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Fish, feather, fur and forest: Exploitation of wild animals in medieval Novgorod and its territory

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1. Introduction

Veliky Novgorod (Novgorod the Great) is a well-known and well-researched medieval city, made almost entirely of wood and with remarkable preservation of its organic remains. It was a thriving urban centre, heavily involved in production and trade, notably of furs and pelts. Increasingly the growing city was dependent on a large territory known as Novgorod Land (Fig. 1), which lay mostly to the east and northeast of the city. At its greatest extent in the 14th and 15th century, this territory was larger than modern day France (Brisbane et al., 2012: 2) and provided much of the wealth of the ruling elite, largely through the collection of tribute.

The inhabitants of Novgorod extensively exploited this territory, especially the forests, not only for raw material for building and street construction, but also for furniture, domestic and agricultural equipment, tools and other everyday items. The lands also provided fuel for heating and cooking, and fodder and pannage for animals. In addition, the wild animals of the forest were hunted and trapped mostly for their skins and furs, but also in some cases for their meat, antler and other products. Lacustrine and riverine environments were also rich in potential food resources.

Using material from Novgorod and other sites, this paper brings together the zooarchaeological evidence for the exploitation of fish, birds and wild mammals and sets them into the context of forest penetration.

2. Location, chronology and sites

Novgorod is located on the River Volkhov, approximately six km from Lake Ilmen. Lake Ilmen itself floods extensively in the springtime when it reaches its maximum extent of approx. 40 km long and 32 km wide but with a maximum depth of only 10 m. The lake's shallowness and flooding helps to create a more equitable microclimate in the Novgorod area, providing better alluvial soils and slightly raised annual temperatures (Spiridonova and Aleshinskaya, 2012: 30). This means that some species of deciduous trees are more widely found here, and that the land, when cleared, is good for growing crops. Around the lake there are a labyrinth of creeks, reed beds and water meadows.

Four main rivers (the Msta, Pola, Lovat, and Shelon) flow from the catchment into the lake but only one flows out, the Volkhov, which continues some 224 km north to Lake Ladoga. This means that the shallow lake has rapid water change and high oxygen levels, making it a very favourable habitat for a wide range of fish: today there are around 26 species (Savenskova et al., 2010).

Novgorod was founded, according to the Russian Chronicles, in AD 862 although archaeological evidence indicates that it began with tree felling and site clearance in the first half of the 10th century on low hills on either side of the Volkhov. However, it is highly likely that nearby earlier settlements started to have an impact on the forest with small-scale land clearance for farming beginning in the 8th century (Yeremeyev, 2012). These settlements were primarily located near the lakeshore and along the river valleys. They included Georgii, Prost, Vasilievskoye and Gorodishche, sometimes known as Ryurik Gorodishche (i.e. Ryurik's 'hillfort'), an important 9th and 10th century centre of trade and artisan production, as well as a military-administrative centre. Situated at the crossing of the Baltic–Volga route, the material culture from this site contains a distinctive assemblage of objects of Scandinavian origin, alongside artefacts attributable to the Slavs. The residence of the Novgorod princes was founded at Gorodishche and it continued in this role, on and off, for most of the medieval period (Nosov et al., 2005).

Around AD 1000 saw the beginning of a period of rapid urban expansion in Novgorod, with substantial population increase and the consequent greater demand on local and regional resources including those from the surrounding woodland, rivers and lakes. The town reached its greatest extent and economic influence between the 12th and 14th centuries, when it became an important *Kontor* of the Hanseatic League, housing first a Gotlanders' Court,

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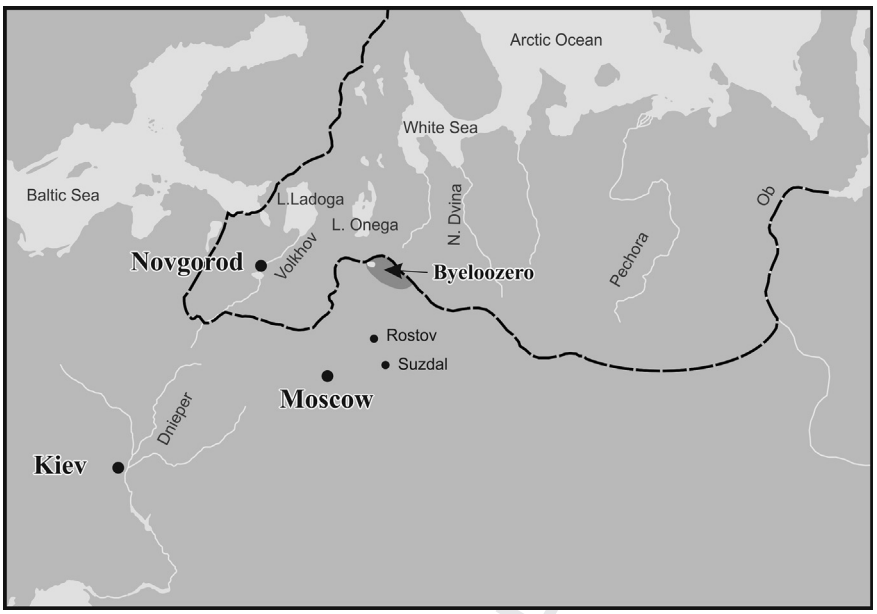

Fig. 1. Map showing the approximate area of Novgorod Land around AD 1400 including the region of Byeloozero where the site of Minino is located. After Yanin 1990, 74, with additions. Drawn by Mark Dover.

and subsequently a German Court known as Peterhof, through which much of the town's trade with the Baltic took place (Brisbane et al., 2012).

In this paper we draw upon evidence from Novgorod itself, mainly from the Troitsky excavations in the south-west quarter of the town, and, from its immediate hinterland around Lake Ilmen, the sites of Gorodishche, Georgii and Prost (Fig. 2). As an example of a site on the edge of Novgorod Land, we also include a group of sites at Minino, which is located on Lake Kubenskoye some 500 km to the east-northeast of Novgorod (Fig. 1). A brief description of these sites follows.

Within the medieval city of Novgorod, many systematic excavations have taken place since the pioneering work of Artsikhovsky began in 1932. Well over 40 open-area excavations located on both sides of the River Volkhov have demonstrated the extent of occupation and its date from the early/mid 10th century onwards. The Troitsky excavation is one such site, located on the Cathedral (West) side of the river, immediately to the south of the kremlin area. Work began here in 1973 and continues to the present time revealing over 6000 m^2 of dense occupation to a depth of almost 5 m. Each area (large trench) of the Troitsky site has been given a Roman numeral from I to XVI. For this exercise, we have used the faunal remains evidence from Troitsky IX, X and XI, where numerous domestic and ancillary buildings arranged around yards and contained within fenced properties were unearthed (Faradjeva, 2007). These properties were usually rectangular in shape with its shorter side facing onto a wooden street. Troitsky has few pits, but occasional wells (Khoroshev and Sorokin, 1992).

