Project Update: October 2010

Report on Results of the Dagi River Expedition

Abstract: *The Dagi River supports one of the largest populations of Sakhalin taimen, listed by IUCN as critically endangered. Its aquatic habitat in the Dagi is relatively well-preserved, despite fragmentation and development pressure in the surrounding floodplain. Our studies determined that the substrate composition of spawning grounds is ideal for taimen reproduction. However, forestry, roads, and other uses affecting floodplain vegetation are having detrimental effects on the viability of spawning grounds. Three critical stages were clearly defined in the life cycle of Sakhalin taimen in the Dagi, including the two most vulnerable ones: the mass migration from the spawning grounds in the second half of June and migration to the wintering grounds in the second half of October.*

Overview of the Dagi River Expedition, October 2010

The Dagi River basin is located on the northeast coast of Sakhalin. A federal highway connecting the City of Yuzhno-Sakhalinsk with the City of Okha crosses the Dagi River in its lower section, 36 km north of the Nogliki settlement. The river flows from west to east and into the Nyisky Bay of the Sea of Okhotsk. A maintenance road for servicing the "Chaivo — Cape Lazarev" oil pipeline runs along the left slope of the river valley and the northern edge of the Dagi basin. Oil and gas pipelines belonging to Sakhalin Energy Investment Company cross the Dagi River in two locations, 0.8 km and 7 km above the bridge (bridge is noted with yellow marker in Figure 1 below). Commercial salmon fishing in the Nyisky Bay is officially prohibited, but there is evidence of a well-developed network of poachers in the area. Sakhalin taimen is often the victim of by-catch during pink and chum salmon illegal fishing in Nyisky Bay.

The experience gained during the implementation of a Conservation Action Plan (CAP) for the Langry River, in northwestern Sakhalin in 2008-2010 was used for the new river basin, the Dagi, the in the northeastern part of the island. The Dagi River is home to one of the largest populations of endangered Sakhalin taimen, with relatively well-preserved river habitat and comparatively low anthropogenic pressure. At the same time, the Dagi watershed hosts a commercially valuable population of pink salmon, along with a high diversity of other fish species. It is important to take into consideration that the Dagi watershed is used for recreation and has significant potential for oil and gas development. When developing the CAP it is necessary to leverage public interest for this watershed as an area for recreation and sport fishing.

Over the entire period of field work, we caught 30 individuals of mature Sakhalin taimen and other fish species and released all of them after the analysis. We also collected larvae and adults of aquatic insects, as well as sampled periphyton, freshwater organisms, and described riparian vegetation. In addition to ichthyological and hydro biological research, we conducted a comprehensive survey of taimen freshwater habitat in the Dagi River.

We decided to conduct our field studies in the fall because of the migration of Sakhalin taimen from the estuary into the river for wintering usually occurs in late September and October. At this time there are fairly high concentrations of Sakhalin taimen and increased poaching activity. This migration of the species happens due to the decrease of water temperatures in the river in early September with temperature ranges from 5°C to 14°C. The salmon fishing season on the Okhotsk coast in general and the Nyisky Bay in particular usually lasts until mid-September. Sport fishermen visit the river more often at that time in order to catch East Siberian Char and Dolly

Varden, which enter the bay from the sea. During this period fishermen also illegally use fishing poles and fixed nets to catch Sakhalin taimen.

While we were working in the field, a Sakhalin taimen weighing 35.2 pounds was caught in the Dagi River just below the bridge on October 2, 2010. One fisherman illegally catches about 2-3 taimen daily. According to our poll data, not all fishermen are aware of the special status of Sakhalin taimen and almost all of them catch the fish only for sport and consumption. As our public survey showed, a lot of fishermen do not yet understand the significance of catch and release technique for taimen. In the near future, the Sakhalin Salmon Initiative (SSI) needs to focus its efforts on educating local people about catch and release sport fishing practices through the development of a targeted educational program for the community.

