NATURAL RESOURCES INSTITUTE FINLAND

C.8 Half-way evaluation report of sea-spawning grayling stocking success

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1. Introduction

The Biodiversea C.8 project comprehensively examines the factors influencing the different life-cycle stages of the sea-spawning grayling. A key component of the project consists of supportive stocking actions in coastal areas within the species' historical distribution range, together with an evaluation of their success. Based on earlier literature and on larval surveys previously conducted within the Biodiversea project, key stocking sites were selected for each marine sub-basin (Bothnian Sea, Kvarken, and Bothnian Bay): Pooskeri in Merikarvia, Valassaaret in Mustasaari, the Raahe archipelago, and the Krunnit archipelago off Ii. Broodstock was renewed from the Bothnian Bay National Park area, where abundant grayling juveniles were observed in 2022 (Figure 1). The selected areas differ in species composition, salinity, and trophic status, and to some extent also in temperature. For stocking activities in the Bothnian Sea and the Quark, a permit was obtained from the ELY Centre (VARELY/1704//2023), as a grayling stock originating from the Bothnian Bay was translocated to these areas. No corresponding permit was required for stocking activities carried out within the Bothnian Bay. In addition, the stocking activities were agreed separately with the local fisheries associations in each stocking area.

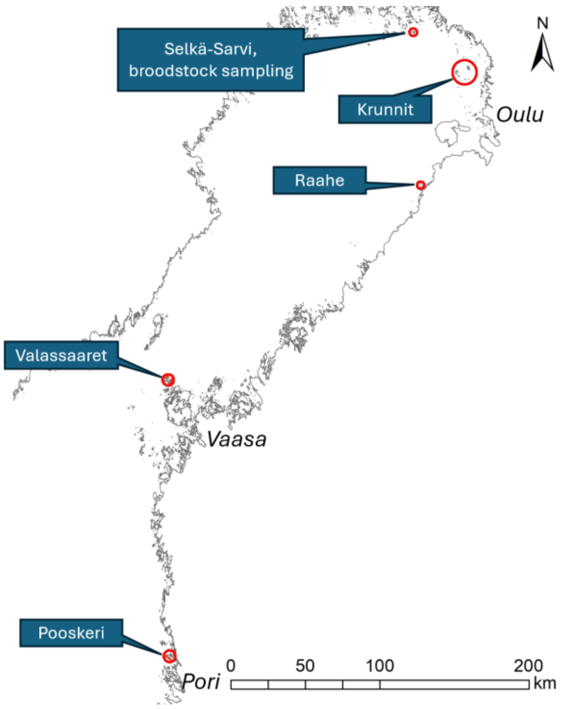

Figure 1. Key areas for sea-spawning grayling stocking and monitoring, and the broodstock capture site.

2. Broodstock sampling

Within the C.8 project, broodstock of the sea-spawning grayling is maintained and renewed. The previous broodstock maintained at the Natural Resources Institute Finland (Luke) Keminmaa hatchery had been originally captured from the Krunnit archipelago off Ii during 2012–2013. As this broodstock required renewal, a new broodstock population was assembled from wild-caught spawners. Broodfish were captured within the framework of the project during 2022–2023 from the Selkä-Sarvi area in the Bothnian Bay National Park. Ice fishing has been shown to be an effective method for capturing sea-spawning grayling in late winter and early spring. Due to thick ice cover, the use of gillnets is difficult and labor-intensive, and fish are typically located in very shallow water among stones. Spawning of sea-spawning grayling takes place immediately after ice break-up, and in the Bothnian Bay access to open coastal spawning grounds is often limited by drifting ice. Ice fishing was therefore selected because the timing requirements of capture are less restrictive than for gillnetting. In addition, handling and translocation of fish is more feasible during winter and cold-water conditions than during warmer periods.

