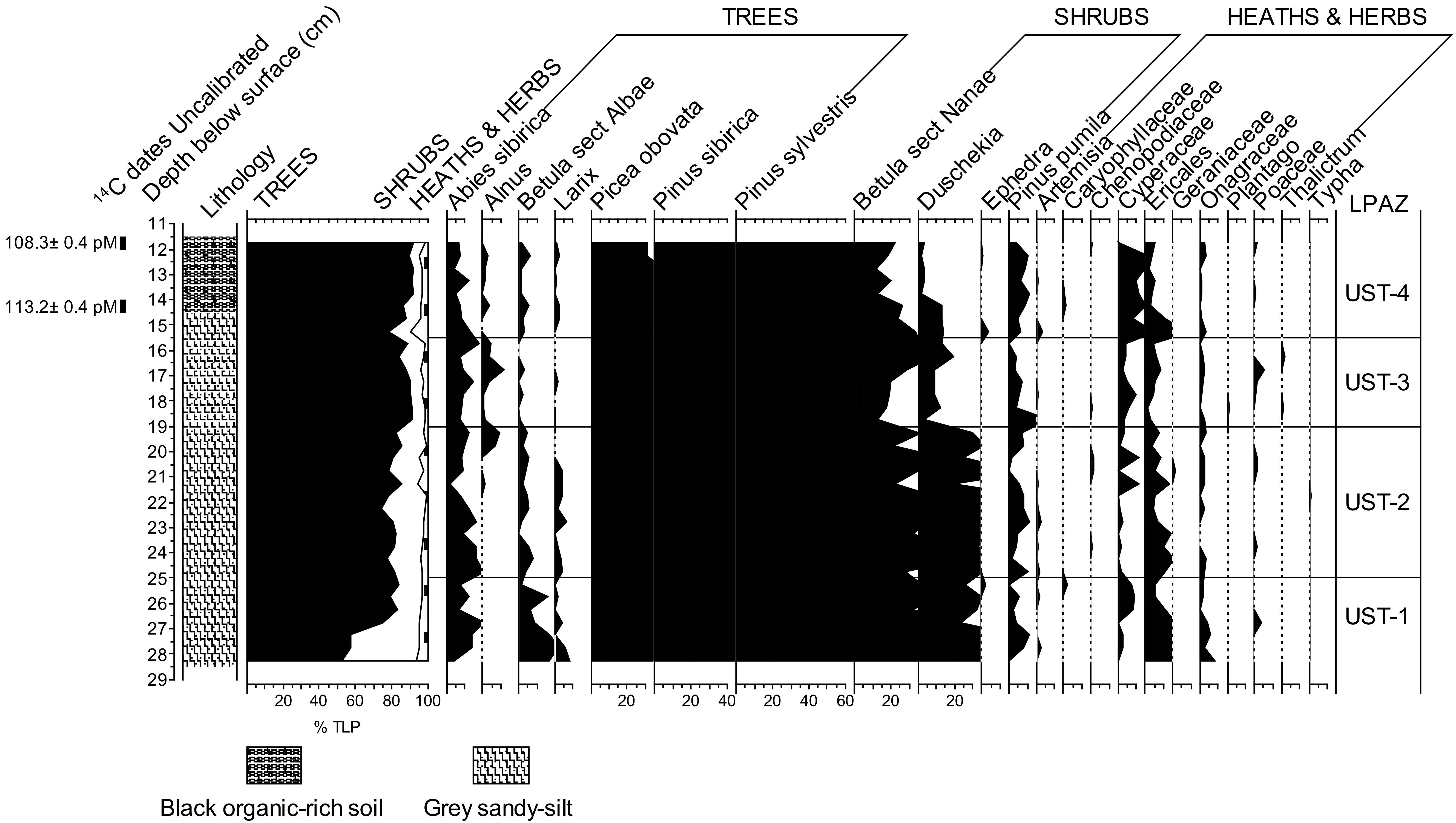

figure S1b