The group of Novgorod hinterland sites studied here were excavated under the direction of Evgenii Nosov of the Institute for the History of Material Culture (St Petersburg). They include the settlement site of Prost (8th to 10th century) where approximately 1000 m^2 were excavated, and the contemporary sites of Vasilievskoye (also an undefended settlement) and Georgii, a slightly

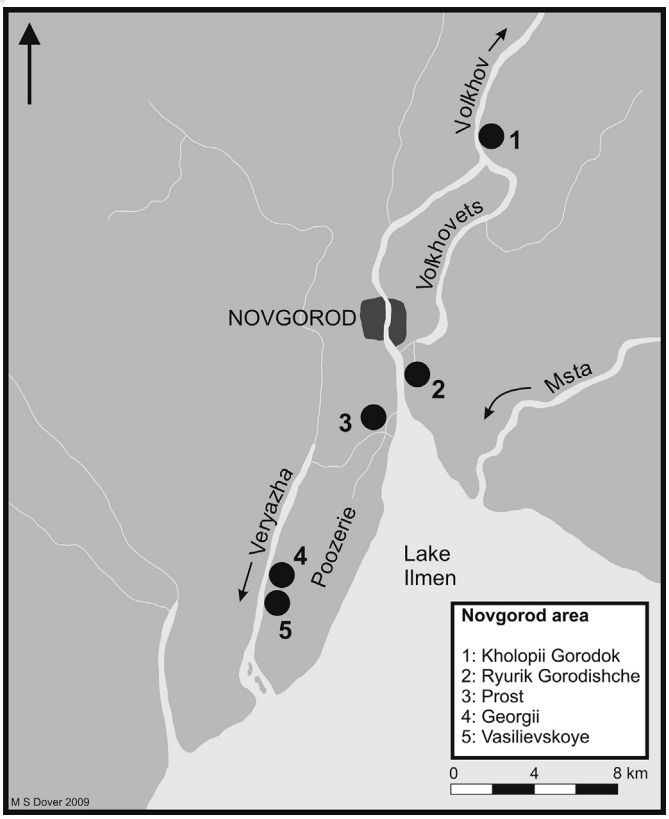

Fig. 2. Map showing Novgorod and its hinterland with other sites mentioned in the text. Drawn by Mark Dover.

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larger defended settlement where more than 600 m^2 were excavated in the late 1980s. But by far the largest defended settlement in Novgorod's immediate hinterland and the subject of much research is that of Gorodishche, located about 2 km downstream from where Novgorod subsequently developed (Nosov et al., 2005). This site occupies a low hill and the extent of occupation has been shown by Nosov to have grown by the 10th/11th century to cover some six to 7 ha (Nosov, 1992: 40).

The medieval sites of Minino were excavated by Nikolai Makarov and his team from the Institute of Archaeology (Moscow) from 1996 to 2003. They comprise three rural sites occupying a total area of no less than 4.5 ha, a burial ground, and an iron production site (Makarov, 2012a: 41). Collectively they date from the second half of the 10th century, continuing through the 11th and 12th centuries before one site was abandoned and another declined.

3. Landscape

The landscape around Novgorod in the 9th/10th century may be divided into four broad types based on soils, hydrology and forest character, the last of these supported by either pollen evidence (Spiridonova and Aleshinskaya, 2012) or archaeological evidence (Brisbane and Hather, 2007), or both.

- The first is around Lake Ilmen with its richer soils due to seasonal flooding and its microclimate. The forest here would not have been extensive with tree species limited to those that could withstand quite long periods of waterlogging such as willow (*Salix*), alder (*Alnus*) and other small trees like birch (*Betula*).
- The second type encompasses the river valleys and floodplains that would have contained mixed woodland with oak (*Quercus*), lime (*Tilia*), elm (*Ulnus*), alder, hawthorn (*Crataegus*), ash (*Fraxinus*) and hazel (*Corylus*) along with some pine (*Pinus sylvestris*), spruce (*Picea abies*) and birch. Some of these areas would have had floodplain meadows.
- The third lay away from the rivers on higher ground with poorer, thinner soils and typical northern European boreal forest of pine, spruce, birch and rowan (*Sorbus*) along with small numbers of broad-leafed species, most commonly lime.
- The fourth type, located within pockets of type three, is the wettest and boggiest, with little in the way of tree cover other than occasional stands of birch, pine and spruce (Spiridonova and Aleshinskaya, 2012: 20–22).

By the end of the 13th century, it seems likely that the forest of types one and two that were within easy reach of Gorodishche and Novgorod had been depleted, the landscape becoming essentially open. By then few trees aside from willow would have grown in the lower parts of the floodplain and most of the meadows would have been tilled and cultivated (Spiridonova and Aleshinskaya, 2012: 22).

Table 1
Fish taxa identified from investigated sites.

Sturgeon	*Acipenser* sp.
European eel	*Anguilla anguilla*
Whitefish	*Coregonus* cf. *lavaretus*
Pike	*Esox lucius*
Cyprinidae (Carp and Bream family) including:	
Bream	*Abramis brama*
Blue bream	*Abramis ballerus*
Chub	*Leuciscus cephalus*
Ide	*Leuciscus idus*
Roach	*Rutilus rutilus*
Silver bream	*Blicca bjoerkna*
Rudd	*Scardinius erythrophthalmus*
Chekon	*Pelecus cultratus*
Wels catfish	*Siluris glanis*
Perch	*Perca fluviatilis*
Zander	*Sander lucioperca*
Ruffe	*Gymnocephalus cernuus*

4. Fish

The fish taxa identified in the assemblages from the sites investigated are shown in Table 1.

At Gorodishche, where sieving was employed as a standard method of retrieval, fish remains were common providing 19% of all bones recovered and 40% of the bones identified to taxon (Table 2). Bones of cyprinids, members of the carp family, are the most common at 39% of the identified bones. Many of these bones were not identified to species, but most were comparable with bream. Other cyprinid species positively identified were roach, chub, ide, blue bream, silver bream and rudd. Pike and zander are next most frequent at 30% and 29% respectively. Several other species are present, including perch (1%), and small numbers of bones of wels catfish, whitefish and sturgeon (Table 3).

Table 2
Mammal, bird and fish bones recovered from Novgorod and other sites in its immediate hinterland.

	NISP Gorod	NISP Georgii	NISP Prost	NISP Vasiliev	NISP Troitsky IX-XI	% Total Gorod	% Total Troitsky IX-XI	% Ident Gorod	% Ident Troitsky IX-XI
Identified mammal	4450	558	260	24	34,304	26.3	53.4	54.7	88.2
Unid. mammal	6290	187	1681	28	24,432	37.1	38.0		
Total mammal	10,740	745	1941	52	58,736				
Identified bird	470	9	1	2	3763	2.8	5.9	5.8	9.7
Unidentified bird	173	3	0	0	498	1.0	0.8		
Total bird	643	12	1	2	4261				
Identified fish	3208	31	395	55	821	18.9	1.3	39.5	2.1
Unidentified fish	2341	40	786	47	471	13.8	0.7		
Total fish	5549	71	1181	102	1292				
Total identified	8128	598	656	81	38,888				
Total unidentified	8804	230	2467	75	25,401				
Grand total	16,932	828	3123	156	64,289	16,932	64,289	8128	38,888

NISP = number of individual specimens; Unid = unidentified.
Gorod = Gorodishche; Vasiliev = Vasilievskoye; Troitsky counts exclude bones in sieved samples.