Broodstock capture was carried out as a collaboration between the Natural Resources Institute Finland and Metsähallitus Wilderness Services. In 2022, ice fishing was conducted between 26 and 28 April, totaling 81 hours of effort and yielding 39 grayling individuals. In 2023, fishing took place between 24 and 25 May, with a total effort of 164 hours and a catch of 69 grayling individuals (Figure 2). A supplementary broodstock capture was planned for 2025; however, due to poor ice conditions, the ice-fishing campaign was cancelled and postponed to spring 2026. Fertilized eggs obtained from the first captured broodfish were used to establish a new broodstock population, which is expected to begin producing eggs from approximately 2027 onward.

Figure 2. Broodstock of sea-spawning grayling was renewed by ice fishing conducted in the Selkä-Sarvi area of the Bothnian Bay National Park.

Age, length, and weight were determined for the smaller grayling individuals captured by ice fishing at Selkä-Sarvi in 2022. The mean length of two-year-old fish was 237 mm (n = 16, min. 221 mm, max. 276 mm), while the mean length of three-year-old fish was 278 mm (n = 9, min. 240 mm, max. 336 mm). In addition, DNA analyses were conducted on broodfish captured in 2022 to support the establishment of the broodstock and to assess relatedness among individuals. Based on genetic analyses, these fish were found to belong to the same population as the previously cultured grayling originating from the Krunnit area, despite the shortest geographic distance between the areas being approximately 40 km.

A total of 39 grayling samples were included in the genetic dataset. Prior to analysis, one sample (no. 15) was excluded due to more than 20% missing genotypes. As reference material, samples collected during broodstock capture around the island of Ulkokrunni in 2012–2013 and analysed in 2013 (N = 29) were used, together with additional grayling samples previously analysed at the Luke Jokioinen Genomics Laboratory (Table 1; Koljonen et al. 2022).

Table 1. Reference samples used in the DNA analyses of broodstock grayling.

Sample	Year	Sample count
Selkä-Sarvi broodstock	2022	39
Krunnit broodstock	2013	29
Etelä-Saimaa, inland lake	2017–2019	29
Lieksanjoki, inland river	1999	23
Puruvesi, inland lake	2018	13
Broodstock lake, Puruvesi	2020	19
Broodstock river, Rautalamminreitti	2020	17

The samples collected in 2022 belonged to the same population as the Krunnit broodstock samples collected in 2013 (Figure 3A). Both sample sets were clearly distinct from freshwater grayling populations. When comparing only the 2013 Krunnit samples and the 2022 sea-spawning grayling samples, the two sample groups form separate clusters; however, some individual samples are positioned close to each other (Figure 3B).