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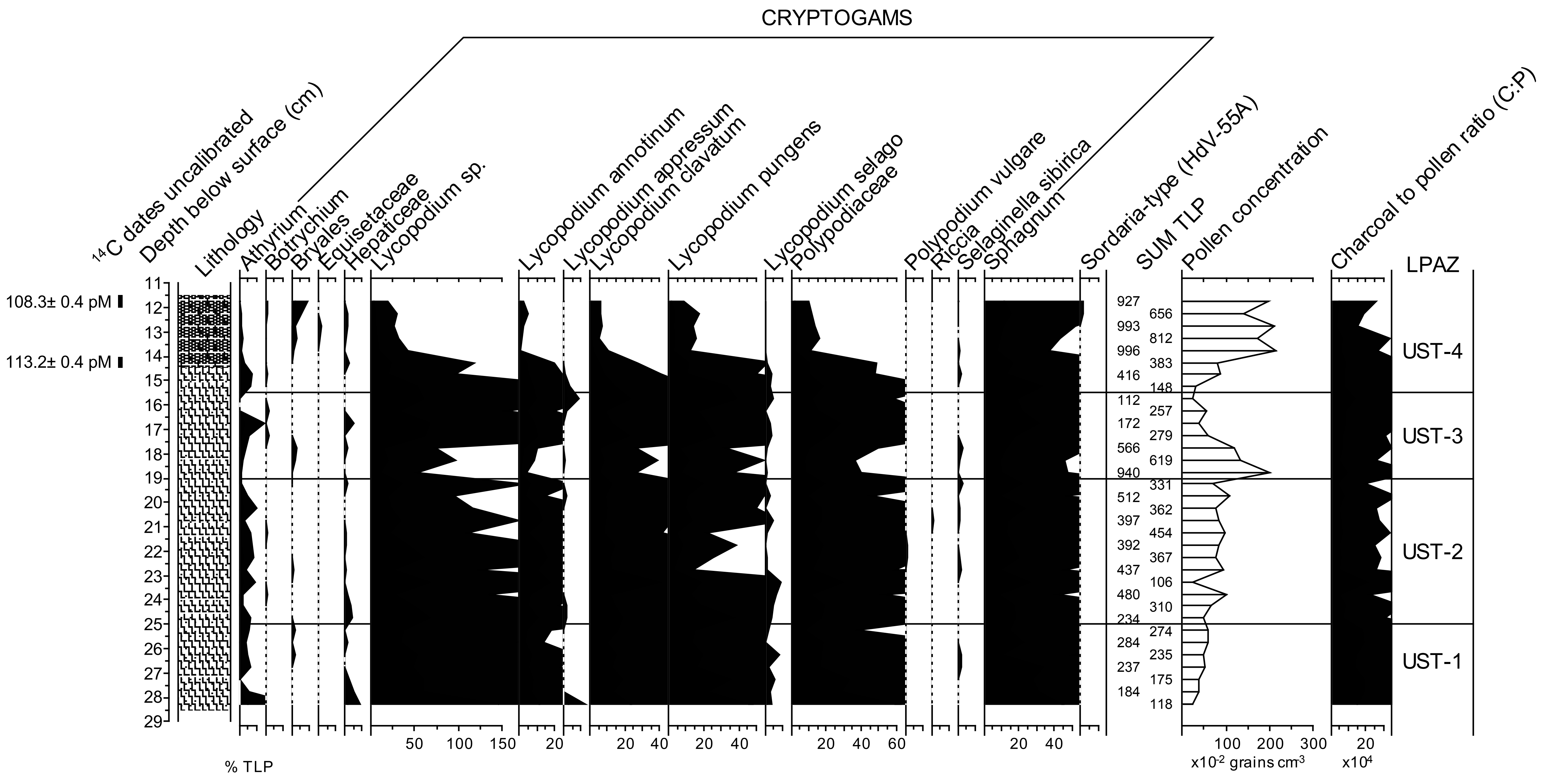

