

Heart of Eurasia on Fire: Biocultural Assessment and Development of Early Response in Lake Baikal Region

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October 2022 A Snowchange Work Report





A View of Lake Baikal. Photo: Snowchange Cooperative

Abstract:

This work report is a biocultural assessment of the Baikal Natural Territory (BNT) in the context of ecological, climate and cultural change. Snowchange Cooperative has been working with the local teams before the Russo-Ukraine War of 2022 on the ground and post-February, remotely to monitor and assess the changes under way.

The report reviews cultural histories of the BNT, ecology of the lake and the region with a special view on the fish, an overview of the scientific view of the forest fires and then inclusion of traditional knowledge of the Evenki and Buryat peoples on the situation. Despite the complex times solutions are offered when the opportunity of international collaborations will be possible again.



Karas, Crucian Carp, a delicacy of the BNT region. Photo: Snowchange Cooperative

Taiga Mountains. Photo: Jeroen Toirkens, Used with Permission

Contents

- A. Introduction: Cultural Context of BNT . . . 4
- B. Aspects of Lake Baikal and its Ecology . . . 8
- C. Lake Baikal Fires in Science . . . 13
- D. Climate and Air Impacts Associated with Fires in the BNT . . . 16
- E. Some Environmental Impacts Resulting from Fires in the BNT . . . 18
- F. Human Observations of the Recent (2019-2022) Fires in East Siberia and Lake Baikal . . . 23
- G. Conclusions Solution Spaces . . . 28



Fire fighters pumping water from Lake Baikal. Photo: Jeroen Toirkens, Used with Permission

A. Introduction: Cultural Context of the Baikal Natural Territory (BNT)

Heart of Eurasia on Fire: A Biocultural Assessment and Development of Early Response in the Lake Baikal Region is a multi-disciplinary and traditional knowledge-based overview assessment of Lake Baikal and the devastating forest fires affecting the region between 2015-2021. We have worked with the Evenk and Buryat communities around the lake as well as drawing on science reports, literature and remote sensing to produce a biocultural assessment of the situation in the region.

Brown et al. (2021) says that Lake Baikal is the largest lake on earth (23,000 cubic km/5,518 cubic miles with a depth of 1,642 m/5,387 ft), home to thousands of species many of which endemic and a high water quality. Almost 300 rivers and streams flow into the lake. They (2021) mention that evolution still continues on the lake making it unique also in this context. Baikal is an ultra-oligotrophic water body, with the residency time of lake water being around 400 years. The region in which Lake Baikal nestles is one of the worst affected by global climate change impacts.

Efimova and Rukavishnikov (2021) record that the largest settlements in the surrounding areas are:

- Irkutsk (Pop. 617,500)
- Bratsk (Pop. 225,000)
- Angarsk (Pop. 225,800)

According to the researchers (2021), more than 75% of the Baikal area is covered by forests and the region is prone to seasonal forest fires. Fire hazard periods stretch over half of the year, from April to September. By investigating science reports, traditional knowledge oral histories, remote sensing and grey literature we try to provide an overview analysis of the present drivers of forest fires. We draw on Brown et al. (2021) to position our geographical range as the Baikal Natural Territory (BNT) - defined in the Federal Law *"On the protection of the lake Baikal"* (1999) that consists the Irkutsk Region, Republic of Buryatia and Zabaikal Region.

We have organized this report into the following sections:

- A. Introduction: Cultural Context of BNT
- B. Aspects of Lake Baikal and its Ecology
- C. Lake Baikal Fires in Science
- D. Climate and Air Impacts Associated with Fires in the BNT
- E. Some Environmental Impacts Resulting from Fires in the BNT
- F. Human Observations of the Recent (2019-2022) Fires in East Siberia and Lake Baikal
- G. Conclusions Solution Spaces

By looking at multiple evidence bases we investigate the status, trends and impacts of the devastating and increasingly frequent forest fires in the BNT. In Section F we present new and unique oral histories and observations from the region, based on fieldwork undertaken by the Snowchange Team between Autumn 2021 and early 2022.

Finally in section G we offer some initial thoughts about solutions and next steps. It should be noted here that major fieldwork was planned for 2022. However, The War in Ukraine, which started in February 2022, has prevented us from realising international collaboration in the BNT during this period. As a result, the solutions and the future pathways presented here regarding the fire events and associated ecological and social processes are preliminary and will be expanded in breadth and depth in future publications.

Cultural Understandings of the Baikal Natural Territory (BNT)

The origins of Lake Baikal has been interpreted in several cultural traditions including by the Buryat. In *Geser*, the Buryat epic poem, the earliest beginnings of the present world are described as a time when there were no celestial deities, no sun, no moon, no stars. There was only an obscured boiling image in lieu of the horizon above, and water everywhere below. The great Mother - the Goddess - was alone in this expanse and decided to create the world. It was she who created the Earth from a piece of clay, which was brought from water by the duck.

In this epic water has sacred significance. The stories hero, Geser, is washed by water from nine springs for three days, and purified with juniper and cedar smoke:

> Their dear Abai Geser the fellow For as long as the three days and nights With the water of the nine springs They had been washing him up. With the juniper and cedar They had been purifying him.

As instructed in their epic, the Buryat People respect and love all sources of water - springs, rivers, brooks, lakes, waterfalls, hot springs. Lake Baikal is one of the most revered of all these water sources, loved by the Buryat and other local peoples for its beauty and natural splendour.

As a key feature in the worldview of Buryatia, Lake Baikal helps form the basic values and ethics of Buryat communities living in the BNT. In addition to the *Geser* epic, Lake Baikaland the Island of Olkhon are the centres of other ancient legends and historic tales which give narrative shape to people's lives. According to Buryat chronicles, *Bargabator*, the father-founder of the Buryat, Oirat and Mongolian tribes was buried on the Island of Olkhon.

These legends are widely held amongst Buryat communities. Buryats from the Tunkinsky and Barguzinsky regions who settled on the shores of Lake Baikal; the Olkhon and Kabansk Buryats, who still live in the immediate vicinity of the lake, and the Buryats living thousands of kilometres away from Baikal in Kizhinginsky, Selenginsky Districts and the steppes of Aga in Transbaikal District, all consider Baikal to be their ancestral home and glorify Olkhon as their motherland (Zhambalova 2000).

People from more than 100 nations live on the shores of Lake Baikal. Prehistoric humans who came to Baikal from Central Asia thousands of yeas ago have, from generation-to-generation, learned to live in and thrive in the severe conditions of a Siberian lake system.

By the Neolithic period (New Stone Age) the first shore-dwellers had grouped together in the most important hunting and fishery areas around Lake Baikal, like the Island of Olkhon, Chivyrkuysky Gulf, the Barguzin and Irkut Valleys, near Lake Kotokel, and near the mouths of all the rivers flowing into Baikal, especially the Selenga River.