Methods

During the expedition, we counted and measured Sakhalin taimen which were caught and subsequently released, collected samples for genetic testing, and surveyed land use in the watershed. We also conducted interviews among locals about Sakhalin taimen and other salmonids.

Methods of field work followed the standard set during the first expedition in 2009, when studies were conducted at several monitoring check points of the main river channel, and test samples were collected in its tributaries. In hydrobiology and ichthyology, the site of a verification survey is called a station. Typical sites, topography, channel measurements, water chemistry and temperature were entered in special forms for each of the surveyed stations. Simultaneously, we used seines for collection of fish and carried out semi-quantitative assessments of aquatic organisms, including river benthos and periphyton. At each site we measured the parameters of the habitat and took pictures of the riverbanks and riparian vegetation: six sampling sites on the Dagi River generally were described following methods used by the science staff at Wild Salmon Centre. For fish samplings, we used spinning rods and fly rods, as well as an 8.5-meter long seine net, while for adult taimen we used a 20-meter seine net with a mesh size of 18 mm and also spinning rods. Triple hooks on spinning lures were replaced by single hooks without barbs to avoid traumatizing the caught fish. The wobbler was recognized to be the most successful bait.

All captured fish were measured; salmon body length was measured according to the Smith method, other species of fish were measured for their “commercial” length to the end of the covering of scales, and the total length from the tip of the head to the end of caudal fin (gobies, Siberian stone loach). Fish were released after measurements were taken. Additional biological material was collected for masu (length of scales), and Sakhalin taimen (length, scales, and scale sample for DNA analysis). After the expedition, all biological materials were processed in the laboratory, and numeric values were processed using standard statistics.

History and Overview of the Dagi River

We were unable to find the origin of the river name. However, T.I. Petrova in her book Oroks’ Language (Ulchi), p.156, explains that the aboriginal name of the local people in the basin was "dakhinnyoni" derived from the name of the river Dakhi, and on the adjacent Val River, they were called "valunnyoni." Later, the Nivkhi tribe’s name for these rivers transformed into the modern "Dagi" and "Val" (Fig.1). The river is 98 km long with a watershed area of 780 km_2. According to the Sakhrybvod data, the spawning area for commercially valuable salmon species is 323,023 m_2.

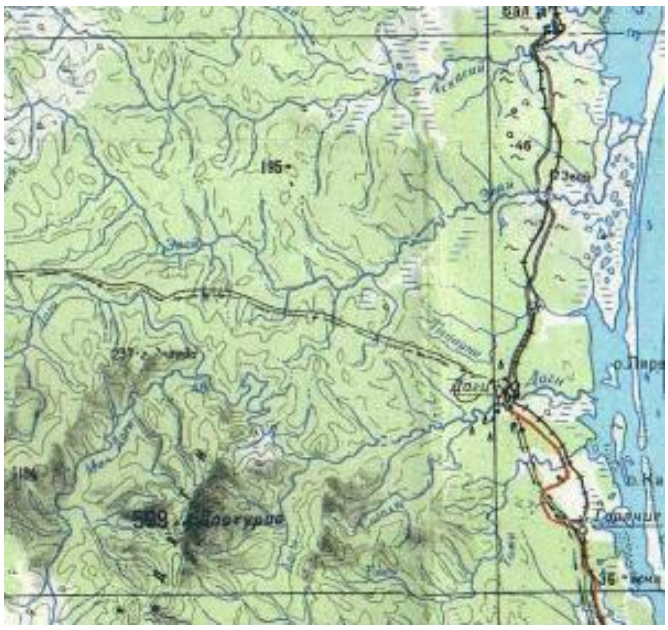

Fig. 2. Map of the Dagi River and railway.