figure S2a

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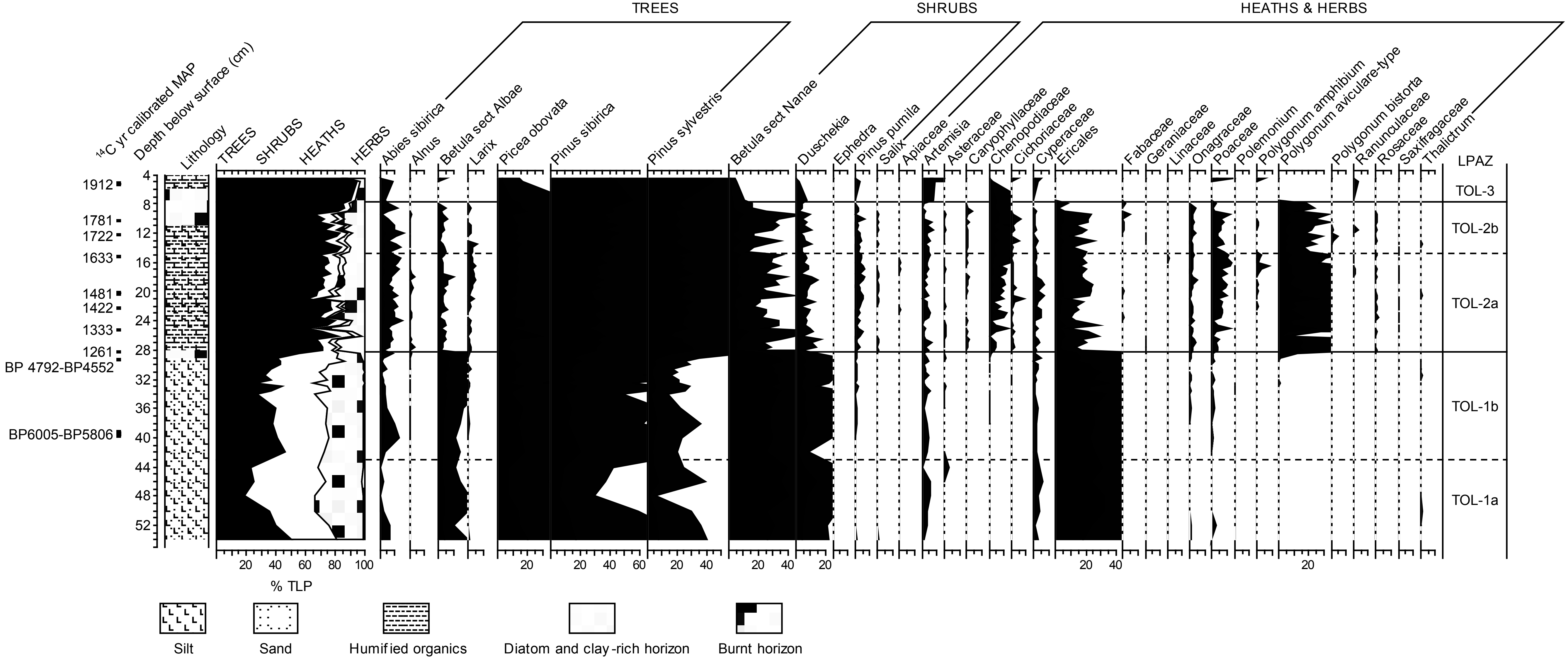