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Table 3
Fish taxa from all assemblages examined.

	Gorodishche	Georgii	Prost	Vasilievskoye	Troitsky (hand)	Troitsky (sieved)	Total	Minino
Eel	0	0	0	0	0	0.2	0	0
Sturgeon	0.03	0	0	0	0.6	0	0.1	0.1
Whitefish	0.1	0	0	0	0	0	0	0
Pike	30.4	16.1	18.7	7.3	26.1	15.9	25.1	9.9
Cyprinid	38.8	54.8	52.9	40.0	25.5	60.0	43.3	38.9
Wels	0.2	0	0	0	7.3	0.1	1.1	0
Perch	1.2	9.7	7.8	0	2.1	6.1	3.0	51.0
Ruffe	0	0	0	0	0	0.1	0	0.1
Zander	29.4	19.4	20.5	52.7	38.5	17.5	27.2	0.1
% Unidentified	42.2	56.3	66.6	46.1	36.5	67.6	53.1	58.1
Total identified	3208	31	395	55	821	1499	6009	1612
Total unidentified	2341	40	786	47	471	3121	6806	2236
Total Fish	5549	71	1181	102	1292	4620	12,815	3848

NISP = number of individual specimens; Unid = unidentified; Troitsky = Troitsky sites, Novgorod.

At Georgii, only a few fish bones were recovered by hand-collection but again cyprinids, zander, pike and perch are present. The first three were also identified at Vasilievskoye. Sieving was employed extensively at Prost and the taxa distribution is similar to that of Gorodishche, with cyprinids prominent, followed by pike and zander and perch (Table 3).

Fishing was evidently an important component of the subsistence economy in medieval Novgorod, as indicated by references to fish in the birch-bark documents (each one given a unique BBD number) and abundant finds of fishing equipment from the excavations (Rybina, 2001, 2007; Brisbane and Maltby, 2002). Bones of fish are indeed the most frequent of the recovered wild fauna at Novgorod but relatively few were retrieved by the standard hand collection at the three Troitsky sites considered (IX, X, XI). The hand-collected fish bones from the Troitsky excavations total 1292 specimens, of which 821 were identified to taxon (2% of all bones identified to taxa – Table 2). In contrast 4620 bones were retrieved from the very limited sieving programme, illustrating the very large number of fish remains that must have originally been deposited. Fish were clearly a much more importance resource than currently evidenced, as there is an inevitable retrieval bias in the hand-collected material towards larger mammal bones.

The hand-collected assemblage was also biased towards large bones of large fish. These include bones of sturgeon and wels catfish. The prestigious and migratory sturgeon is recorded in one birch-bark document (BBD 259) but it was not represented in the sieved assemblage and, despite its large size, sturgeon provides less than 1% of the identified hand-collected fish bones. By the time of Novgorod's foundation the sturgeon had already become uncommon in the Baltic and Lake Ladoga region (Kolman et al., 2011). The wels catfish is not recorded in birch-bark documents. This very large species provided 7% of identified fish from the hand-collected material at Troitsky but only 0.1% of the sieved assemblage - again indicating retrieval bias (Table 3).

Pike is only mentioned in one birch-bark document (BBD 44) but, in contrast, provides 26% of identified fish in the Troitsky hand-collected sample and 16% of the sieved. This predatory species is commonly found in the River Volkhov and Lake Ilmen and a variety of sizes are represented in the assemblage, including some very large fish.

The zander is another common local freshwater species. It has not been recorded in the birch-bark documents thus far but in the Troitsky hand-collected sample provides 39% of the identified fish bones and 18% in the sieved samples. The related but smaller perch is also locally abundant but again not recorded in documents. In the Troitsky hand-collected samples it provides 2% of identified fish and 6% in the sieved samples.

Whitefish, the highly prized relatives of salmon, are the most frequently listed fish in birch-bark documents (e.g. BBDs 144, 260, 280, 831), and sometimes units of up to fifty fish are mentioned. However, their bones have very rarely been recovered from the excavations. There were none in the main Troitsky deposits, although a few bones were retrieved from a mixed layer and some were previously recovered from the Nerevsky excavations located in the northwest part of the town (Sychevskaya, 1965). This migratory fish is no longer found in Lake Ilmen since the construction of the Volkhov hydroelectric dam in 1927.

Cyprinids (26%) are only slightly less frequent than pike in the hand-collected material from the Troitsky sites, but they completely dominate the sieved material (60%). At least seven species are present with bream the most commonly represented. Bream is the only cyprinid recorded in birch-bark documents, being mentioned in just one document – the same one as the pike (BBD 169).

Two other species were found in sieved samples – two bones of ruffe, a very small fish related to the perch, and three bones of eel. The Novgorod area is likely to have been at the limit of the migratory reach of eel and, as the bones represent quite large specimens, it is possible that these remains may have been from traded, preserved, fish.

There is a striking contrast between the documents and the bone assemblages. The birch-bark documents mostly concern tribute payments (e.g. BBD 92 lists tributes of salmon and squirrel), and highlight the traded and prestige fish such as the salmonids and sturgeon, which are rare in the excavated remains. The assemblages, on the other hand, are dominated by locally abundant but less prestigious species commonly used for food. The main taxa exploited were cyprinids, pike and zander. The commercial fish catch in Lake Ilmen today is similar with bream and blue bream the principal cyprinids caught (Savenskova et al., 2010).

At Minino, the fish assemblage, recovered by sieving, is somewhat different; the identified remains are dominated by perch (51%) and cyprinids (39%). Roach, bream and ide were positively identified with roach identified most often and ide rarely. The remains of pike (10%) form the third most frequent group. Other fish species were very rare, consisting of one bone each of ruffe and zander and two dorsal scutes of sturgeon (Table 3). In Lake Kubenskoye today, the three most commonly found fish species are bream, roach and ruffe, followed by pike, ide and perch. The near absence of zander in the archaeological deposits of Minino is explained by the fact that it was only introduced to the lake in 1936 (Bolotova et al., 2001).

The variations in species abundance between Minino and the sites in the Novgorod area probably largely reflect the availability of

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different fish stocks due to local ecological constraints/factors. In both cases there is an emphasis on the capture of local resources rather than the species featured in the tribute documents.

5. Birds

The bird taxa identified in the assemblages from the sites investigated are shown in Table 4.

Table 4
Bird taxa identified from investigated sites.