During this period the first coast-dwellers of Baikal persisted through many climatic and natural disasters, such as glaciation, flooding, volcanic eruptions, devastating earthquakes, movements of mountain ranges, gigantic mud and landslides. Surviving this period was indeed an epic achievement for the peoples who had made Baikal their home. Stories about these events were passed from generation-togeneration and became lodged as a genetic memory which would become the foundation of the Buryat shamanistic concept of the Universe (Baikal: nature and people 2009).

According to O.Ye. Afanasieva and A.V. Trotsenko, toponymic (placename) legends are *"paramount indicators of national memory preservation and territorial identity"*. The place-based information contained in these legends reveals cultural, ethnographic and regional histories and characters that would otherwise remain hidden (Zhigacheva 2015). Many people try to connect the name of Baikal with Yakut words bai (which means 'rich') and *kyol / kel* which means 'lake'. That is, they suggest that *Baikal = a rich lake*. Other linguists (Rigdilon 1957) assert that the name Baikal comes from the word '*Baigaal*', which means 'enormous water'. The Buryats call the Lake '*Baigaal-dalai* - Water as big as the sea' pointing to the fact that the lake is as big as a sea. The Evenks call the Lake '*Lamu / Lama*' which means 'a sea'.

Honoured above all, Lake Baikal is the centre of economic, cultural and political consolidation of the taiga tribes of Eastern Siberia, mountain ranges around Lake Baikal, including the Tunka Alps, Khamar-Daban, the Primorskiy and Barguzin ranges, the Island of Olkhon, the Irkut and Angara Rivers, the Strait of Olkhon Gate, river mouths of the Selenga, the Sarma, the Anga, the Kurtuna, the Goloustnaya and the Bouguldeika.

As a central focus for regional cultures, Lake Baikal's challenging conditions have given rise to the so-called 'cult of Lake Baikal'. As part of this system of belief and practice, Buryat peoples have maintained an elaborate set of rituals designed to worship the Lord of the Water – *Lusaad* - with the help of shamans or lamas who hold water purification rites.

The *Geser* epic of the Mongolian Peoples describes the eco-friendly traditions which people practise in order to maintain harmonious relations with the waters they rely upon. For example, *Geser* opposes the notion of vanquishing *Lobsogoldoy*, the Lord of Water, for fear that offending him would cause devastating drought.

That running water of ours Might get dried up from the river head That the growing grass of ours Might get dried up from the very root. (Khundaeva Ye.O., Erdineeva Ch.V.2015). According to the Buryat there are many different spirits living in the Lake. These include a dragon called *Lusaad-Khan*, and a great number of other creatures, both evil and kind, including the water devil, *Uhan-Ezhin*. Some of these spirits reflect the physical properties of the Lake, for example, the lustre of the water surface was manifested by *Tuya-Khatun* (Queen of Sun Rays) and *Gerel-Noyon* (King of Daylight). Storms were manifested by *Dolion-Khatun* (Queen of Waves). Living alongside these spirits is a fearful fish, *Abarga Zagahan* (Enormous Fish or King-fish), which is considered to be an ancestress and 'tsarina' of all the fish. People made sacrifices to this fish in times past.

Evenki – the Original Peoples of the BNT

The Evenki People (also known as the Tungus) are one of the most ancient peoples in eastern Siberia. According to archeological researchers, the origins of the modern Evenks goes back to the so-called Glazkov Culture in the Baikal region's early Bronze Age (1700-1300 BC).

These ancestors left an archaeological legacy including numerous items used to ornament clothing, made from materials like nacre and nephrite. These closely resemble the decorative features found in old Evenki (Tungus) clothing. Folklore and anthropological data also testify to the genetic connection between the Glazkov culture-bearers and the latest Evenki/Tungus tribes.

This evidence strongly suggests that the present day Evenk are descendants of the Glazkov culture of the territory adjacent to Lake Baikal, and therefore to a people who lived in the region as far back as the late-Neolithic and early-Bronze ages. The Evenk traditionally live nomadically and semi-nomadically. They have a reputation as excellent forest hunters and pathfinders. Wilhelm Kuechelbeker called the Evenks Siberian aristocrats. In the Buryatia, Irkutsk and Transbaikal regions place names of Evenki origin are the oldest and make up one third of the total number of known toponyms. These Evenki place names are not evenly distributed, however. They are mostly focused in the northern districts where the Evenks continue to live in greatest numbers today.

In the past, Evenki lifeways depended directly on the state of nature. As a People, they hold many customs and traditional laws that devote them to environment preservation. The general ethos of Evenki ecological traditions is to inflict as little harm on more-than-human nature as possible.

For example, Evenki traditional culture forbids catching spawning fish as one of many measures to avoid overfishing. The Amur and Okhotsk Evenks also cleaned up gravel sites in rivers to actively support salmonid fish species, which use these gravel 'redds' to spawn. Strong taboos also forbid the disposal of waste into lakes and other water bodies.

During the fieldwork undertaken for this project, several Evenki, including elder Vladimir Mikhailovich Murzakin (2021), stressed the deep connections that their communities have with the BNT and the lake and its surroundings. These connections are rooted in the ways the BNT supports the Evenki culture of reindeer herding, fishing, hunting and other traditional activities. Murzakin and others testified to the sacredness of the landscapes around the lake, demonstrating multigenerational involvement with these ecosystems.



B. Aspects of Lake Baikal and Its Ecology

Lake Baikal, the largest freshwater lake on Earth, has a volume of 23,000 cubic kms of water and reaches 1,642 metres in depth (Brown et al. 2021). Nearly 300 rivers and streams flow into Lake Baikal, which is home to thousands of endemic species and is considered an ultra-oligotrophic (oxygen rich) lake with very high water quality. Water in Baikal has a residency time of around 400 years, which means that the lake's waters are particularly vulnerable to the accumulation of airborne, aquatic and terrestrial pollution. In 1996 the Lake Baikal region was recognised as a UNESCO World Heritage site.

A tree with sacred ribbons. Photo: Jeroen Toirkens, Used with Permission

A View on the Fish of Lake Baikal- BOX

Lake Baikal is a vital fishery for the Evenk and Buryat Peoples. Here we provide here a short snapshot of the endemic fish species present in the lake:

- **Gobies (Gobius ophiocephalus)** are both bottom-dwelling and live at medium depths. Fish of the Goby family are the most abundant of Baikal's endemic fishes.
- Bullheads (Batrachocottus baicalensis, Dybowski, 1874) are mostly bottom-dwelling. Their dark colouring helps camouflage them. Local fishermen also call bullheads 'shirokolobka' ('broad head'). Some bullhead species can be found along the shoreline, at shallow depths. Some species inhabit areas where the lake floor is stony, other where the lake floor is sandy. Another bullhead type, the Baikal sculpin, forms coastal shoals, which are a source of food for omul and other fish species. Juvenile sculpin seek to escape these predators by reacting to a smell which predatory fish emit.
- The long-finned Baikal sculpin (C.inermis. Jakowlew, 1890) grows as long as 22 cm. It feeds on plankton, gliding alongside through the middle depths, helped by its fins and light weight. This manner of movement has earned this fish the nickname 'samoletik' ('little aeroplane', in Dagbaeva 2016).
- The Baikal Omul (Coregonus migratorius, Georgi, 1775) feeds on small crustaceans, invertebrates and the juvenile goby fish. The Omul enters rivers to spawn from late August to the end of November. The spawning period depends on water temperature, as Omul will not spawn until the water is cold enough. One spawning Omul shoal may consist of between 1.5 million and 6 million fish. Omul release spawn on sand-and-pebble areas of the river bottom. Fertilised eggs develop for 170-200 days and

the young fish appear in April or May. They are carried down into Baikal's bays ('sory') and then into the open water of the Lake. The Omul which fishermen catch are usually around 19 years old and 38 centimetres long, though some fish may live to 25 years of age and reach up to 51 centimetres long. In summer, omul swim near the surface of the water at certain places in the Lake, while during winter the fish hibernate at depths of 200-300m, close to the areas where they will feed in summer. Omul are artificially nurtured at a fish nursery not far from Baikal on the Bolshaya Rechka river and half of the fish are released into the Lake. There is a similar nursery in Koma village in the Pribaikalsky District of the Republic of Buryatia. This fish is especially prized by the fisherpeople of Lake Baikal.

- Four subspecies of the Omul are known to live in the Lake: North Baikal, Chivyrkuysky, Selenga and Posolsk. The North Baikal and Barguzin Omul favour shallow water, while Posolsk and Chivyrkuysky omul inhabit deeper areas. The small, fat Omul, which are caught in the Maloye Morye ('The Little Sea') near Olkhon Island, are called Malomorsky and are closely related to the North Baikal and Chivyrkuysky subspecies.
- The Selenga Omul is the most numerous subspecies. It spawns primarily in the Selenga river and in other rivers flowing into Baikal. It lives in the southern trough of the Lake and the southern part of the middle trough.
- The Chivyrkuysky Omul is the most productive subspecies where fishing is concerned, as it grows and gains mass swiftly and can be artificially spawned.
- The North Baikal Omul is distinguished by its small size. It migrates up the Upper Angara river to spawn and is sometimes referred to as the Angarskaya omul. It is also known to spawn in the Kichera and other mountain rivers, as well as in the Chivyrkuysky Gulf.

- The **Posolsk Omul** is the largest subspecies. Fishermen have caught specimens weighing up to 5 kilograms and up to 50 centimeters in length (Dagbaeva 2016).
- The Baikal Sturgeon (Acipenser baerii Brandt, 1869) is the biggest and most ancient fish in the lake. These fish can reach up to 1.5

 1.8 m in length, and weigh between 100-130 kg. The sturgeon is the only cartilaginous fish species living in Lake Baikal. In the wider Baikal catchment sturgeon are found in the delta of the Selenga, the mouths of some rivers and bays with a depth of 20-50 m. In autumn the sturgeon swim down to the depths of 150 metres, over-wintering in deep lake bottoms in the mouths of big rivers. In April the sturgeon swim up the Selenga, the Upper Angara and the Barguzin rivers to spawn. In the Maloe Sea and in Slyudyanka the sturgeon is seldom found. Sturgeons grow very slowly: male fish reach maturity by the age of 15, while females take 18-20 years to reach maturity.
- The Baikal Cisco or Whitefish (Coregonus baicalensis Dybowski, 1874) resembles the Omul, but is distinguished by its protruding upper jaw. It has small round black spots on its head and dorsal fin. Its head is extended with a cuspidal shape. This fish can be found only in Lake Baikal and the Baunt Lakes. Baikal Cisco are of two types: lake and lake-river. A great amount of lake Cisco are found in the Barguzin and Chivyrkuysky Gulfs, and in the Selenga Delta's shallows. There are three sub-types (ecology has a dissenting view on classification of Coregonus) of Baikal Cisco: Chivyrkuysky, Barguzin and Maloye Morye. Mature Cisco feed on mollusks, plankton, larvae, worms and young Goby. Numbers of Cisco have fallen due to intensive poaching in the fishery.
- Another renowned fish in Lake Baikal is the Grayling (Thymallidae in Gill, 1884), in the form of two Baikal sub-species of the Siberian Grayling – the Black and the White Grayling.
- The Black Grayling (Thymallus baicalensis Dybowski, 1874)

has bright scales and high, bright fins. It can be 60 cm long and can weigh 1.5 kg. Graylings occur in all the rivers flowing into Baikal and in the Angara River. During summer, Graylings live at a depth of 10-20 m and in winter swims down to depths of 3-12 m. Graylings swim hundreds of metres up mountain rivers with gravel beds to spawn. These fish can leap out of the water to a height of 0,5 m while hunting for flying insects.

- The White Grayling (T. brevipinnis Svetovidov, 1931) is larger than the Black, its scales are less dense. It has red spots on its silver sides and shorter fins. It usually lives close to the Baikal shoreline at a depth of around 50 m. Both the Black and White Grayling live for between 10-12 years.
- The Roach (Rutilus rutilus Linnaeus, 1758) is found throughout Russia, but the largest roach live in Lake Baikal. Local people call this fish a 'soroga', and there are two types of 'soroga' in the Lake: a small 'sor' fish and a bigger open-water fish. The Roach has dense scales and distinctive red fins, and it is the second most numerous fish in catches made by Baikal fishers. A mature roach of 5-7 years may be 13-15 cm in length, and it can grow to 30 cm when it reaches an age of 11-17.
- The Sazan or Eurasian Carp (Cyprinus carpio) is a handsome fish with golden and yellow scales, dark back and fair belly. It lives only in fresh water basins. In warm water it feeds vigorously and it grows quickly. Its maximum weight can reach more than 20 kg. In cold periods, the fish remains dormant at the bottom of a waterbody and stops eating.
- The best-known fish in Buryatia is the Silver Carp
 (Hypophthalmichthys molitrix). The Silver Carp is widespread
 in shallow lakes. It is a calm and idle fish preferring to stay in
 quiet places with plenty of slime and no shortage of food. The
 Carp does not usually grow to more than 30 cm in length and the
 specimens found in most lakes are 11-13 cm.