Dagi River headwaters begin on the eastern slope of the Dagi mountains and the river empties into the Dagi Bay of Nyisky Bay of the Sea of Okhotsk. The mainstream of the river is highly sinuous and a relatively low elevation watershed. However, in the middle reaches, the river cuts through the Dagi mountain range, which has peaks reaching 230 m above sea level. There are a few major tributaries, among them the Malaya Dagi, Aasy Creek, Okabykay Creek, and Sigal Creek. Small tributaries flow into the main channel as gradually cascading small waterfalls, preventing the entry of fish into the creeks in low-water periods. The adjacent river basins are the Evay River to the north and the Tomi River to the south. The general direction of the river flow is from the northwest to the southeast. The river is mountainous, and the channel is graded significantly through its entire length to the estuary.

In the upper and middle sections, the river flows through the mountains, but rifts and deep stretches are almost absent here, because the river has a box-like channel with steep banks. The average depth of the channel in the rifts is 0.4-0.8 m, and on deep stretches up to 1.8 m. The terrain is hilly. Larch and spruce grow in the floodplain. Alder is abundant on the banks; birch and mountain ash are less common. The water has a reddish hue throughout the entire river due to inflow of tannins from numerous floodplain wetlands. The river bottom is composed of sandstone, loam, and only the lower reaches have gravel and slightly rounded pebbles. The floodplain of the river is narrow, and in some places, where the bank is limited to steep hills, there is no floodplain at all. According to Sakhrybvod data, pink salmon is the prevailing fish species in this river in numbers, coho, chum, and masu are also common species. Among non-target species are rudd, Asiatic smelt, white spotted char, dolly varden and Sakhalin taimen. Occasionally, in the lower reaches, great Siberian sturgeon and So-iny mullet can be caught. The composition of species varies annually and seasonally depending on whether it is an abundant or weak pink salmon run, but the long-term population fluctuations in numbers of other fish species are also common.

Preliminary Findings of Dagi River Watershed Survey

Summary of Human Impacts

The shape of the Dagi River delta and its depth is related to the diurnal tides, which can be up to 1.5 m. The Dagi River's lower reaches are crossed by numerous temporary roads from the mouth

of the river to about 4.6 km upstream (Fig. 2). Silt particles from the roads enter the river after rainstorms. Oil drilling sites pose potential danger to the river after heavy flooding and also pose some degree of a fire hazard during draughts.

Fig. 2. Lower section of the Dagi River basin shows fragmentation of valley and floodplain vegetation.

Fig. 3 and 4. A highway bridge heavily used by trucks, and the 670 km marker over the Dagi River.

After big floods a large number of logs become jammed at the bridge. They pose a particular danger to the bridge structure (Fig. 5), accumulating large pieces of wood and creating blockage. In late fall, all the logs remain on the riverbed until the spring floods of the following year. Upstream from the bridge, the left bank is the high floodplain and the right bank is lower. The riverbed is composed of sand, gravel, and silt. Such banks can easily be eroded by heavy water flows, after which small soil particles settle on the bottom creating a thick layer of silt. Silting of the river bottom is the primary reason for reduction of the spawning grounds (Fig. 5).

Fig. 5. View from the river to the road bridge. Fig. 6. The Dagi River above the bridge. The access areas near the bridge are used by sport fishermen and truck drivers for recreation.

A

B

C

D

Figures 7 A-D below show the temporary pipeline crossing over the Dagi River from different angles. Figure 7A depicts a pipeline hanging over the river. According to the engineers, this section of the temporary pipeline was created three years ago to repair oil leakage on the right bank of the Dagi River. Special constructions were erected on both sides of the river to hold up the pipes with the aid of a metal cable. Figure 7C shows the low reliability of this type of mounting, which is supposed to support a long, curved pipe at one point. During a big flood, water would flow over the pipe and cable, and woody debris could accumulate, resulting breakage of the pipeline. There is absolutely no protective structure over the water surface to prevent such a break! It is very a serious source of potential danger. Figure 7D shows the place where the pipe comes out onto the floodplain tundra on the right bank. There is no protection of metal pipes from corrosion except a

thin layer of geological material. Under the conditions of freezing and thawing in the northern region this layer is very low-level of protection. Such river crossings of the pipeline should have increased protection against possible emergencies.