Great-crested grebe	*Podiceps cristatus*
Cormorant	*Phalacrocorax carbo*
Heron	*Ardea cinerea*
Bittern	*Botaurus stellaris*
Stork	*Ciconia* sp.
Swan	*Cygnus* sp.
Domestic goose or cf. Greylag	*Anser anser*
Goose, cf. White-fronted	*Anser albifrons*
Goose, cf. Lesser white-fronted	*Anser erythropus*
Domestic duck or Mallard	*Anas platyrhynchos*
Teal	*Anas crecca*
Other ducks including:	
cf. Garganey	*Anas querquedula*
cf. Wigeon	*Anas penelope*
cf. Shoveller	*Anas clypeata*
cf. Goldeneye	*Bucephala clangula*
cf. Pochard	*Aythya ferina*
cf. Tufted	*Aythya fuligula*
Eagle, cf. White-tailed	*Haliaeetus albicilla*
Sparrowhawk	*Accipiter nisus*
Goshawk	*Accipiter gentilis*
Buzzard	*Buteo buteo*
Hen harrier	*Circus cyaneus*
Kestrel	*Falco tinnunculus*
Hobby	*Falco subbuteo*
Merlin	*Falco columbarius*
Capercaillie	*Tetrao urogallus*
Black grouse	*Tetrao tetrix*
Hazel hen	*Bonasa bonasia*
Partridge	*Perdix perdix*
Domestic fowl	*Gallus gallus*
Crane	*Grus grus*
Coot	*Fulica atra*
Wader, cf. Woodcock	*Scolopax rusticola*
Wader, cf. Snipe	*Gallinago gallinago*
Other waders	eg *Tringa* sp., *Limosa* sp.
Gull	*Larus* sp.
Woodpigeon	*Columba palumbus*
Pigeon, cf. Stock dove	*Columba oenas*
Owl, cf. Tawny	*Strix aluco*
Owl, cf. Tengmalm's	*Aegolius funereus*
Raven	*Corvus corax*
Rook/Crow	*Corvus frugilegus/corone*
Jackdaw	*Corvus monedula*
Small corvid, cf. Jay	*Garrulus glandarius*
Small passerine	

Bird bones recovered from the excavations at Gorodishche were not as numerous as those of fish but more frequent than those of the wild mammals and constitute 6% of the total number of bones identified to taxon (Table 2). Bones of ducks are dominant, comprising 46% of all bird bones and 62% of identified bird bones (Table 5). It has not been possible to distinguish all duck bones to species due to close morphological similarities. However, most of the larger ones are closely comparable with mallard and the smallest ones comparable with teal. Bones of other ducks are present but are less frequent; these include some bones of diving ducks such as goldeneye, whilst others match wigeon. Bones of domestic fowl are the second most frequent type and comprise just over 25% of the identified bird bones. Goose bones, all of domestic/greylag size, are the third most frequent group at 8%. At least nine other species are present in small numbers. The most frequent of these is capercaillie. Other taxa identified are eagle, a medium-sized accipiter (probably sparrowhawk), crane, swan, cormorant, wader (woodcock-sized), raven and two other corvids.

Table 5
Bird NISP percentages from Novgorod hinterland sites.

% of identified	Gorodishche	Georgii	Prost	Total
Cormorant	0.2	0	0	0.2
Swan	0.2	0	0	0.2
Goose, domestic/greylag	7.9	66.7	0	9.0
Mallard-sized duck	40.2	22.2	0	39.8
Teal-sized duck	15.3	0	100	15.2
Other ducks	6.8	11.1	0	6.9
Eagle	1.1	0	0	1.0
cf. Sparrowhawk	0.2	0	0	0.2
Domestic fowl	25.1	0	0	24.6
Capercaillie	1.3	0	0	1.3
Large galliform	0.2	0	0	0.2
Crane	0.2	0	0	0.2
Waders	0.2	0	0	0.2
Raven	0.4	0	0	0.4
Corvid	0.6	0	0	0.6
% Unidentified	26.9	25.0	0.0	26.8
Total identified	470	9	1	480
Total unidentified	173	3	0	176
Total bird	643	12	1	656

NISP = number of individual specimens

In Novgorod, birds provide 6% of all hand-collected bones from the Troitsky sites and 10% of bones identified to taxon. As with the fish remains, birds are under-represented because of retrieval bias, although it is less marked. More than 30 species are present (Table 6). As expected, domestic fowl (chicken) were important but in Novgorod, unusually for a medieval town assemblage, ducks are much better represented. Their abundance can be explained by the locally favourable conditions and Novgorod's proximity to migration routes.

As at Gorodishche, a range of duck sizes and types are present. Most bones were classified as mallard-size. These could include domestic/tamed ducks but the bones were no larger than those of wild mallard, a very common resident bird in the area today. The smallest duck bones match teal and are well represented. Some are of garganey-size and a few of those classed as teal-sized may be of this small dabbling duck. Other duck bones include those of intermediate size, for example wigeon, and there are also a number of bones of diving ducks, including several of goldeneye and tufted duck. These are all migratory and are still commonly hunted: the main hunting seasons today are April–May and September–November. Other wetland birds potentially used for food include swan, stork, heron and several wader species. The large galliform bones include 77 positively identified as capercaillie and ten of black grouse. Smaller game birds, such as hazel grouse and partridge, are also present.

Birds are very rarely mentioned in the birch-bark documents but one lists the prestigious black grouse (BBD 842), another mentions a falcon (BBD 54) and one a gyrfalcon (BBD 248). As with fish, common species do not appear in the documents and were presumably not considered prestigious enough for tribute. Gyrfalcons were largely reserved for royalty throughout Europe (Potapov and Sale, 2005: 232), although remains of this arctic species were not found in Novgorod, several other raptors are represented. These include eagle, buzzard, goshawk, sparrowhawk, harrier, kestrel,

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Table 6
Bird NISP percentages from Troitsky sites, Novgorod.

% of identified	Troitsky IX	Troitsky X	Troitsky XI	Troitsky XI	Troitsky XI	Total
	10-E12	10-E12	10-E12	M12-E13	M13-E15	
Grebes	0.3	0.4	0	0.1	0	0.1
Cormorant	0	0	0.1	0.4	0	0.1
Heron	0	0	0.4	0	0	0.2
Bittern	0	0	0.1	0	0	0.1
Stork	0.3	0	0	0	0	0
Swan	0	0.2	0.5	0.1	0	0.3
Goose, domestic/greylag	2.7	5.6	4.1	6	7.5	4.8
Other goose	0	0.2	0.6	0.3	0	0.4
Mallard-sized duck	45.8	53.9	40.6	19.7	15.4	36.8
Teal-sized duck	6.8	6.3	11.2	6.6	9.6	9.2
Other duck	5.8	5.6	6.1	4.9	5.4	5.7
Eagle	0	0.2	0.1	1.3	3.2	0.6
Sparrowhawk	0.8	0	1.1	2.9	1.1	1.3
Goshawk	0	0.7	1.1	1.4	2.1	1.1
Buzzard/Goshawk	0	0	0.1	0	0	0.1
Harrier	0	0	0	0.3	0	0.1
Kestrel	0	0	0.2	0	0	0.1
Hobby	0	0	0.1	0	0.4	0.1
Merlin	0	0	0	0.3	0	0.1
Domestic fowl	33.7	22.6	27.5	47.3	50.4	33
Capercaillie	0.8	2.9	1.6	3.5	1.4	2
Black grouse	0.3	0	0.3	0.6	0	0.3
Large galliform	0.5	0.2	0.8	0.8	0.7	0.7
Hazel grouse	0	0	0	0	0.7	0.1
Partridge	0	0	0	0	0.4	0
Crane	0	0.2	0.3	0.6	0.4	0.3
Coot	0	0	0.1	0	0	0
Waders	0.8	0.7	0.2	0.4	0.4	0.4
Gulls	0	0	0.3	0.1	0	0.2
Pigeons	0	0	0.1	0.3	0	0.1
Owls	0	0	0.3	0.6	0	0.3
Raven	0.5	0	0.5	0.3	0	0.3
Rook/Crow	0.5	0.2	0.4	0	0	0.3
Jackdaw	0.3	0	0.1	0.8	0.4	0.2
Corvid	0	0	1.5	0.6	0.7	0.9
% Unidentified	9.4	11.1	13.1	9.4	11.1	11.7
Total identified	365	447	1954	717	280	3763
Total unidentified	38	56	295	74	35	498
Total Bird	403	503	2249	791	315	4261