- The main predatory fish found in Lake Baikal is the **Pike (Esox lucius, Linnaeus, 1758)**. The Pike has spotty colouring, light bands along and across its sides with a dark back and whitish belly with grey specks. Its fins are slightly brown with black spots, and its thoracic and abdominal fins are yellowish-red. The Pike is a fairly large fish, up to 80 cm in length, and it grows very fast: by 5 years it weighs up to 1 kg, by 12 years it reaches 6 kg and the fish have been known to grow to 20 kg. The Pike can live up to 70 years. In Baikal a young pike is called *'travyanka'* ('grass dweller') due to its habit of inhabiting shallow water where grass grows, watching for prey.
- Taimen or Siberian Giant Trout (Hucho taimen Pallas 1773) is a large fish of the salmon family. It grows up to 1.5 metres long and can weigh up to 60 kg. The Taimen has a peculiar colouration, which corresponds to different phases of its life and the different seasons of the year. At spawning time, for example, it is covered with crimson spots and its tail becomes dark red. The taimen is a predatory fish. It feeds on fish, small animals and birds all the year round except when spawning. It lives in small numbers in the pure mountain rivers flowing into Baikal. It is registered in the IUCN Red List.
- Burbot (Lota lota Linnaeus, 1758) is another sor, or shore fish. It is found in Baikal and the main rivers that flow into the Lake, as well as in other basins in Buryatia. It has a serpent-like body with black-brown spots and bands all over it. Its belly and neck are of grey colour and the fish has two dorsal fins and a little barbel on its chin. Burbot can grow up to 2 metres in length and weigh 30 kg. There are two kinds of Burbot in Baikal: one that lives in lakes and rivers, and one that lives in lakes only. Ichthyologists note that lake Burbots differ from those that also live in rivers in their faster rate of growth, high levels of body fat and lighter colouring. Lake and river Burbot spawn in rivers, while lake Burbots are

believed to spawn in Lake Baikal itself. The Burbots release eggs during the very severe frosts of December and January. Spawning sometimes lasts until March, April and even May.

The Oil Fish (Comephorinae Gunter, 1861) is the most exciting of Baikal's other endemic fish species. It grows to no more than 20 cm and its pinkish body, which lacks scales, is almost translucent, consisting mostly of fat. There are two types of Oil Fish living in Baikal: the Great Oil Fish (Comephorus baicalensis Pallas, 1776) and the Lesser Oil Fish (Dybowski Korotneff, 1905). Both are found at various depths, but the first is more often found living close to the bottom of the Lake. The Great Oil Fish is very sensitive to temperature: when the temperature drops below 8 degrees centigrade, it is unable to move and becomes static. The Great Oil Fish does not spawn but gives birth to live young. The female fish produces up to 3000 fry, which develop into young fish in spring and summer. Adult Great Oil Fish are cannibalistic, feeding on the young of the same species. Their main food source are epischuras - a type of copepod zooplankton. The Lesser Oil Fish is a subspecies, also endemic to Baikal, which lives in the open waters of the Lake at depths of up to 1600 m. Lesser Oil Fish feed primarily on epischuras, macrohectopus (a freshwater amphipod), and the young of the Greater Oil Fish and of its own species. Ichthyologists have found it difficult to define what group of fish the Oil Fish belong to. It was first considered to be a kind of Mackerel, then as a member of the Codfish family. It was only at the turn of the 20th century that it was found to be closest to Sculpins in the Cottidae family (as in Dagbaeva 2016).

56 species of Baikal fish are commercially fished, including Baikal omul (*Coregonidae migratorius*), Baikal whitefish (Coregonus *baikalensis Dybowsky*, 1874), Black and White Baikal Grayling (*Thymallus baikalensis and Thymallus brevipinnis*), Roach (Rutilus rutilus), Dace (*Linnaeus* *leuciscus baicalensis Dybowski*, 1874), Perch (*Perca fluviatilis*), Pike (*Esox lucius Linnaeus*), Burbot (*Lota lota Linnaeus*, 1758), Ide (*Leuciscus idus Linnaeus*, 1758), crusian carp (*Carassius carassius*).

Some introduced species are also of commercial value: Amur sazan (*Cyprinus rubrofuscus La Cepede*, 1803), Bream (*Abramis brama Linnaeus*, 1758) and Amur fresh-water catfish (*Parasilurus asotus* Linnaeus, 1758).

Earlier, such fish as Baikal or Siberian sturgeon (Acipenser baerii Brandt, 1869), Taimen (Hucho taimen Pallas, 1773) and Lenok (Brachymystax lenok Pallas, 1773) used to be of commercial value, but their numbers have declined and they are now included on the IUCN Red List of rare and endangered species. Catching Baikal Sturgeon has been banned since 1945. Today it can be caught only for research purposes. The disturbing overall decline of the Omul began in the late 1960s and is connected with the construction of the Irkutsk hydroelectric power station on the Angara River (Brown et al. 2021), water pollution, deforestation in the water preservation zone and unsustainable fishing practices. By the 1990s the number and biomass of Omul had somewhat increased. The total biomass was 20-26 thousand tons and the catch yield was 2-3 thousand tons. Today, catching Omul is banned. Overall, Brown et al. (2021), as well as professional fishers like Andrey Gladishev (2022), comment that fish production, quality and quantity have been negatively altered in recent years on the BNT.

The Baikal Seal (*nerpa*) is the amongst the only aquatic mammals that lives in freshwater lake systems (along with the Saimaa Ringed Seal in Finland and the Lake Ladoga Seal in the Republic of Karelia). A mature seal can be 120-140cm in length and its weight can be 80-90 kg. A newborn seal (*belyok*) will weigh about 3kg on average.

The seal has got frequent teeth with some additional top teeth which is connected with eating of small-sized fish like oilfish and some other bullhead types like zheltokrylka, or Baikal yellow fin (*Cottocomephorus grewingkii*). The seal has always been of commercial value. Since

Perch and roach are key fish species for food security in the BNT. Photo: Snowchange Cooperative 1999 it has been allowed to hunt for one-year old seals (*kumutkans*). Seal hunting is regulated by the Federal law "On lake Baikal protection" by the Russian Federation Governmental decree § 67 from January 28, 2002 "On special aspects of protection and harvesting of endemic species of aquatic animals of Lake Baikal" and by some other minor laws (Baikal: nature and people 2009).





C. Lake Baikal Fires in Science

Scale of Historic and Contemporary Fires

Forest fires have occurred in the coniferous taiga that characterises the BNT for centuries, if not thousands of years (Brown et al. 2021). Based on their research into the region's historical context, Voronin and Ruzhnikov (2018) write:

"...the history of forest fires for six areas of mixed pinewoods in the Baikal region (Eastern Siberia, Russia) was reconstructed. We found traces of 56 forest fires (fire scars) which occurred in the past four centuries. Besides the fire scars on the trees we also used the reduced growth of the trees after a forest fire. On the basis of these investigations we found sixteen periods of important fire activity from 1669 to 2003. The mean time interval of the fires varies from 11 to 20 years depending on the forest type and human activity. Whereas in the 18th century the mean time interval between two fires was 19.25 years, it was only 11.75 years in the 20th century. Based on the correlation and spectral analysis, the occurrence of forest fires depend strongly on the precipitation during May and June. For these precipitations are found the major cycle with the duration of 60 (61-62) years. This agrees well with the occurrence of forest fires in the 20th century."