figure S2b

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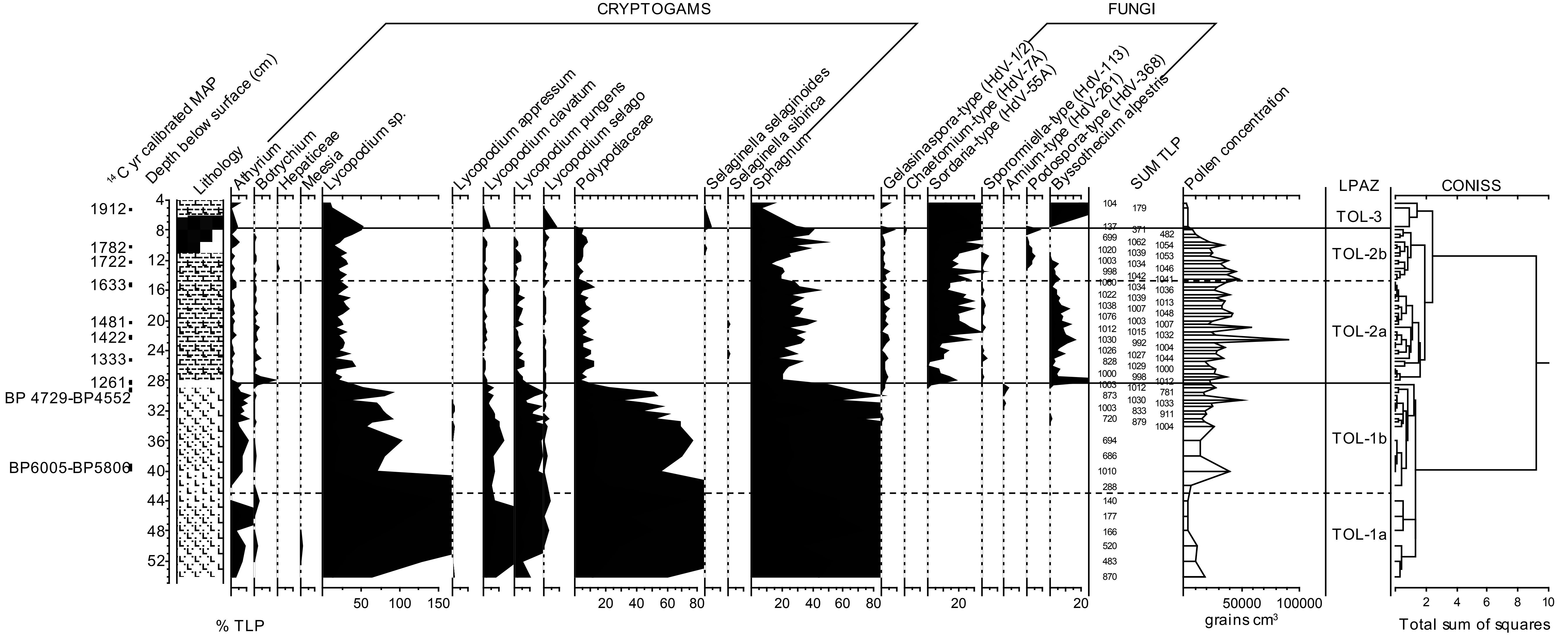