hobby and merlin. Of these, goshawk, sparrowhawk and kestrel are the most frequent and several finds are of complete or partial skeletons. Many of these remains are probably of birds kept for falconry (Prummel, 1997). Falconry equipment, including swivels, bells and hoods, has been found at Gorodishche and in several excavations in Novgorod (Fedorov et al., 2011). In some instances leg bones of hawks and other birds were recovered that still have jesses (leather thongs) attached. In one case these are on the bones of an immature crane, perhaps used to train hawks, and in another case on the tarsometatarsus of a buzzard. Although this species is not usually a falconer's bird itself, it may have been used for training and as a decoy, and falconry may also explain the presence of owls and harriers (Zeiler, 2010). Raptors can be trained to take a variety of birds and mammals in addition to their normal prey (Prummel, 1997) and several potential quarry species are present in the excavations, including hare, heron, galliforms and waders. The goshawk can also be trained to take ducks made to rise off the water (Fedorov et al., 2011) although the majority of these were probably caught by netting as the large number of duck bones are unlikely to have derived from falconry alone. Nonetheless, our present evidence would suggest that many properties on Novgorod and Gorodishche kept raptors for hunting.

Apart from domestic fowl and possibly some geese kept within the settlements, the archaeozoological evidence shows a focus upon the exploitation of the abundance of local wildfowl, particularly ducks. Other waterfowl were utilised as well as the large prestigious game birds, such as capercaillie and black grouse. Capercaillie, in particular, favour spruce-dominated forest and this may explain the relatively low number of finds, as the birds may have been uncommon around Novgorod itself. Birds of prey are present and include several species potentially used in falconry. Other remains such as jackdaws reveal the local bird life in town.

6. Wild mammals

The wild mammal taxa identified in the assemblages from the sites investigated are shown in Table 7.

Table 7
Wild mammal taxa identified from investigated sites.

Bison or aurochs	*Bison bonasus* or *Bos primigenius*
Elk	*Alces alces*
Reindeer	*Rangifer tarandus*
Roe deer	*Capreolus capreolus*
Hare	*Lepus* sp.
Wild boar	*Sus scrofa*
Brown bear	*Ursus arctos*
Squirrel	*Scirius vulgaris*
Beaver	*Castor fiber*
Otter	*Lutra lutra*
Marten	*Martes* sp.
Polecat	*Mustela putorius*
Stoat	*Mustela erminea*

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Table 7 (*continued*)

Fox	*Vulpes* sp.
Lynx	*Lynx lynx*
Wolf	*Canis lupus*
Badger	*Meles meles*
Hedgehog	*Erinaceus europaeus*
Field vole	*Microtus agrestis*
Rat	*Rattus* sp.
Mouse	*Mus/Apodemus* sp.

The bone assemblages of Novgorod and its hinterland sites are dominated by domestic mammals, particularly cattle and pig. The 9th and 10th century levels at Gorodishche have produced very low numbers of wild mammal remains, contributing only between 0.2% and 2% of the mammal assemblage (Table 8). Elk and bear are the only large species recorded, the latter only represented by a solitary third phalanx. This may have been attached to an imported bear-skin, although these bones were also sometimes used as pendants. Smaller mammals included hare, pine marten, stoat, red squirrel, wolf, fox and vole. A few of the largest pig bones may have belonged to wild boar but most were from smaller domestic stock. Butchery marks were observed on several beaver bones, indicating its meat was occasionally consumed (Maltby, 2012).

hundreds of thousands of pelts were collected annually from the forest zones of northern Russia. Squirrels were particularly important but other species such as beaver, marten, otter, sable and fox were also heavily exploited. The trade in furs from Novgorod through the Baltic into western Europe was enhanced from the 13th century by its involvement in the Hanseatic League. For example, in 14th century London, squirrel furs from Novgorod attracted high prices (Veale, 1966). There are many references to squirrel pelts in Novgorodian birch-bark documents and seals of cylinders containing furs brought as tribute have also been found (Makarov, 2012b). Evidence for hunting is also found in the form of equipment such as the distinctive blunt arrowheads made from wood and antler (Smirnova, 1994). However, the great importance of these fur-bearing species is not reflected in the zooarchaeological record from Novgorod itself. Wild species formed less than 1% of the total mammal assemblage from the Troitsky excavations, and even in the sieved samples where the bones of small species had a better chance of retrieval, wild species contributed less than 4% of the mammal bones (Table 8).

Although only forming 25% of the wild mammal bones from hand-collected assemblages, elk, given their large size, would have provided much more meat than any of the other wild mammals, albeit seemingly forming only an occasional supplement to the

Table 8
Wild mammal species totals from recent excavations in Novgorod and its territory.

Sites	Gorod	Georgii	Prost	Tr IX	Tr X	Tr XI	Tr XI	Tr XI	Tr Total	Tr Sieved	Minino	Minino	Minino	Minino
Dates (century)	9–10	9–10	9–10	10-E12	10-E12	10-E12	M12-E13	M13-E15	10-E15	10-M13	11-E12	L12-13	11–13	Total
Bison/aurochs	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Elk	7	18	0	9	5	16	34	16	80	0	31	56	20	107
Reindeer	0	0	0	2	0	0	0	1	3	0	7	4	2	13
Roe deer	0	0	0	0	0	0	0	0	0	0	2	2	2	6
Hare	44	1	0	14	5	26	20	49	114	4	6	13	5	24
Boar	0	0	0	0	0	1	1	2	4	0	2	6	7	15
Bear	1	1	0	0	1	2	4	2	9	0	0	2	0	2
Squirrel	11	1	0	1	0	2	0	0	3	1	214	153	56	423
Beaver	23	3	1	18	16	64	2	0	100	6	423	183	252	858
Otter	0	0	0	0	0	0	0	0	0	0	4	7	1	12
Marten	1	0	54	0	0	0	0	0	1	0	45	40	19	104
Polecat	0	0	0	0	0	0	0	0	0	0	2	4	1	7
Stoat	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Fox	0	0	0	0	0	0	0	1	1	0	5	5	1	11
Lynx	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Wolf	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Badger	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Hedgehog	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vole	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Rat	0	0	0	0	0	1	4	2	7	0	0	0	0	0
Mouse	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Total	94	25	56	44	27	113	65	73	322	12	741	476	366	1583
% Wild	2.1	4.5	21.5	1.2	0.4	0.8	1.3	1.4	0.9	3.9	72.6	58.1	59.9	64.6

Counts are of number of individual specimens (NISP).
Gorod = Gorodishche; Tr = Troitsky.
E; early; M; mid; L; late.
Data from Minino adapted from Savinetsky (in press).