Fighting the forest fires. Photo: Jeroen Toirkens, Used with Permission

Voronin and Ruzhnikov (2021) connect historic fire cycles to fluctuations in temperature, precipitation and human activities. They note that the intervals between these fire cycles became shorter in the 20th Century. Brown et al. (2021) mention that the large forest clearances of the Soviet Era (1917-1991) and industrial developments affected interconnected forest and lake ecosystems. Brown et al. (2021) describe the major environmental changes caused by human interventions in the BNT over the past century as follows:

- Increase in cattle raising and sprawl of arable land, peaking at 877,000 hectares in 1975;
- Deforestation, with 12% of forest cover lost between 2013-18;
- Development of the Irkutsk Hydropower Plant on the Angara River in 1950;
- Two paper mills constructed in 1959 on the Lake;
- Construction of the Baikal-Amur Railroad from 1975.

The BNT has also become a target of conservation actions. Organisations devoted to the protection of lake Baikal formed relatively early on (Brown et al. 2021), during the Soviet era. The Soviet regime and, since 1991, the Russian Federation, established a range of conservation measures in the BNT, with varying degrees of success. These include supporting the BNT to become a UNESCO World Heritage Site in 1996.

In recent years, forest fires have proliferated across the BNT region. Sukhodolov et al. (2019) write that these fires have severe consequences for the whole country:

"Forest fires lead to the serious damage of the ecological state and national economy of the country. This problem is especially relevant for Siberians. According to Greenpeace, Siberian forest fires in 2019 reached record levels in the entire history of observation in terms of burning area and the amount of carbon dioxide emitted into the atmosphere." Gorshkov et al. (2021) reviewed the impact of forest fires over the past 20-years across East Siberia as a whole. According to their research (2021), the fires burned:

- 2015: 62,500 km²
- 2016: 79,500 km² (a peak)
- 2017: 44,400 km²
- 2018: 36,100 km²
- 2019: 72,400 km² (second peak, data from Gorshkov et al. 2021 and Brown et al. 2021)

Figure. Trends in Siberian Forest Fires 2001-2020. Data based on Russian Academy of Sciences



Gorshkov et al. (2021) mention that, in 2019, fires in East Siberia were considered a global environmental disaster: forests across an area of up to 72,400 km² were engulfed in fire. Brown et al. (2021) identify the main causes of the fires as human activities, such as agricultural burning, and thunderstorms. These fires have altered watershed loading into Lake Baikal, as well as soil geochemistry. They also cause smoke pollution, cause aerosol changes, decrease quantities of water and release greenhouse gases. Kichigina and Bilichenko (2019), referring to fires between 2015-17, state:

"Wildfires in recent years made the picture in the Baikal natural territory catastrophic. There were catastrophic fires in 2015-2017, which have not been here for decades. 38 fires were recorded in 2015 only in the territory of the Pribaikalskii National Park, which accounted for 73% of all forest fires in the Zapovednoe Pribaikalie (preserved territories of the Baikal region). The fire area amounted 34423.83 ha or 8.2% of the entire territory of the Pribaikalskii National Park. The largest centers of fires were registered near the Peschanaya Bay, Primorskii Range, Olkhon Island, as well as in the Baikalo-Lenskii Nature Reserve. The main reason for the fire danger increase in recent years is considered to be the low water, dry period, with frequent dry thunderstorms."

According to Golobokova et al. (2020) the aerial impacts of the fires are also directly interconnected with the Lake environment:

"Aerosol deposition affects the aquatic environment of the watershed basin and the lake itself. Wildfires can have a much greater impact on the environment. Smoke emissions entering the area of Lake Baikal due to wildfires change the chemical properties of the atmospheric aerosol and increase its mass and number concentrations. Wildfires destroy large forest areas, which threatens disruption of the ecological stability of natural ecosystems. Wildfires also pollute air, soils, surface and ground waters, and cause a significant decrease in biodiversity. Atmospheric emissions of various harmful substances of the burnt material and CO2 from large fires, as well as large areas of burnt forests, accelerate the global warming of the planet."

Figure. Aerial View and a Photo of the Fires in Republic of Sakha-Yakutia, Russia in 2021.





D. Climate and Air Impacts Associated with Fires in the BNT

Golobokova et al. (2020) and Brown et al. (2021) demonstrate that recent forest fires are affecting multiple aspects of the environment in the BNT. This includes air pollution. Efimova and Rukavishnikov (2021) write that:

"Smoke from wildfires contains many air pollutants that can affect public health, including carbon monoxide (CO), nitrogen dioxide (NO2), ozone, particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). Smoke from forest fires can affect large populations, even those far from the fire, by degrading local, regional, and global air quality...Exposure to wildfires can result in a wide range of acute cardiopulmonary morbidity for the elderly, and impaired respiratory function in children."

According to Efimova and Rukavishnikov (2021), in Irkutsk, at a distance of 2000 km from the furthest fire hot spots, maximum short-term concentrations of CO2 reached 2.4 times, and particulate matter 1.4 times, the relative to the background levels in August 2021. In other words, fire impacts were felt far beyond the immediate areas that burned.

Referring to the 2019 fires, Sukhodolov et al. (2019) write:

"Ministry of Emergency Situations of Russia (said that) on July 28, the 143 forest fires with a total area of 597,298 hectares are active in the Irkutsk Region. Totally, in Siberia and the Far East, forest fires are burning in the area comparable to Belgium. Of course, such an essential loss of natural resources leads to negative environmental, economic and social consequences. For instance.. it was established that during intensive burning of the taiga, the concentration of carbon monoxide increases by almost 30 times

Fire is raging in the BNT. Photo: Jeroen Toirkens, Used with Permission

in comparison with the background content in the air, methane by 2 times, carbon dioxide in 8%. Such exceeding lead to the health deterioration of the inhabitants of the Irkutsk region. In addition, due to the annual, large-scale forest fires blazing near Lake Baikal, chemical components, such as ammonium, expedite the reproduction of various microorganisms that destroy the aquatic ecosystem of the Baikal region."

In a recent study, Efimova and Rukavishnikov (2021) discuss the air pollution associated with the fires in Sakha-Yakutia and in Irkutsk, writing:

"Two time periods were considered. First: long term, 2011–2020, to assess annual and monthly air pollution. Second: July–August 2021, when massive forest fires were registered for 3 months in adjacent territories, namely in the Republic of Sakha-Yakutia and in the north of the Irkutsk region. Analysis of air pollution in areas remote from fire centers showed qualitative and quantitative differences in the composition of pollutants. At a distance of 2000 km from the fire centers, short-term concentrations increased during the smoke period: CO increased by 2.4 times and PM10 increased by 1.4 times relative to the background level. In the area located close to the fires, an increase in short-term concentrations was noted regarding not only CO (21.0 times) and TPM, but also SO2 (13.0 times) and formaldehyde (12.0 times)."