figure S3

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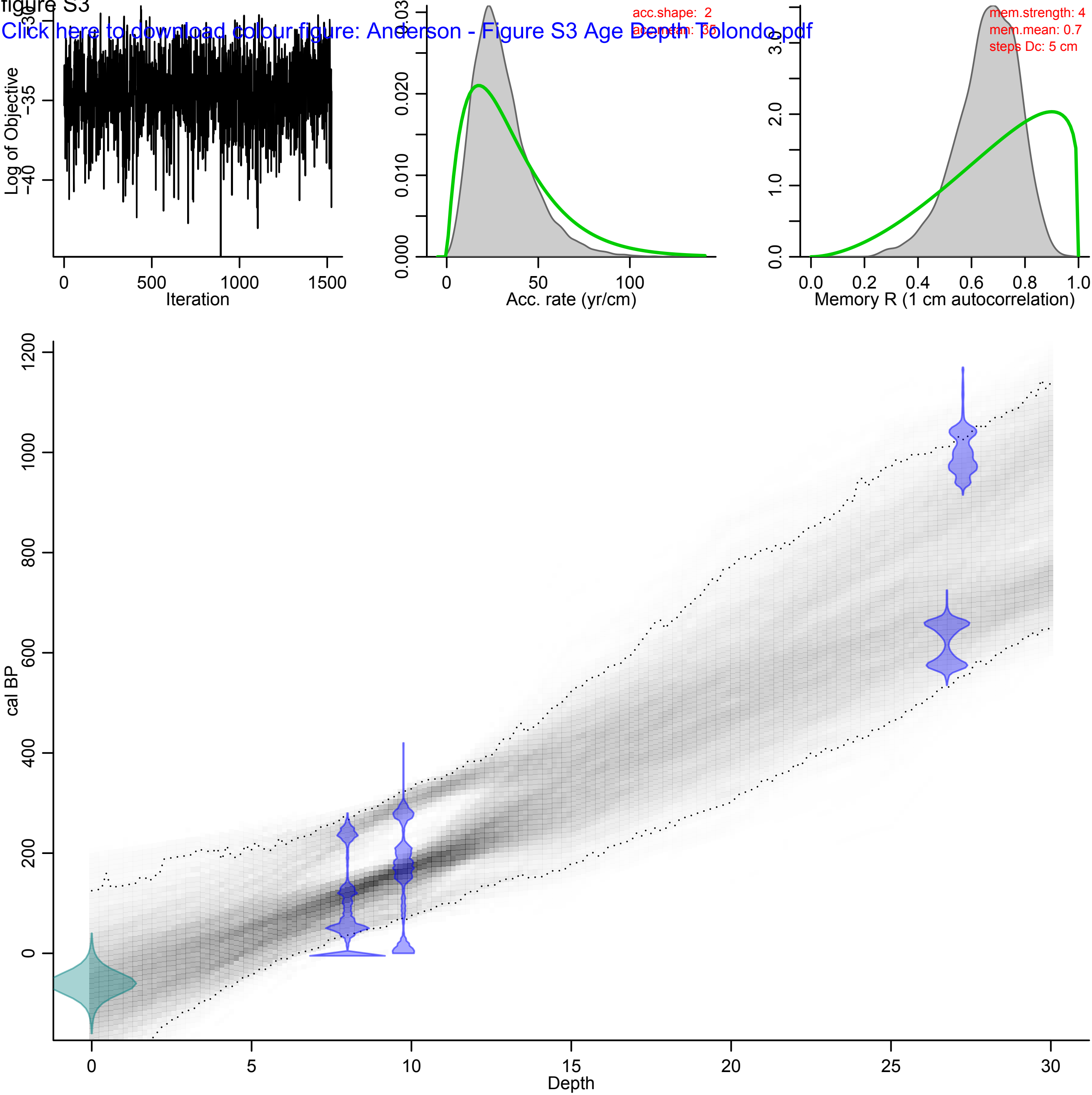