Wild mammals were slightly better represented at Georgii, providing 5% of the mammal bones. Most of these belonged to elk, although a few bones of beaver, bear, squirrel, and lynx were also identified (Table 8). As at Gorodishche, however, there was no evidence of large-scale procurement and processing of fur-bearing animals. At Prost, on the other hand, one deposit produced foot bones from at least four pine martens, which accounted for the much higher percentage of wild mammal bones (22%) in that assemblage. These presumably were from the skins of animals captured nearby.

Documentary sources indicate that Novgorod's wealth was largely created by its pivotal role in the international fur trade (Martin, 1986; Makarov, 2012b). These documents show that meat diet of most inhabitants in the town. It is, however, plausible that their importance is underestimated as many elk may have been butchered at the kill sites in the hinterland and only filleted meat or good-quality joints brought to the town. However, bones from all parts of elk skeletons have been found, possibly indicating that whole carcasses were sometimes processed in the town (Fig. 3). Alternatively, the relatively high percentage of lower limb bones (carpals/tarsals, metapodials and phalanges) may indicate that elk skins were commonly imported with these bones still attached. Skinning marks were observed on several of these bones and elk skins are specifically named in a few birch-bark documents. There is no doubt that elk antlers were imported in large numbers for the manufacture of combs and other artefacts. Many antler

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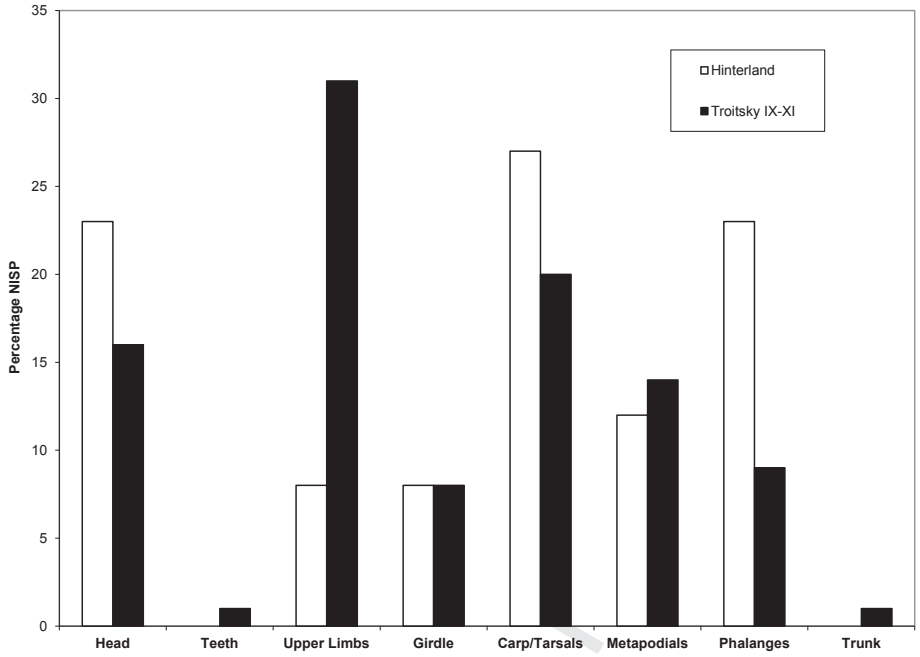

Fig. 3. Percentages of elk body parts from Novgorod (Troitsky IX-XI – N = 80) and hinterland sites (Gorodishche; Prost; Georgii – N = 25).

offcuts have been found within some properties (Smirnova, 2005) and these are not included in these counts.

Hare was the most common wild mammal recovered from the Troitsky sites, providing 35% of their bones in the hand-collected assemblage (Table 8). Here, and on the other sites discussed here, it is believed that all the hare bones are from the mountain hare (*Lepus timidus*), as the brown hare (*Lepus europaeus*) was not introduced into the region until the post-medieval period (Thulin, 2003). Hare skins were also mentioned in the birch-bark documents but it is likely that most of the hares were brought to the town for food. In this respect, it is probably significant that the only finds of bear from the Troitsky sites in Novgorod were third phalanges (claws), which had probably been attached to skins.

Only 106 beaver were recorded from Troitsky sites (Table 8). Foot bones are under-represented (Fig. 4), probably previously having being removed with the skins. Butchery marks were observed on 35% of beaver bones, most of which were associated with butchery for meat rather than skinning (Maltby, 2012). Very few squirrel bones have been recovered from Novgorod. Although further sieving could produce more evidence for these and the other small fur-bearing species found such as marten, otter and fox, the importance of these species is not reflected in the bones found

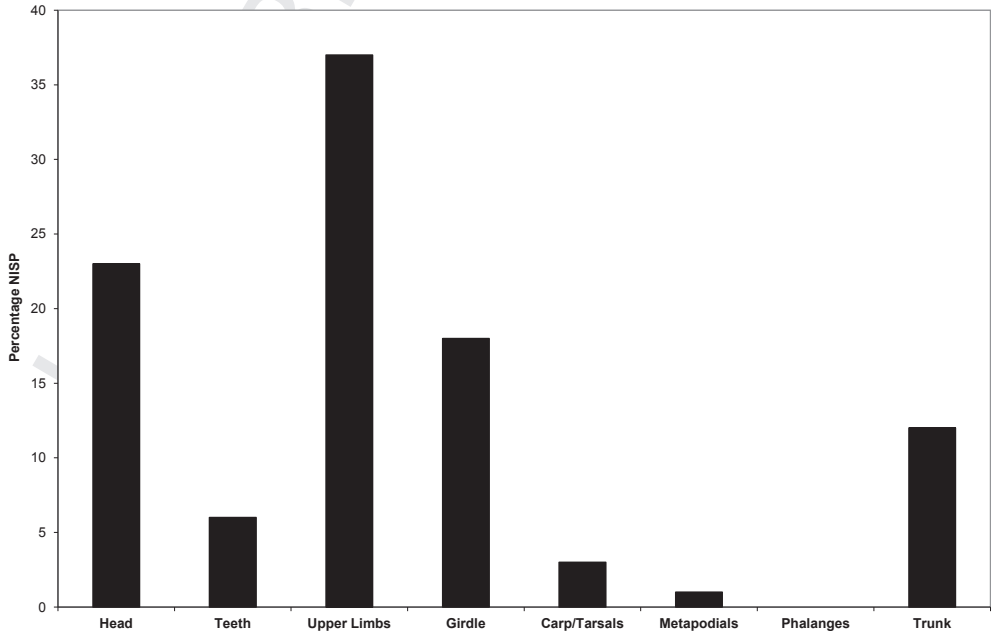

Fig. 4. Percentages of beaver body parts from Novgorod (Troitsky IX-XI – N = 100).

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in the archaeological deposits. We should perhaps not be surprised by this. The Novgorod merchants were dealing with skins and pelts and not whole carcasses.

For clearer zooarchaeological evidence for large-scale fur procurement we must turn to the more remote parts of the forest zone. At Minino, wild species made up an astonishing 73% of the identified mammal bones from 11th to early 12th century deposits. Most of these belonged to squirrels and beaver but bones of pine marten were also quite common and there were small numbers of bones from fox, otter, polecat and bear (Table 8) (Savinetsky, in press). Several other contemporary assemblages from that region also contain high percentages of fur-bearing species (Makarov, 2012b). Novgorod's role in the international fur trade therefore is best reflected in the composition of the animal bone assemblages on supply sites like Minino rather than in the town itself.