> Conversing with the knowledge holders during a Snowchange community event in earlier years. Photo: Snowchange Cooperative





E. Some Environmental Impacts Resulting from Fires in the BNT

The forest fires around Lake Baikal have a number of direct and indirect environmental impacts on terrestrial and aquatic ecosystems. They also alter the chemical composition of the streams flowing into Lake Baikal. Kichigina and Bilichenko (2019) state:

"...a catastrophic situation has arisen in the Baikal natural area associated with forest fires. In 2015-2017, there were catastrophic forest fires. Changes in the chemical composition of the rivers water take place after the forest fires: the concentrations of nitrates, nitrites, phosphates, and bicarbonates increase; the transfer of water from the hydrocarbonate to the sulphate class of the calcium group is noted. At the pyrogenically disturbed watersheds, the temperature regime of the water changes due to an increase in daytime temperatures and differences between daytime and night time temperatures, the mineralization regime is not stable, and the amplitudes of level fluctuations are higher."

Kichigina and Bilichenko (2019) mention that a year after the fire, a calculated average of 240 kg of nitrates and 15.5 kg of phosphates were flushed into waterways from a single km2 of burnt area. Their findings demonstrate how these fires lead to eutrophication and other alterations to aquatic ecosystems in the BNT.

One of the impacts caused by the large fires concerns polycyclic aromatic hydrocarbon (PAH). PAH is a hydrocarbon—a chemical compound containing only carbon and hydrogen—composed of multiple aromatic rings. The group is a major subset of the aromatic hydrocarbons. The simplest of such chemicals is naphthalene, having two aromatic rings. The three-ring compounds are anthracene and phenanthrene.

Sending fire brigades to the front line. Photo: Jeroen Toirkens, Used with Permission

Gorshkov et al. (2021) have explored PAHs as drivers of environmental change in the Baikal region. According to their research:

"A high level of the PAH concentrations in aerosol above the water surface and a 3.5-fold increase in transport rates of airborne particulate matter onto the surface of Lake Baikal are of key importance for explaining the phenomenon of the appearance of the extreme concentrations of pollutants in the upper water layer. The influx of PAHs from the atmosphere is the main channel of the impact of wildfires on the cleanness of water in the lake."







Fighting the forest fires, coordinating efforts over massive territory of BNT. Photo: Jeroen Toirkens, Used with Permission

In the next section we are looking at the Nasa Earth Observatory satellite images in the public domain to investigate how the 2003-2015 fires look like. This provides context and scale over the past 20 years on the burning area and its relationship to the BNT. The image captions are from Nasa Earth Observatory.

2003

East and west of Lake Baikal in south-central Russia, hundreds of fires were burning and filling the skies with dense smoke on May 8, 2003. This true-colour Moderate Resolution Imaging Spectroradiometer (MODIS) image from the Terra satellite shows the active fires marked with red dots. The southern end of Lake Baikal is losing its winter covering of ice. The high-resolution image provided above is 500 metres per pixel. The MODIS Rapid Response System provides this image at MODIS' maximum spatial resolution of 250 metres (Source: Nasa Earth Observatory).

Southeast of Lake Baikal (top left corner), scores of fires are burning across southern Russia on May 7, 2003. This Moderate Resolution Imaging Spectroradiometer (MODIS) image from the Aqua satellite shows active fires marked with red dots. The fires are producing rivers of smoke which extend far to the south into China and have spread eastward over the Pacific Ocean. The high-resolution image provided above is 500 metres per pixel. The MODIS Rapid Response System provides this image at MODIS' maximum spatial resolution of 250 metres. (Source: Nasa Earth Observatory).





2008

Southeast of Russia's Lake Baikal, scores of large fires choked the skies of the southern part of the country with smoke. This image of the fires (locations outlined in red) was captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite on April 17, 2008. Early spring is not a common time for naturally occurring

wildfires in Russia, so most of these fires are probably intentional agricultural fires or wildfires accidentally caused by people. Fires are also burning to the east of this area, north of the Amur River (visible in the large version of the image). (Source: Nasa Earth Observatory).

2015

The 2015 fire season has been harsh in parts of western Canada and the United States. On the other side of the Northern Hemisphere, a significant amount of burning also has taken place.

Burning in Siberia took off in springtime, when smoke from deadly fires in southern Russia crossed the Pacific Ocean and reached North America. By mid-summer, fires and smoke obscured the shoreline of Lake Baikal, as revealed in satellite imagery from July 27.

Wildfires around the lake were still burning on August 8, when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NA-SA's Aqua satellite captured the image above. Actively burning areas, detected by the thermal bands on MODIS, are outlined in red. Scientists think the high intensity of fires on August 8 led to the formation of at least one pyrocumulonimbus—a high-reaching cumulonimbus cloud created by the heat from fire rather than by evaporation from sun-warmed ground. Dense smoke plumes were lofted high into the atmosphere, a phenomenon visible on subsequent days in data from the Ozone Mapping Profiler Suite (OMPS) on the Suomi NPP satellite.

According to news reports citing Russia's federal forestry agency, fires in Siberia had burned 1,400 square kilometres (540 square miles) as of August 12. Many of the fires were in southern Siberia, particularly in Buryatia and Irkutsk. Straddling those two areas is Lake Baikal. According to the Siberian Times, vacationers reported ash on the lake and on camp sites, and more than 40 people were evacuated. Fires are a regular occurrence in this region during fire season. But according to news reports, water levels in Lake Baikal—the largest freshwater lake by volume in the world—have been dropping. As a result, the drier coastline could lead to more summertime wildfires (Source: Nasa Earth Observatory).





F. Human Observations of the Recent (2019-2022) Fires in East Siberia and Lake Baikal

The *Heart of Eurasia on Fire* project was initiated to collect observations and seek new solutions to the urgent questions posed by intensifying fire cycles in the BNT. The project was able to function between Autumn 2021 and March 2022, when the War in Ukraine rendered international collaborations impossible. Nevertheless, dozens of data items, oral histories, photographic evidence and other cultural materials were collected and summarised as part of the project, including:

- Visits to regional and community museums to conduct land use and occupancy studies of Buryat and Evenk villages;
- **R**eview of publicly available media stories from the fire seasons and responses;
- Community workshops and visits to Elders and knowledge holders for their oral histories on change in Yeravninskiy region, Maksimikha, Bagdarin, Tungokochenski District in Zabaikalsk region, Bauntovski District, Okunevo village, Kurumkanski district and the villages Alla and Ulyunkhan and Alla village;
- Other available cultural materials, such as the Buryat Epic, Geser.

Fire has gone through. Photo: Jeroen Toirkens, Used with Permission

Based on our research and that conducted by others, we can state that the intensified BNT fire events and their associated environmental impacts (air, water, loading from the catchment areas, loss of habitat, loss of fish and animals) are events of centurial significance in the BNT. A 2019 Siberian Times report (2019a) reflects these realities as follows:

"Federal and local routes are disrupted, residents complain they fear getting burned alive while driving through the blazing taiga near to Lake Baikal. Thousands of firefighters and volunteers are out in woodland in the Irkutsk and the Trans-Baikal regions of Eastern Siberia, desperately seeking to extinguish the infernos. Russian Consumer rights watchdog RosPotrebNadzor issued a warning to the locals, calling on them to keep windows shut at all times, to wear damp masks and drink a lot of water. 'It's impossible to breathe, woods all around us are burning, villages are burning, people are sure to lose houses again! I only wish that they survive!! Shop attendants in the city wear masks, this is awful', wrote Inna Shishkina from Irkutsk."