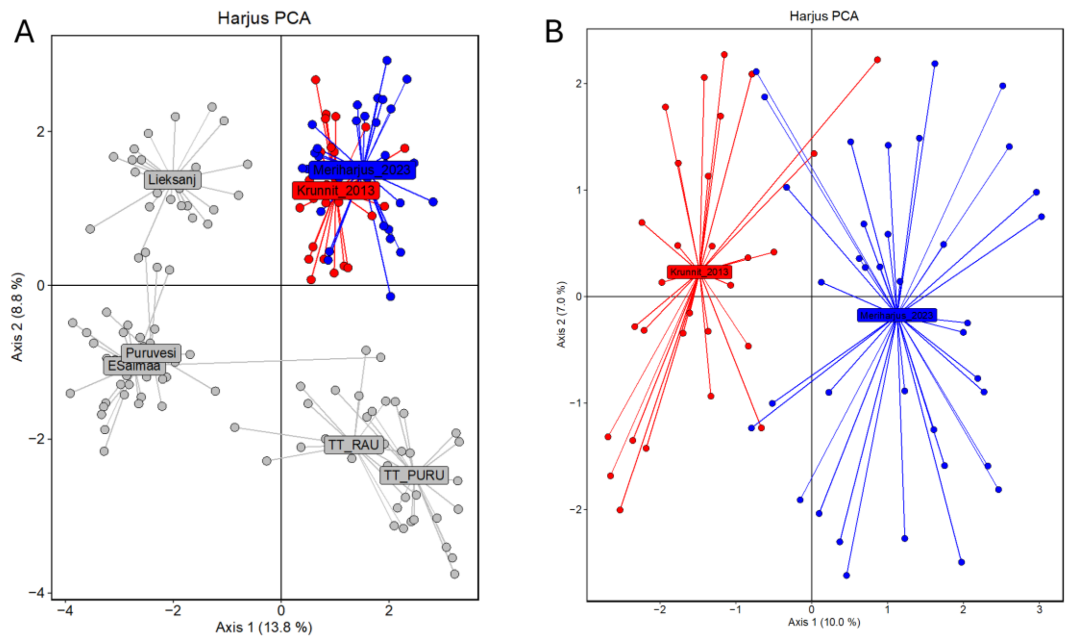

Figure 3A and B. Results of the principal component analysis (PCA). (A) All samples included in the analysis. (B) Broodstock samples from Krunnit collected in 2013 and samples from Selkä-Sarvi collected in 2022.

Consequently, in supportive stocking of sea-spawning grayling in the northern Bothnian Bay, offspring originating from broodfish captured both within the Bothnian Bay National Park and from the Krunnit area can be used. Broodfish are stripped, and their eggs are incubated at the Natural Resources Institute Finland (Luke) Keminmaa quarantine hatchery, while the rearing of stocking juveniles is carried out at the Keminmaa and Ohtaoja hatchery facilities operated by Luke.

3. Stockings

Sea-spawning grayling juveniles have been stocked both as newly hatched larvae and as one-year-old juveniles. Stocking was carried out at the selected key areas. Newly hatched grayling larvae were transported by road from the Keminmaa hatchery in oxygenated transport bags. The transport time to Valassaaret is approximately eight hours and to the Pooskeri archipelago approximately ten hours. The newly hatched larvae were found to survive road transport; however, the final stage of transport by boat following the long road journey proved challenging. During boat transport, vibration and rolling caused by wave action are unavoidable and may compromise larval condition.

All stocked newly hatched larvae were marked with alizarin dye. The marking was carried out at the Keminmaa hatchery during packing of the larvae. The marking procedure and dosage had previously been shown to be effective in stocking of newly hatched larvae (Veneranta et al. 2025); however, in this case the exposure duration was considerably longer, covering the entire transport period. Alizarin dye leaves a permanent mark in the fish otolith, enabling later verification of hatchery origin when individuals are sampled.

During stocking, newly hatched larvae were observed to experience very high mortality. The proportion of dead larvae was difficult to quantify precisely, but based on a rough estimate only about one tenth of the stocked individuals survived until release and dispersed normally after stocking. The same pattern was observed in both the Valassaaret and Pooskeri stockings in 2022 and 2023. In 2023, larvae that had been started on feed shortly after hatching were also tested for stocking, but no clear reduction in mortality was observed. In some cases, larvae were transported as eggs, which hatched during transit. Based on these observations of poor survival, stocking with newly hatched larvae was discontinued in 2025 and cannot be recommended when transport durations extend over several hours.

Grayling juveniles stocked at one year of age weighed approximately 4–6 g at the time of stocking, and their adipose fins were clipped prior to release. For stocking, juveniles were transported from Keminmaa to the nearest harbor in an approximately 1 m³ oxygenated water tank, after which they were dip-netted into an oxygenated tank of approximately 400 L volume on board the boat for transfer to the release sites. Oxygenation of the tanks was provided using oxygen cylinders and aerators. During stocking, one-year-old juveniles were released from the onboard holding tank using dip nets close to the shoreline. Mortality of juveniles was observed to be very low during stocking, with the exception of the 2024 stocking off Pooskeri, where oxygenation in the holding tank weakened during boat transport and the grayling showed signs of oxygen deficiency. No immediate mortality was nevertheless observed at the time of release (Figure 4).