Although still prominent (58%), the percentages of wild mammal bones fell in the 13th century assemblage from Minino (Savinetsky, in press). This decrease may have been due to over-exploitation and woodland clearance. This was probably part of a wider phenomenon, as supplies became more difficult to obtain. In Novgorod, references to beavers on birch-bark documents disappear after the early 13th century (Rybina, 2001). Beaver bones were also largely absent from 13th century and later deposits on the Troitsky sites (Table 8).

7. Forests

As noted in the landscape section above, there was considerable variation in the forest cover in the Novgorod region at the time the area was settled for extensive agriculture by incoming Slavonic tribes in the 8th/9th centuries (Nosov et al., 2005). Based on archaeological evidence, the first areas chosen were around the lakeside and near the deltas of Ilmen's rivers. This pattern fits well with the general evidence for the early Slav population in north-west Russia having a preference for settling lacustrine and flood-plain landscapes (Yeremeyev, 2012: 150). The Ilmen settlements have recently been mapped by Yeremeyev, and a number excavated (e.g. Georgii and Prost), showing a preference for their location on elevated knolls and low hillocks. Following the establishment of these sites, settlement appears to spread up the river valleys, often best indicated by the location of burial mounds (*sopki*). It is precisely these areas that would have been dramatically changed by slash and burn methods of forest and scrub clearance to create arable areas and to expand hay meadows. Novgorod began as one of these settlements, most likely in the early to mid 10th century, despite backdated chronicle references to its earlier origins, and quickly grew to be the dominant settlement of first the Ilmen region and subsequently well beyond.

From the 11th to the middle of the 15th century, when it was largely replaced by a three-field rotation system of agriculture, the slash and burn method of forest clearance predominated. The resulting clearings were ploughed, but did not remain fertile for more than a few growing seasons, depleted fields left abandoned where soon re-colonised by birch, hazel and alder (Martin, 1995: 269).

During early settlement phases, larger deciduous trees such as oak, plus pines and spruce, were being selected for settlement construction of houses, fences, streets and, in some cases, fortifications. In a study by Novgorod's dendrochronologist examining the timbers recovered from the Troitsky excavations, Tarabardina (2007, 2009) showed that after the 10th century the use of deciduous wood declined and it was pine and spruce that was selected depending on the type of building work being undertaken (e.g. pine for planking, flooring, and road construction; spruce largely for fences, palisades and support structures). She also demonstrated that from the mid-13th century onwards, there was a noticeable trend towards the use of older pine trees, especially for constructing the streets. At the same time the town's inhabitants stopped dismantling the planking from earlier road levels when making new roadways, no longer bothering to re-use timber as in the past. It has been conjectured that this fits chronologically with the expansion of Novgorod Land into new territories with access to abundant sources of wood from primary forests (Tarabardina, 2007: 118).

We can therefore begin to postulate a model for how the creation and expansion of extensive agriculturally-dependent settlements caused forest depletion and changes both locally and regionally. Starting first with lakeside and river delta occupation, then spreading up the river valleys and into the hinterlands, anthropogenic factors had a dramatic impact on precisely those forests where wild mammals thrived. As areas were opened up for hunting and trapping, then farming and subsequently exploited for their timber, the wild animal population were doubly affected. In addition to hunting and its consequences for the over-exploitation of fur-bearing species leading to population decline, some species such as beaver would have been affected by habitat changes through agricultural expansion, exploitation of woodland and forest clearance. Species that are more selective about their habitats (e.g. capercaillie and their preference for spruce) would have felt these changes directly and immediately, whilst others, such as mustelids, would have migrated deeper into primary forests over time. Others may have benefitted from these changes. For instance, partial woodland clearance in wetter areas would have encouraged the regrowth of aquatic species, offering improved feeding conditions for elk (Bauer and Nygrén, 1999).

Of course, these processes were further accelerated by Novgorod's growing reliance, especially from the 12th century onwards, on commerce, notably with first the Gotlanders, then Germans who grew to dominate Baltic trade. With the primary export of the Novgorodians being massive amounts of furs and pelts, there was an increasing need to go further into the forests of the north and east, eventually extending even beyond the dense birch and coniferous forest to the spruce and larch-dominated southern taiga along the White Sea. It is sites such as Minino that show us that the increased demand for furs was not met solely by extracting tribute from indigenous peoples or by camps engaged exclusively in hunting and trapping, but also by self-sufficient settlements who were fully engaged in trade and benefitting from its consequences (Makarov, 2012b). In addition to their intensive hunting of woodland animals, it was these communities who increased pressure on the forest through their agricultural practices and their demand for timber for construction, manufacture and fuel.

8. Conclusions

Zooarchaeologists are used to examining changes in diet – and explaining this due to people adapting to changes in wild and domesticate resources. Likewise historians have known and written about the large numbers of furs, pelts and other natural resources taken from the forests of northern Russia. But here we are attempting to go further by examining subtle variations within and between different parts of a territory, witnessing changes over time due to stress and habitat degradation, as well as specific anthropogenic impacts on those habitats. Documentary, environmental and zooarchaeological evidence have, for example, been combined to monitor and account for the decline in beavers both in Novgorod and Minino in the 13th century. We have postulated that ecological variations in rivers and lakes in the Novgorod lands could account for variations in the types of fish exploited at different settlements. We have also demonstrated that some highly prized species of

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imported fish, as indicated in the birch-bark documents, were probably extremely rare additions to the diet of most Novgorodians. However, we need to develop our understanding of the history of the forests, river and lakes of Novgorod in much greater detail.

One way to deepen our understanding is to develop models that simulate the way in which the forest was affected by various anthropogenic factors over time. To this end, we are using a forest simulation programme known as LANDIS II, which simulates forest succession, disturbance (including fire, wind, harvesting), climate change, and seed dispersal across large landscapes (see for instance, Cantarello et al., 2014). This software is commonly used by forest ecologists to predict the long term impact of different forest management regimes, but it is also possible to use it to model woodland changes in the past. For instance, it should be able to show how the intensity and form of land clearance together with the extensive exploitation of woodland through activities such as artisan production and town construction impacted on the forest, its ability to regenerate, the decline of certain species (deciduous mainly), and the deliberate removal of older and larger trees for construction and other purposes.

Work on this for the Novgorod lands is in its early stages, but the intention is to model forest changes from around AD 800–1600, using different scenarios to see how the forest was affected. The implications for wildlife discussed in this paper can then be further examined and integrated into a wider understanding of how humans affected the regions ecology over the past millennium.

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References

Bauer, K., Nygrén, K., 1999. Alces alces. In: Mitchell-Jones, A.J., Amori, G., Bogdanowicz, W., Kryštufek, B., Reijnders, P.J.H., Spitzenberger, F., Stubbe, M., Thissen, J.B.M., Vohralík, V., Zima, J. (Eds.), The Atlas of European Mammals. Academic Press, London, pp. 394–395.