The same remark applies to the thick and wood jam under the pillars of the existing road bridge and abandoned railway bridge. Figures 8 and 9 show the remnants of a railway bridge with a large log jam. Normally jams that do not cross the river completely are good shelters for migrating salmon. Such accumulation of woody debris increases habitat diversity for fish and aquatic invertebrates in the stream. But when jams become too big, normal functioning of the stream is disturbed, which can lead to creation of new side channels and change the configuration of the main channel and stream underflow. Such processes are well known for mountain rivers, where wood jams create natural dams, later destroyed by subsequent river flooding.

Fig. 8. Bridge across the Dagi River. This is the abandoned Nogliki-Okha railway line. Large accumulation of the logs as a result of floods is clearly visible under the bridge. Fig. 9. Collapsed bridge across the Dagi River. A number of trees washed away by floods have accumulated between the bridges.

In the 1980s the village of Dagi was located not far from the road bridge. Now on modern maps it’s marked as "uninhabited." In the old days, when the villagers were engaged in fishing, temporary storage for fuel, engines, and nets were built on the left bank. Now there are abandoned metal barrels, sheds, and warehouses, which are used by fishermen for temporary accommodations. Today, the river has lost its commercial fishing value and has acquired a new primary purpose as a zone of oil development, as it is in a productive oil and gas region. For several years, a drilling rig has been exploring potential for deep-hole drilling oil reserves on the left bank of the river. The zone of oil development and prospecting is easily distinguished on Google maps.

Poaching is very active on this river. Fish inspectors are unable to enforce regulations on rivers north of the village of Nogliki and the Tym River. In fact, there are only four full-time fish inspectors for such a large area. Transportation and fuel for boats and cars are insufficient. The network of public fish inspectors is poorly developed because this activity is not covered in the Sakhalin Fishery Management agencies (SakhRybvod) budget. There are several sections of the river that require enhanced protection, in particular in a 6-km section downstream from the road bridge. There are a lot of trails and roads here that are used to put in illegal nets and allow for relatively easy retrieval of caught fish. Better protection of salmon and Sakhalin taimen could be ensured here by specialized mobile enforcement groups funded from extra-budgetary resources.

Below is a photograph showing an area with obvious signs of poaching presence. There is a place to store fishing gear, surrounded by trails, and areas where poachers set up their nets and park their vehicles. Figure 10 shows multiple storage areas 200 m downstream from the railway bridge. They are still used, especially in the winter as a shelter.

Fig. 10. Remains of fishing storage units on the left bank of the Dagi River.

During our watershed survey, we saw poaching groups that were openly fishing with nets. The sport fishermen, who used the sport fishing gear: fly rods and spinning rods, are hostile to these poachers. This moment of social confrontation can be used to fight illegal fishing. If a network of sport fishermen is expanded or licensed fishing is organized in the area, the presence of people on the banks of this river can help significantly. Civilized forms of fishing can block any poaching activity. The high level of unemployment among local people creates preconditions for illegal fishing. Fish inspectors, who understand this problem, try to minimize the number of fines.
Survey of the Dagi River

State of Spawning Habitat
The substrate at the spawning grounds is composed of rounded pebbles, gravel, sand, and silt. Fine particles of bottom substrate don't allow the stream underflow to penetrate deep into the sediments. Figure 11 shows the ideal substrate for salmon spawning grounds with gravel and coarse rounded pebbles. The composition of the river bottom is determined by the rocks composition of the riverbed. If the river flow is not fast, the edges of these stones are slightly rounded. This composition of substrate and river alluvium is used as a substrate for building redds by chum and coho. Dolly varden and white spotted char spawn in the upper part of the river where the bottom substrate is shallow.