The 2019 fires were followed by massive flooding, described here by the Siberian Times (2019b):

"Almost 3 million hectares on fire, including Arctic, with fumes having hit area larger than European Union. A series of natural disasters are hitting Siberia, with the latest a dire threat from severe flooding to Baikal - the oldest and deepest lake in the worth, containing 20% of the planet's unfrozen freshwater. The alert concerns flooding in Baikalsk - where evacuation has begun - and concerns that toxic mudflows can dump poisonous sludge from a former pulp and paper mill into the lake's pristine maters. Pools of liquid sludge containing lignin poses a huge threat to the life in Baikal with warnings of an 'ecological catastrophe'. 'We can only pray now," said one campaigner pointing to a risk of a dam burst on the Solzana River where a bride had been swept away already. While Baikal Pulp and Paper Mill, a Soviet-era production facility seen as an ecological threat to the lake, is now closed, the risk of pollution from untreated waste storages at the site is acute, say reports. The last devastating Baikal mudflow was in July 1971 which washed 20 kilometres of the Trans-Siberian Railway into the lake and destroyed several sections of the road from Irkutsk to Ulan-Ude."

Evenki Elder Vladimir Mikhailovich Murzakin (2021) is a respected knowledge holder in the BNT. As part of community oral history work undertaken as part of the *Heart of Eurasia on Fire* Project he observed that:

"The weather and climatic conditions have changed during the last twenty years. First of all I should mention wildfires, but luckily there have not been any big wildfires during recent years (in our community). In the alpine part of the mountains wildfires begin because of lightning strikes. But the main reason for wildfires is people, and fire carelessness. There is a lot of gold mining in the district and cross-country vehicles are everywhere. Some of them do not have extinguishers."

Here Indigenous Evenk knowledge confirms what science (Brown et al. 2021) has also reported – worsening fire seasons can be attributed to changes in the weather. Murzakin also describes how fires are sparked. In the mountains, the causes are often natural. At lower altitudes, humans are the main cause. According to him, the Increased activities of the extractive industries plays a role, too.

Elder Murzakin (2021) also noted and stressed changes in nature:

"Generally, nature is one whole. But in recent years we can see deforestation. For example, there used to be capercaillie mating places. These capercaillie mating places have disappeared because birds have flown to other places. Upland game and waterfowl have vanished. Wild boars have disappeared, too. Basically, gold is mined here. The biggest gold mine in the Republic is the Tsipikan gold mine in Bauntovski District. They used to level the dumps, and grass would grow, but now they don't. At present, there are big complaints about 'Zakamensk-Les', the biggest gold mining company here. You have seen the dumps, I suppose, while coming here. Much of the ground is furrowed and dug, and it will be dug more."

Large scale industrial land uses have, according to Murzakin, changed the forest cover and structure in the BNT, resulting in ecological shifts (e.g. capercaillie, forest mammals have left). Soil structure has also changed because of mining.

Orochon Stepanovich Bereltuev, who is an 88-year-old Evenk Elder from Kurumkansk, and Elvira Orochonovna, have also detected similar disturbing changes in their regions. They are very concerned about the fires and share similar observations to Murzakin.

During a research visit to her community, Evenkknowledge holder Nina Nikitichna (2021) described how:

"Some years ago when I came to the wood I could see moose, ground squirrels and squirrels. When I go to the wood now, it is terrifying that there are no animals. There are even no birds. Once I was picking up some black currants in the forest. And a bird was flying nearby. I told the bird: "I will not pick up all the currant here, I will leave some berries for you, too". The bird, as if it understood my words, sat down on the tree and waited for me to go away. And I left some berries for the bird."

In this extremely relevant Indigenous knowledge observation we can see how local traditional land users are able to monitor habitats affected by fire and, more importantly, how the Evenk and other local people are maintaining their cultural practices of conserving natural resources and sharing them – as in this oral history – with the birds and other non-human-beings. As we will see in the conclusions these lifeways offer solutions and ways forward..

Andrey Gladishev (2022) and his fellow fishers from the Pribaikalets Cooperative participated in a community workshop to share their concerns about how the fires and changes in the environment have affected their work. Fishers on the lake are some of the most important traditional knowledge holders and observers after the fires, as the loading from the basin into the main water bodies can only be seen after the initial devastation has happened. For example, fire-related eutrophication proceeds rather slowly after the influx of organic material from streams and rivers.



Save the Karas, Crucian Carp, save the food security. Photo: Snowchange Cooperative

Key observations from the fishers involved in this workshop include:

- The winter is very warm this year. Lake Baikal even has not got covered in ice yet: Fishers observe here that recent winters, such as that of 2021-22, have been warmer. Climate change is proceeding, with more open water days and later freeze-ups.
- Something has changed in the environment. For example, according to my observations, there has been little water for approximately five years. But the level of water has increased. The rise of the water level may be connected with the sewage discharge: Fishers have a concern that there is a system shift under way in the BNT. Post-fires, there is less water in the lake and from the catchment areas. On the other hand the levels of water in the Lake have increased. The fishers believe pollution may be one cause. The operations of the Irkutsk Hydropower Station may also play a role.
- I should say, every year the fish catch is getting worse and worse: Here, one of the fishers observed that catch sizes are decreasing and quality of fish is worsening. There is a negative trend.
- All of a sudden, all the seagulls disappeared because cormorants attacked them and cormorants started swallowing Omul: Changes in food chains and arriving species (cormorants) have been observed to affect fish stocks. Literature indicates that cormorants thrive in warmer and more eutrophicated waters, corresponding to the observations that the lake is becoming less oligotrophic, due in part to fire impacts.
- I suppose deforestation plays a big negative role in the changing of the climate, for example, there used to be 360 rivers which flowed here into the Bay of Proval and then into Lake Baikal, unfortunately, many of them have dried up now. And it is not clear where the water comes from. How does the water level rise in the Baikal? It is highly likely that the rise of the water level is due to the discharge of sewage into the water. For example,

the burbot likes pure water and these fish were everywhere here. Our grandfathers used to catch burbot, pike and peled. Nowadays, you cannot catch this fish here because the water is dirty everywhere. You can see some kind of foam and mud in the water which appears from about midnight: Fishers are aware of the changing land use and extractive industries operating in the basin. Rivers have dried up, according to them. Aquatic pollution has been observed and the fishers are using three cultural indicator species, burbot, pike and peled (a species of Coregonus) to understand change over time and trends of worsening conditions.