Bolotova, N.L., Konovalov, A.F., Borisov, M., Dumnich, N.V., 2001. Natural and anthropogenic factors of the establishing of invasive fish populations in the aquatic ecosystems of the Vologda Region. Russian Journal of Biological Invasions 1 (4), 251–263.

Brisbane, M., Hather, J. (Eds.), 2007. Wood Use in Medieval Novgorod. Oxbow, Oxford.

Brisbane, M., Maltby, M., 2002. Love letters to bare bones: a comparison of two types of evidence for the use of animals in Medieval Novgorod. Archaeological Review from Cambridge 18, 100–119.

Brisbane, M., Makarov, N., Nosov, E., 2012. Medieval Novgorod in its wider context. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 1–9.

Cantarello, E., Lovegrove, A., Orozumbekov, A., Birch, J., Brouwers, N., Newton, A.C., 2014. Human impacts on forest biodiversity in protected walnut-fruit forests in Kyrgyzstan. Journal of Sustainable Forestry 33 (5), 454–481.

Faradjeva, N.N., 2007. Buildings at the Troitsky excavations. In: Brisbane, M., Hather, J. (Eds.), Wood Use in Medieval Novgorod. Oxbow, Oxford, pp. 62–105.

Fedorov, V.M., Matekhina, T.S., Osipov, D.O., 2011. To the history of falconry in Novgorod Land. Transactions of the Institute for the History of Material Culture 6, 199–211 (in Russian).

Khoroshev, A.S., Sorokin, A.N., 1992. Buildings and properties from the Lyudin end of Novgorod. In: Brisbane, M. (Ed.), The Archaeology of Novgorod, Russia., The Society for Medieval Archaeology, Monograph Series: No. 13, Lincoln.

Kolman, R., Kapusta, A., Morzuch, J., 2011. History of the sturgeon in the Baltic Sea and Lake Ladoga. In: Williot, P., Rochard, E., Desse-Berset, N., Kirschbaum, F., Gessner, J. (Eds.), Biology and Conservation of the European Sturgeon Acipenser sturio L. 1758: The Reunion of the European and Atlantic Sturgeons. Springer.

Makarov, N., 2012a. The Minino Project: the investigation of a group of medieval sites in the Byeloozero region of northern Russia. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 40–57.

Makarov, N., 2012b. The fur trade in the economy of the northern borderlands of Russia. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 381–390.

Maltby, M., 2012. From Alces to Zander: a summary of the zooarchaeological evidence from Novgorod, Gorodishche and Minino. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 351–380.

Martin, J., 1986. Treasure of the Land of Darkness: the Fur Trade and its Significance for Medieval Russia. Cambridge University Press, Cambridge.

Martin, J., 1995. Medieval Russia 980-1584. Cambridge University Press, Cambridge.

Nosov, E.N., 1992. Ryurik Gorodishche and the settlements to the north of Lake Ilmen. In: Brisbane, M. (Ed.), The Archaeology of Novgorod, Russia. Society of Medieval Archaeology Monograph Series 13, Lincoln, pp. 5–66.

Nosov, E.N., Goryunova, V.M., Plokhov, A.V., 2005. Gorodishche pod Novgorodom i poseleniya Severnogo Priilmenya (Gorodishche near Novgorod and the Settlements to the north of Lake Ilmen). Russian Academy of Sciences, St Petersburg (in Russian).

Potapov, E., Sale, R., 2005. The Gyrfalcon. Poyser, London.

Prummel, W., 1997. Evidence of hawking (Falconry) from bird and mammal bones. In: Serjeantson, D. (Ed.), Subsistence and Symbol, Papers from the ICAZ Bird Group Meeting 1995, International Journal of Osteoarchaeology 7,4, pp. 333–338.

Rybina, E.A., 2001. The birch-bark letters: the domestic economy of medieval Novgorod. In: Brisbane, M., Gaimster, D. (Eds.), Novgorod: the Archaeology of a Medieval Russian City and its Hinterland. British Museum Occasional Paper 141, London, pp. 127–131.

Rybina, E.A., 2007. Fishing and hunting. In: Brisbane, M., Hather, J. (Eds.), Wood Use in Medieval Novgorod. Oxbow, Oxford, pp. 124–135.

Savenskova, T., Lemeshko, N., Asnova, T., 2010. Ilmen Lake brief. In: ILBM Challenges for Three Russian Lakes: Ilmen, Chudsko-Pskovskoe/Peipsi-Pihva and Ladoga, Compiled by Aladin, N., Plotnikov, I. Presentation to the Final Review Meeting and International Symposium, ILBM-Governance Project, November 2010. Shiga University, Shiga.

Savinetsky, A., 2016. The exploitation of mammals at Minino. In: Maltby, M., Brisbane, M. (Eds.), Animals and Archaeology in Northern Medieval Russia: Zooarchaeological Studies in Novgorod and its Region. Oxbow, Oxford (in press).

Smirnova, L.I., 1994. Once More on the Subject of Blunt Arrows: on the Question of the Hunting Trade in Medieval Novgorod, in Novgorod i Novgorodskaya zemlya: Istoriya i arkheologiya 8 (Novgorod and Novgorod Lands: History and Archaeology 8). Novgorod State Museum, Novgorod, pp. 143–156.

Smirnova, L.I., 2005. Comb-making in Medieval Novgorod (950-1450). British Archaeological Reports International Series, 1369. Archaeopress, Oxford.

Spiridonova, E.A., Aleshinskaya, A.S., 2012. Results of palynological investigations of the archaeological sites in the Lake Ilmen and Lake Kubenskoye study areas. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 10–39.

Sychevskaya, E.K., 1965. The fish of medieval Novgorod. Soviet Archaeology 1, 236–256 (in Russian).

Tarabardina, O.A., 2007. Building timber in medieval Novgorod based on materials from the Troitsky XI and Troitsky XII excavations. In: Brisbane, M., Hather, J. (Eds.), Wood Use in Medieval Novgorod. Oxbow, Oxford, pp. 106–116.

Tarabardina, O.A., 2009. Dendrochronological studies of medieval Novgorod: (based on the findings of archaeological excavations 1991–2006). Archaeology, Ethnology and Anthropology of Eurasia 37 (1), 77–84.

Thulin, C.-G., 2003. The distribution of mountain hares *Lepus timidus* in Europe: a challenge from brown hares *L. europaeus*? Mammal Review 33 (1), 29–42.

Veale, E., 1966. The English Fur Trade in the Later Middle Ages. Boydell and Brewer, London.

Yanin, V.L., 1990. The archaeology of Novgorod. Scientific American 262 (2), 72–79.

Yeremeyev, I.I., 2012. The natural environment and settlement patterns of the Lake Ilmen region in the last third of the first millennium AD. In: Brisbane, M., Makarov, N., Nosov, E. (Eds.), The Archaeology of Medieval Novgorod in Context. Oxbow, Oxford, pp. 139–151.

Zeiler, J.T., 2010. Hunting the hunters: owls and birds of prey as part of the falconers' game bag. In: Prummel, W., Zeiler, J.T., Brinkhuizen, D.C. (Eds.), Birds in Archaeology: Proceedings of the 6th Meeting of the ICAZ Bird Working Group in Groningen. Barkhuis, Groningen, pp. 165–168.