Fig.11 (left). Composition of river bottom which is ideal for taimen spawning grounds. Fig. 12 (right). Deep stretch of the river used by fish as a shelter. These areas are not suitable for spawning because of the deep water and fast flow.

Deep stretches of the river are often used for spawning. The more uniform the depth and flow velocity of the river in the section, the higher the quality of spawning substrate. Because the river bottom is made of sediment, it is easily washed away during floods. The areas of the floodplain without vegetation erode the fastest.

Fig. 13 River pool used for overwintering by species with multi-year cycles (repeat spawners).

A B

Fig. 14 A-B Deep stretches in the lower section of the Dagi River. Right bank has a high floodplain, left – marshy sandbars.

Results of Sakhalin Taimen Survey

Dagi is one of the few rivers where the endangered taimen is still fairly abundant. The strongest populations of taimen always inhabit basins with well-developed estuaries. The most important habitat for this species in the basin is pools in the lower reaches of the river (the lower 10 kilometers) and the intertidal zone. Most likely, the most important habitat for Sakhalin taimen in the basin of the Dagi River is the estuary. During our float trip we could not find taimen there – probably because it migrated out to sea for feeding.

For taimen, as well as for other fish species, isometric growth is typical. Fig. 15 shows that individuals of up to 8 years of age and body length of 67 cm are not yet mature. Immature individuals of taimen are fished in large quantities in the wintering grounds and in autumn during their migrations to the lower reaches of river.

The relationship between body size and age is described by a linear equation. Fig. 15 shows the coefficients of this relationship. The maximum age in our samples did not exceed 12+, i.e., there were two individuals which were 13 years old each.

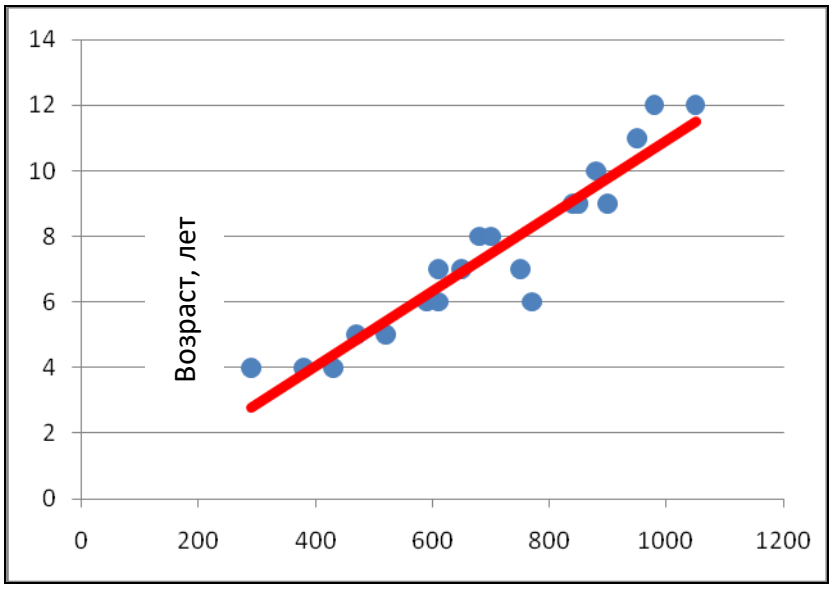

Fig. 15 Relationship between size and age of fish determined from scales and the regressional relationship of straight line with the coefficients.

Taimen juveniles were not used for tissue samples. The probability of trauma and death of immature individuals is high at this age/size. We measured body size and density of individuals on a test area. Calculations were based on the number of fish caught per unit of area covered by the seine. Density index can be used to compare the relative abundance of Sakhalin taimen in different regions and among different populations. Figure 16 shows three-year-old Sakhalin taimen caught in the lower river.