figure S4

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Table S4: Soil characteristics Tolondo Pit 2

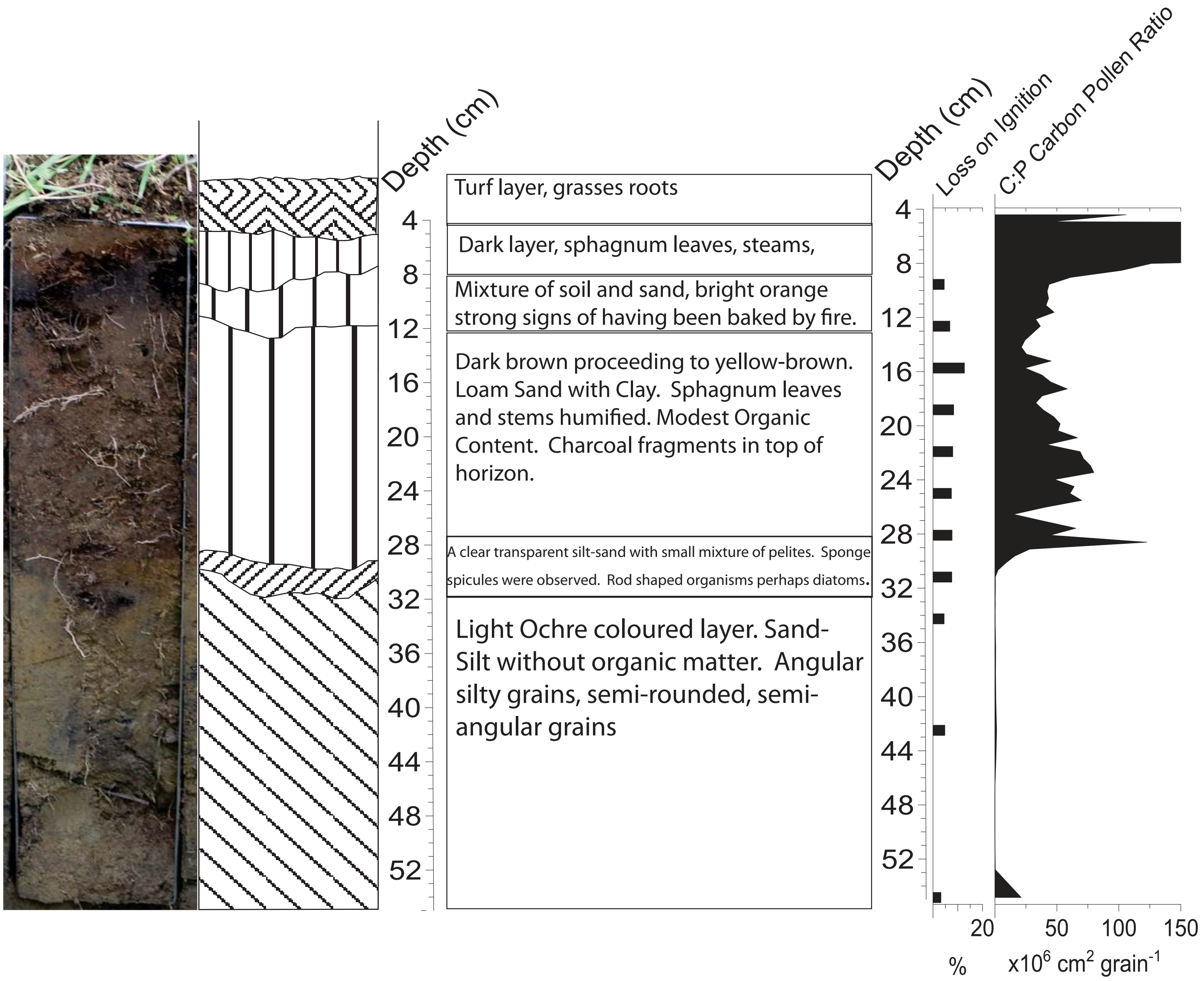

table 1
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Table 1: Calibrated Radiocarbon Dates from the Zhuia River Valley

Site,Lab №,Type	Depth cm	^{14}C age	Calibrated dates (σ)	Highest Probability
Ust'-Nechera				
Ua-41681 MF	12-12.5	108.3± 0.4 pM		
Ua-41682	14,5-15	113.2± 0.4 pM		
Ua-38491	39-40	5960±26		
Tolondo				
Ua-38489 Bulk	6.0-10	99,7 ± 0,4 pM		
Ua-41676 MF	9.5-10	191± 30	1727-1812	53.4%
Ua-40207 Bulk	26.5-27	669±30	1275-1392	95.4%
Ua-41677 MF	27-27.5	1085± 30	894-1016	95.4%
Ua-44060 MF*	29-29.5	5818± 45	BP 4792-BP4552	95.4%
Ua-43843 Bulk**	30-31	6864±290	BP6392-BP5299	95.4%
Ua-38490 Bulk	39-40	7 026 ± 44	BP6005-BP5806	95.4%

Tolondo Age-Depth Extrapolation (95% probability)

Depth cm	MAP BP	Century	Min yr BP	Max yr BP	Spread (years)
5	38.5	20th	-44	221	265
10	169.3	19th	65	335	270
15	317.2	17th	172	527	355
20	469.4	16th	301	781	480
25	617.1	14th	456	976	520
30	726.8	13th	649	1144	495

* charcoal visually extracted from soil by the MAL, Umeå University
** lab warning of extremely low quantities of charcoal

Table S1
Phytozone III – Ust'-Nechera 1 – Abandoned Milking Corral
2003-2008

Species	% of Area
Capsélla búrsa-pastóris (L.) Medik.	40
Polýgonum aviculáre L.	20
Taráxacum officinále Wigg.	<1
Potentílla anserína L.	<1
Chenopódium álbum L.	<1
Gálium boreále L.	<1
Géum aléppicum Jacq.	<1
Póa angustifólia L.	<1
Plantágo média L.	<1
Ranúnculus polyanthémos L.	<1
Tanacétum vulgáre L.	<1

Table S2
Phytozone II – Ust'-Nechera 1 – Active Reindeer Marshalling Area Surrounded by Smudges 2003-2009

Species	% of Area
Polýgonum aviculáre L.	35
Capsélla búrsa-pastóris (L.) Medik.	10
Póa angustifólia L.	8
Amória répens (L.) C. Presl	6
Taráxacum officinále Wigg.	3
Achilléa asiática Serg.	<1
Drába sibírica (Pall.) Thell.	<1
Àrabis péndula L.	<1
Lupináster pentaphýllus Moench	<1
Trifólium praténse L.	<1
Plantágo média L.	<1
Tanacétum vulgáre L.	<1

Table S3
Phytozone II – Ust'-Nechera 2 – Abandoned Reindeer Marshalling Area 1960-1979