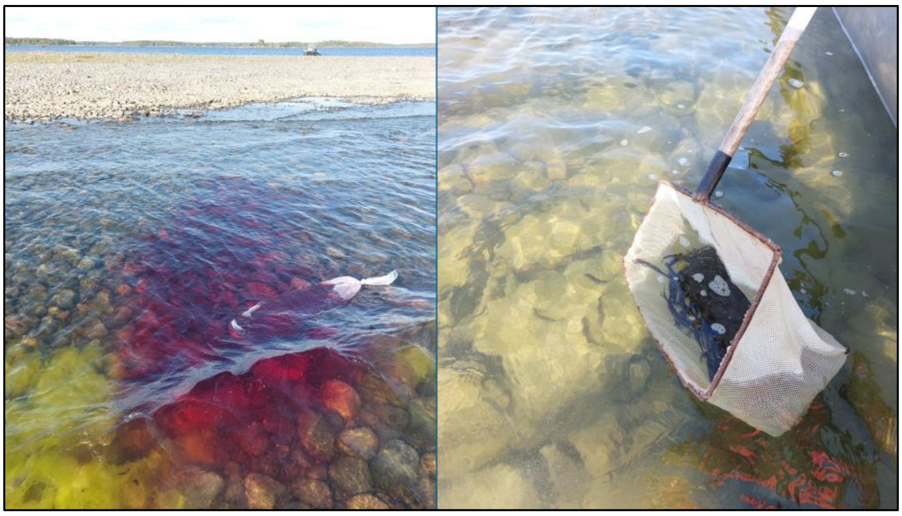

Figure 4. *Newly hatched sea-spawning grayling larvae were transported to the stocking sites in oxygenated bags, with alizarin dye added to the water and visible as a red coloration. The larvae were released into nearshore waters. One-year-old, adipose-fin-clipped juveniles were released using dip nets from an onboard fish transport tank.*

Stocking activities at the Krunnit, Valassaaret, and Pooskeri sites were carried out entirely by the Natural Resources Institute Finland (Luke). For the Raahe area, the final stage of fish transport was conducted by the Raahe Fishermen's Association. The annual number of juveniles stocked at each key area varied between 2,850 and 4,850 individuals (Table 2). Within each area except Krunnit, the stocked juveniles were distributed among three separate release sites.

Table 2. *Numbers of sea-spawning grayling eggs, newly hatched larvae, and one-year-old juveniles stocked in coastal areas during 2023–2025.*

Year and area	One year old	Larvae	Eggs at hatching	Sum
2023	**14200**	**400000**	**200000**	**614200**
Ii, Krunnit	3000			3000
Merikarvia, Pooskeri	3500	100000	100000	203500
Raahe, outer archipelago	2850	200000		202850
Mustasaari, Valassaaret	4850	100000	100000	204850
2024	**15450**	**130000**		**145450**
Ii, Krunnit	3950			3950
Merikarvia, Pooskeri	4000	0	0	4000
Raahe, outer archipelago	4000	0	0	4000
Mustasaari, Valassaaret	3500	130000	0	133500
2025	**11100**			**11100**
Merikarvia, Pooskeri	4000	0	0	4000
Raahe, outer archipelago	3100	0	0	3100
Mustasaari, Valassaaret	4000	0	0	4000
Total sum	**40750**	**530000**	**200000**	**770750**

4. Monitoring of stocking success

The occurrence of stocked sea-spawning grayling was surveyed using experimental fishing in the vicinity of the stocking sites during 2024–2025, with the exception of the Raahe area. The purpose of the 2024 pilot survey was to assess the applicability of the methods and the time required for fieldwork. Experimental fishing was conducted using light spinning lures (spinner size 8–10), fly fishing (hook sizes 12–16), and a grayling board (harrilauta) equipped with 5–7 flies (hook sizes 12–16). The primary target was small grayling of approximately 20 cm in length.

Rod-and-line fishing for grayling has been shown to be more effective than gillnetting, for example in test fisheries conducted by the County Administrative Board of Norrbotten, Sweden (personal communication, Andreas Bromann, CAB Norrbotten). In addition, grayling captured by rod fishing can be released in good condition, whereas the risk of injury is higher in gillnet fisheries (Veneranta et al. 2018). All grayling captured during the experimental fishing were measured and examined for the presence of an adipose-fin clip. For other fish species, only the number of individuals was recorded.