Usually, to calculate the density of juvenile taimen aged 0 + (fingerlings), scientists use the method of selective capture using a minnow seine. Comparing these characteristics received from different watersheds, we can determine the rating of the abundance of taimen populations.

Fig.16 Juvenile taimen caught in minnow seine.

Fish migration: chum and coho salmon enter the river by mid-October for spawning. According to the ichthyologists of Sakhrybvod, in some years, spawning of these species of salmon continues until the end of November. Migration of Sakhalin taimen into the river for wintering coincides with the autumn cooling of water down to 4-8°C. In October, Mikhail Baboed, an expert from Sakhrybvod was interviewed on the bank of the Dagi River. Critical periods of taimen life cycle and potential conservation actions were discussed.

Mikhail Baboed highlights four critical periods of the Sakhalin taimen's life cycle:

Summer period: Migration lasts until the beginning of the high runs of pink salmon. During this time, mature taimen migrate downstream after spawning. Spawning period lasts from early May to late June. Young taimen individuals with a body length of 30-40 cm migrate to Nyisky Bay together with adult individuals after spawning.

Early autumn: migration to wintering grounds starts in September. Taimen prey in the sea on Sakhalin stickleback, herring, delta smelt; in the river they feed on Pacific lamprey, pond smelt. In the past, capelin was a big part of the taimen diet, but now the abundance of this species is low. During this period, taimen is often caught in poachers' nets.

Thus, the most vulnerable periods for taimen are when a lot of individuals are concentrated in a short period of time in the river. These are periods of mass migrations to spawning grounds (the second half of June) and migrations to the wintering grounds (late September - October).

Recommendations for Conservation Action for the Dagi River

The key characteristic feature of salmonids is high migration activity during all periods of their life cycle. These are anadromous migrations into the river from the sea to spawning grounds, feeding migrations and catadromous migration of juveniles in the sea. This feature allows the salmon to cover large areas, but at the same time makes them easy to catch. Therefore, we identify a number of factors affecting the survival and ultimate abundance of salmon species.

The leading one of them is poaching and unlicensed commercial fishing. Commercial fishing that takes place at sea can be eventually regulated but poaching (including poaching for roe/caviar) is not amenable to complete control, because of its social and economic nature. The second type of threats is associated with impacts on salmon habitat. The following adverse factors are particularly acute: road construction, erosion of river valleys and banks, erosion of forest soils, and forest fires. A protected area should be created to provide effective protection for Sakhalin taimen and its habitat.

The following conditions should be fulfilled for this decision to be supported by the government of Sakhalin:

1. Protection of taimen as an endangered species should become a priority federal objective.
2. The land of Dagi River basin should not be allocated for economic use.
3. The Dagi River basin should not be included in plans for industrial and other similar development of the area.
4. This area should be removed from the plans of future oil development and logging.
5. Support of officials of the Department of Forestry to create protected area should be obtained.
6. Additional funds for the preparation of a biological justification for the subsequent creation of the reserve should be secured.
7. Additional enforcement measures in the lower reaches of the river, downstream from the road bridge should be provided.

This is not an exhaustive list of conditions that have be fulfilled in order to create an ecosystem-based protected area in the Dagi River basin that would protect not only water resources, but also the biomes in the floodplain and the valley of this river. Special brigades (like the "Tiger" and "Korean Pine" enforcement brigades in Primoriye Region) should be formed at the first stages of creating the reserve. These brigades could include: a specialist from the regional branch of the

federal fishery agency, ichthyologist from Sakhrybvod, a police officer, and community members or volunteers. Such a brigade should be equipped with weapons, transportation, fuel, boat engine, sleeping bags, tents, radios, and provisions. This brigade should be located in the village of Goryachie Klyuchi in order to work on Dagi, Aksakai, and Val rivers. The enforcement brigade should work in the lower reaches of the river between the mouth of the Segal creek and Nyisky Bay from July 10-30 each year. The section of the river from the 27th km of the road to the mouth of the Sigal creek should be protected first. This area has virtually no human impacts and access to the river. Guard posts can be created at the turn of the road 27th km (permanent post) and on the road bridge (temporary post). Thus, we can close access to the most productive taimen habitat and prevent the transit of illegal products to the federal highway. It is very important to publish educational articles on taimen in the local press and distribute display stands on catch and release fishing technique on the popular fishing places on the river.