- You can see some snow in the forest now because there are no trees in the woods. The mountains are bald. Nature reserves have been cut down: Snow patterns are shifting, which may help explain flood events. Fishers observe that whilst many conservation areas have been established in the BNT, as Brown et al. (2021) confirm, logging continues and is intensifying in some areas.
- All the water pollution comes from the Selenga: Selenga, the main river delivering water to Lake Baikal from a massive basin, is understood to be the main cause of environmental degradation.
- I think today the main problems which we observe here are warming of winters, deforestation, increasing of the number of cormorants and Baikal seal, and the discharge of sewage which leads to the reduction of the number of fish: Here a fisher summarises a simultaneous range of observations as seen from the actual lake and ice conditions. Climate change plays a major role, as do land use changes, pollution and increases in the number of predatory animals, affecting fish stocks.





Evenki and Buryat Children grow into fishery around BNT from infancy. Photo: Snowchange Cooperative

G. Conclusions – Solution Spaces

Heart of Eurasia on Fire: A Biocultural Assessment and Development of Early Response in the Lake Baikal Region was able to operate for a year, providing an opportunity to better understand the fires in the BNT, collect Indigenous observations and wisdom from local communities and assess existing science in order to develop ideas for responding to this system-altering threat.

In this report we have summarised Indigenous knowledge and observations uniquely gathered for the project in the villages and cooperatives affected by the changes under way, presented some key science on fire cycles from the 2000s to the present and reflected on multiple, intersecting environmental problems. Despite these achievement, we acknowledge that our 2022 data gathering and the scope of our work have been severely limited since the start of the War in Ukraine in February 2022.

In literature and in their comprehensive review of BNT, Brown et al. (2021) describe actions that could help to remedy the situation of wild-fires around Lake Baikal, including more research on the outcomes and origin points of environmental change. They point to a more sustainable future building on the BNT's unique 'bioeconomy', which would preserve Lake Baikal and its "intricate web of endemic life".

Efimova and Rukavishnikov (2021) suggest increased monitoring of environmental change as a critical next step, writing:

"Large areas of the BR are sparsely populated and do not have permanent air pollution monitoring posts. The lack of stationary observation posts in the vast territories makes it especially relevant to search for opportunities to assess atmospheric air pollution and its danger for the population of small settlements, remote from large centers, with a developed infrastructure for monitoring the quality of the environment and providing emergency medical care in emergency situations." Sukhodolov et al. (2019) suggest prioritising early suppression of new wildfires when they start to form:

"The most important problem in forest fires fighting, besides the protecting of people's lives, is a quick and effective fire suppression, planned to minimize the total damage. Controlling of the process of suppression, transportation of forces to the place of fire is made by employees of forest protection organizations. In the most cases they make decisions based on their personal experience. But even with experience, defining an optimal fire fighting plan is, often, a quite difficult task. For many years, scientists have been studying models that allow them to find optimal solutions of fire fighting forces control under an active forest fire. These attempts are being made to take into account the characteristics of the spread of fire, the capabilities of the available fire-fighting forces and equipment, topographic features and other factors."

Needless to say, the sacred Lake Baikal is one amongst many lakes and rivers in Buryatia. All of these landscapes hold significance for the Buryat and Evenk, where applicable.

It is interesting to mention the links between the current place names of Buryatia and their history. It is obvious that the place names are multilayered, and one can observe the stratification of multilingual geographic names. This phenomenon is natural in toponymy, and it is due to the centuries-old history of the area. The linguistic diversification of the place names testify the presence of Indigenous tribes and peoples, speaking different languages on this territory in the distant past and today.

In the south-west, there are many waterfalls and hot springs in the mountains of Okinsky and Tunkinsky Districts. In the north-east, there are countless lakes, as well as big rivers, in Yeravninsky and Kurumkansky Districts. Apart from the Selenga and Uda, the Barguzin and Turka, the Dzhida and Chikoy, Buryatia is home to more than 2000 small rivers, as well as mineral and hot springs. All of these sites are affected by the fires and must be considered in efforts to protect and respond to the threats affecting the BNT and human settlements within it.

Fishers like Andrey Gladishev (2022) render the interconnected whole of the BNT visible. Gladishev says that, upon reflecting on the negative changes underway, *"in my personal view, we should close winter fishing for two years to let the roach multiply."* This is in line with the views of Evenk knowledge holder Nina Nikitichna (2021), who identified the practices of conservation and sharing as vital for providing safe spaces and resources for non-human beings to survive major environmental changes.

Based both on the science and Indigenous knowledge collected for this report, we wish to offer four key actions we believe are vital for protecting the BNT from more harmful fires. These steps are not exhaustive or comprehensive – they require local grounding and post-war discussions. However, based on the available information we can summarise our recommendations as follows:

- 1. Early detection and suppression of fires in the BNT remains a key action: Communities around the region should be resourced, trained and equipped with capacities to establish early warning systems. Fire fighters, rangers and land guardians should be enabled to respond in a timely way, especially to new spring fires that evolve into devastating summer blazes.
- 2. Observations of change must be increased: Scientific monitoring stations across the BNT are needed. As is comprehensive Indigenous knowledge monitoring and an appreciation of cultural indicators, including local place names and linguistic knowledge. Backcasting changes using toponyms and cultural knowledge, as well as supporting and resourcing land and water guardians, like the fishers of the Pribaikalets Cooperative, are examples of actions

unique part of Eurasia.

that can happen today. They would also support the revitalisation of the BNT's unique cultural heritage.

- 3. Positioning the changes and monitoring missions to Arctic and northern international feeds: Organisations and processes such as Arctic Passion, NASA Earth Observatory, Northern Forum Working Groups and Arctic Council, where applicable in the future political and science contexts are highly significant warning mechanisms, given that BNT is a hotspot for climate change in many ways and a
- 4. Enforcing and restoring the protection of natura systems: Much of the BNT is protected, especially areas close to the Lake. Yet, as Brown et al. (2021) have shown, poor 'management', poaching, logging, mining and other extractive land uses are worsening the fires. Indigenous co-researchers for this report indicated this fact several times. Therefore, legal enforcement of existing protected area status and sensitive management is vital. As is the exploration of the potential of rewilding and restoration of habitats where required, in order to lessen the speed, scale and severity of the new fires and repair the damages already done.

In closing:

In the Buryat epic, Geser, there is a passage which warns against attempting to vanquish *Lobsogoldoy*, Lord of Water. It states that any attempt to subjugate *Lobsogoldoy* will lead to the drying up of rivers, and the perishing of the vegetation vital to our survival. There can be no better or more prescient message for our troubled times.

> That running water of ours Might get dried up from the river head That the growing grass of ours Might get dried up from the very root. (Khundaeva Ye.O., Erdineeva Ch.V.2015).



In 2010s and 2020s the fires are now on landscape level. Photo: Jeroen Toirkens, Used with Permission

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A rest from the day of rescue operations. Photo: Jeroen Toirkens, Used with Permission