Species	% of Area
Elytrígia répens (L.) Nevski	70
Vícia crácca L.	5
Taráxacum officinále Wigg.	5
Póa angustifólia L.	5
Plantágo média L.	10
Potentílla tergemína Sojak	3
Gеránium praténse L. subsp. pretense	2
Achilléa asiática Serg.	1
Thalíctrum símplex L.	1
Ranúnculus polyanthémos L.	1
Artemísia integrifólia L.	1
Bistórta vivípara (L.) Delarbre	1
Lactuca sibirica (L.) Benth. ex Maxim.	1
Siléne amoéna L.	1

Table S4
Phytozone I – Lake Tolondo – Main Meadow near the abandoned foundation of the cabin

Species	% of Area
Elytrigia repens (L.) Nevski	80
Vicia cracca L	10
Geránium praténse L. subsp. pretense	3
Achillea asiatica Serg	2
Amória répens (L.) C. Presl	1
Tanacétum vulgáre L. subsp. vulgáre	1
Siléne amoéna L.	1
Póa praténsis L.	1
Taráxacum officinále Wigg.	1
Potentílla tergemína Sojak	1
Plantágo média L.	1
Rhinánthus serótinus (Schönh.) Oborny	1

Table S5
Phytozone II – Lake Tolondo – Phosphate Vector 'C' Possible Location of a Reindeer Corral

Species	% of Area
Dasíphora fruticósa (L.) Rydb. (shrub)	10
Cárex caespitósa L.	70
Geránium praténse L. subsp. pretense	10
Elytrígia répens (L.) Nevski	10
Thalíctrum símplex L.	5
Galeópsis bífida Boenn.	1
Vícia crácca L.	1

Table S6
Phytozone II/III – Lake Tolondo – Phosphate Vector 'D' Rectangular Plant Community Nearer the Lake – Possible Location of a Shaded Marshalling Area or a Corral

Species	Prevalence %
Anemóne dichotóma L [in a rectangular pattern]	80
Elytrígia répens (L.) Nevski	10
Cárex caespitósa L.	5
Thalíctrum símplex L.	3
Tanacétum vulgáre L.	3
Stellária gramínea L.	3
Póa praténsis L.	2
Galeópsis bífida Boenn.	1
Chamaenérion angustifólium (L.) Scop.	1

* The size of this rectangular are was 5.5x11m or approximately 60 square meters

To: Editors, Human Ecology
From: Anderson, Ineshin, Lavento, Vinkovskaia
Re: Revisions to "Landscape Agency and Evenki-Iakut Reindeer Husbandry"
Date: 14 July 2013

Thank you for the helpful comments on the article. We have incorporated all of the suggestions of both reviewers.

Reviewer 1 requested minor changes to figure 16 and to the concept of herd-following (p.4), both of which have been done.

Reviewer 3 had a longer list of minor changes, all of which have been incorporated:

a) The reviewer asked us to comment on the extent that post 1843 and Soviet-era activities obliterated earlier patterns. This is a clumsy question in the sense that Russian settlement did occur on top of meadows opened first by reindeer. The later occupation obliterated artefacts and plant cover but not the soil record. The point of the method is explain these soil markers. We reviewed the article and we think that this is clear, although we added clauses of clarification on pages 18 and 21.
b) The section on the problems with phosphate analysis was reworded, but I think as the reviewer accepted, the problems with the method are clear. The one citation he provided (Wells et al) was not added since it refers to the interpretation of middens and not activity areas.
c) Figure numbers, names all made consistent
d) Although the term 'environmental archaeology' is widely used in Europe, esp in the Scandinavian languages (miljø arkeologi), it is not the main theme of the article and therefore the term was dropped.
e) An addition clarification added about the indirect link of pollen and phosphate tests to human occupation on page 4
f) The paragraph on access to the site deleted.
g) The use of aerial photographs in the research was stressed in the original text on page 10 and footnote 2. These were slightly reworded for re-emphasis. These are of higher resolution than the satellite photographs the reviewer suggests. A portion of one is submitted as figure 4.
h) We added a short sentence and footnote on the subject of semi-domestication on page 22 (quoting the reviewer).

The text (including footnotes and references, excluding abstract) shortened to 9,800 words.