According to the assessment of Mikhail Baboed, the following rivers are prime rivers for the protection of Sakhalin taimen in Nogliki District: Val, Askasai, Dagi, Evai, Nabil, Koira. The studies on taimen of the Dagi River should be continued until the creation of a protected area.

Summary of Results of the 2009-2010 Joint Expeditions, including Findings of Genetic Surveys of Taimen

Abstract. Our research indicates that the Dagi River represents ideal habitat for the species, including high quality habitat for spawning, rearing and overwintering. In addition, the river supports a genetically distinct Sakhalin taimen population. Our genetic data indicate that the population is likely to be small and inbred. We document for the first-time evidence that the species hybridize with white-spotted char in this river system, which is an indicator that the taimen population may be critically low in abundance. Finally, while rivers were likely connected by marine migratory corridors in the past that allowed populations to be more resilient to change, recent evidence suggests that the migratory form may becoming increasingly rare. In aggregate, these research results underscore the urgency in which we need to act to conserve this species.

We have been able to make substantial progress on our work in understanding extinction risk, migratory life history patterns and genetic differentiation in this species. As is often the case of carrying our field work and laboratory work, especially under challenging logistical and politically complex situations in the Russian Far East, we have been forced to adapt our original work plan the on-the-ground realities.

As a way to gain a clearer understanding of factors responsible for decline in the species and help guide us in the selection of candidates for establishing new protected areas focused on Sakhalin taimen, we developed a model to describe distribution and extinction risk throughout the known range of the species. We specifically analyzed spatial autocorrelation in their distribution, and concluded their distribution is highly contiguous. This suggests that migratory exchange among river populations is likely to exist but may be limited in spatial extent. We examine this further below using genetic markers. We applied the model to predict the historical distribution of the species (Figure 1). In addition, we found that watersheds that are of low gradient and have large floodplains, with minimal conversion of land to agriculture, are much more likely to support stable taimen populations. Further, we found that intermediate precipitation patterns (mean monthly precipitation within the range of 54-96 mm) and relatively cold climate (mean annual temperature less than 5.2 C) were critical for maintaining stable status for the species. It appears a combination of precipitation and temperature places a northern limit to the species' historical distribution.

These results provide useful guidance in identifying candidates for protected area status in the northern portion of their range, and these results certainly have implications in how these fish might be able to adapt to climate change in the future.

The Dagi River is situated further into the core of their historical distribution, and hence may be a more appropriate river to establish a protected area for the species. Our field observations in 2009 indicate that the species is relatively abundant in this river system. In addition, our model indicated that the existence of lagoonal habitat near the river estuary is a key determinant for the existence of stable taimen populations.

We have been successful in further developing our genetic baseline for the species. We have found relatively little population differentiation based on microsatellite DNA markers (with two exceptions that we describe below). One way to interpret these results is that there has been a level of gene flow between populations that is sufficient to refute the hypothesis that these are closed populations. Because this species has been observed in coastal trap nets for decades, it is not surprising that we see evidence of panmixia among these populations. This underscores the idea that these are migratory species, and it is reasonable to conclude that, at least in recent history, there were migratory links between river populations, even in some instances across international borders. We found two rivers systems that group strongly together and were both highly differentiated Nabile and Dagi Rivers. This population is also unique in that it shows evidence of hybridization with *Salvelinus* spp. – to our knowledge, this is never been documented before. This result could be interpreted as evidence of a small effective population size for taimen in this system. This, coupled with a sympatric, larger resident population of *Salvelinus* spp., can lead to higher levels of introgression. These results suggest the Nabile-Dagi complex is also distinct, and hence should be considered a distinct population segment in the species. There is additional genetic evidence that indicates that these river populations of taimen are highly inbred – this interpretation is preliminary, and we intend to investigate this further. This evidence of inbreeding and hybridization, coupled with the fact that the species grows very slowly and has a very long generation time, underscores the need to take immediate conservation action.

In 2009, SSI Centre entered into a formal collaboration with Dr. Zhivotovsky's Institute to develop and receive Ministry of Natural Resources approval for a genetic research effort (for a duration of 3 years) focused on Sakhalin taimen. This is an extremely important step forward to build capacity for this type of research within Russia. Samples from the Nabile and Dagi Rivers were obtained during our field expedition in 2009 (22 individuals). Through collaboration between Steve Weiss at the University of Graz, methods of identifying and typing microsatellite loci were established in Dr. Zhivotovsky's lab in Moscow in 2009. Dr. Zhivotovsky has successfully identified 12 loci (adding two new loci) and has begun generating results from his laboratory (Table 1, below). This represents an important step forward in laying the foundation for future genetic studies of Sakhalin taimen and other salmonids on Sakhalin to help inform on-going and future conservation planning.

SSI Centre staff is currently reviewing potential protection options for the Dagi River and elaborating a strategy for 2011-2012 to create a protected area. SSI Centre in collaboration with its partners will work to prepare biological justification for granting this river conservation status. Research on the presence of the rare taimen in the Dagi River basin, along with the other findings described above, will contribute to the justification for creation of protected area.

Table 1. Description of loci identified and analyzed at the Institute of General Genetics in Moscow, Russia.

Loci	Primer Sequence	Structure	Number of alleles/Number of samples	Interval size (number of base pairs)
Pper_1G	F: gta ccc aca cta ctt tgt gct tt	(TGTC)n	29/55	≈126-246
	R: cac agt cag taa ggc agt cta			
Pper_2G	F: caa gta ggg tga atc aac atg tt	(GACA)n	14/56	≈162-230
	R: atg tgg cca ttg ttc tga tga t			
Pper_3G	F: cca ctc tct cct gta tta tgt	(GTCT)n	17/55	≈146-226
	R: tga cac aca ccg gag cta gt			
Pper_5	F: gct ctg gac ctt tct gtg	(AC)n	.5/55	≈152-168
	R: gtt taa agg gta aag gtg tgt gag			
Pper_6G	F: gat gta att tac ctt gtg ttg act aca	(CA)n	.10/54	≈105-129
	R: gta aag ttt cat tgc cac cac aat ca			
Pper_7G	F: gga atc gct gct caa tg	(TG)n	.4/55	≈128-146
	R: tgc agt atg tgt ggg tgc tct			
Pper_8G	F: gag gga tta aga gat aga gat ata aag a	(AG)n	.5/55	≈111-121
	R: gtc aat ggc aaa aag tat cta agt c			
Pper_11	EF: tgt cag gag gac aca ctg ta	(ATGG)n	.15/54	≈130-210
E	R: gtt ttg ttc agc acc aaa tca c			
Hper15	F: tgg tta gca tcc atg tgg aa	(GT)n	.7/56	≈96-112
	R: cat cca gcc tat cga agc c			
Smm5	F: aga tgt gtg ata aac tca gcc tc	(CA)n C(CA)n	.2/56	≈80-82
	R: agt tgt tta aat agg gcg gat ag			
Smm17	F: aag gat ggt gag gac aat aca	(CA)n	.5/56	≈132-140
	R: acc ttg aga aat cta tat gtg gtc ta			
Omy301	F: act taa gac tgg caa cct t	Unknown	.2/56	≈70-72
	R: cta cac ggc ctt cgg gtg aga			