During fishing, active fishing time was recorded, defined as the time during which rod gear was actively used at a fishing site. The location of each site was recorded using a handheld GPS device (Garmin GPSMap 76 CSx) or the boat's GPS system (Simrad NSS9 EVO3). The boat was equipped with a GPS-guided electric bow motor, which allowed movement between fishing spots along the same shoreline or anchoring the boat in position. Fishing effort was targeted according to a predefined plan, focusing particularly on gravel–stone substrates along island edges, headlands, and shallow rocky areas extending above the water surface, in predominantly shallow waters of approximately 0.3–2 m depth.

Fishing was conducted between July and September, mainly in August. In 2024, fishing effort remained limited, with a total of 6.1 hours using the grayling board and 1.0 hour of fly fishing at Merikarvia and Valassaaret. The catch consisted of a single bleak (Alburnus alburnus). A more extensive survey at Valassaaret was planned in cooperation with Metsähallitus, but strong winds during the scheduled period resulted in cancellation of the fishing effort.

In 2025, active fishing time amounted to 27.1 hours at Krunnit, 16.0 hours at Valassaaret, and 16.8 hours at the Pooskeri area in Merikarvia. Three fishers participated at Krunnit, while one to two fishers were involved at Valassaaret and Pooskeri depending on the day. Fly fishing accounted for 11 hours of effort, while the grayling board was used for only 45 minutes; thus, most of the fishing effort consisted of spinner fishing. Lure fishing was considered the most efficient method, as spinners allow larger areas to be covered more rapidly than fly fishing.

No formal comparison among gear types was conducted at Krunnit; however, the majority of grayling (79%) were captured using spinner lures. No fish were caught using the grayling board, despite a total of six hours of use in 2024. The grayling board was not tested at Krunnit, making assessment of its fishing efficiency uncertain. Some fishing was conducted from the shoreline at Krunnit and Valassaaret, but most effort was boat-based to improve efficiency (Figure 5).

Figure 5. Experimental fishing for sea-spawning grayling at Ulko-Krunni in August 2025.

In the experimental fishing surveys, grayling were captured only in the Krunnit area, with a total catch of 29 individuals, corresponding to a catch per unit effort of approximately 1.1 individuals per hour. No grayling were captured at Valassaaret or in the Pooskeri archipelago, and no confirmed observations of grayling were made during fishing at these sites. Across all areas, bycatch species consisted mainly of ide (Leuciscus idus) and perch (Perca fluviatilis); in addition, occasional whitefish (Coregonus spp.) were captured in the Krunnit area. Bycatch was particularly abundant at Valassaaret, especially ide and perch, whereas catches at Merikarvia consisted mainly of ide.

Based on visual assessment during fishing, the size range of ide was approximately 0.5–1.5 kg, while perch weighed approximately 0.1–0.4 kg. Notably, fishing was conducted in outer archipelago areas, and bycatch species were captured from habitats typically associated with grayling occurrence. In particular, ide were commonly observed in flowing water at straits or along rocky shorelines in less than 0.5 m of water within the wave-exposed zone (Table 3).

Table 3. Catches at different key areas expressed as number of individuals and catch per unit effort (cpue, individuals per fishing hour).

Area	**Perch ind. (cpue)**	**Grayling ind. (cpue)**	**Pike ind. (cpue)**	**Whitefish ind. (cpue)**	**Ide ind. (cpue)**
Krunnit	29 (1,1)	29 (1,1)	0,5	3 (0,1)	8 (0,3)
Valassaaret	16 (1,0)	0	2 (0,1)	0	23 (1,4)
Merikarvia Pooskeri	1 (0,1)	0	0	0	16 (1,0)

Of the grayling captured, seven individuals were adipose-fin clipped, corresponding to approximately 24% of the catch. The mean length of captured grayling was 371 mm (min. 270 mm, max. 470 mm; Figure 5). The lengths of adipose-fin-clipped grayling ranged from 305 to 350 mm, indicating that these individuals most likely originated from the stocking carried out at Krunnit in 2023. Prior to this, one-year-old grayling juveniles had last been stocked in the Krunnit area in 2015. In 2019 and 2022, newly hatched larvae were stocked in the Krunnit area; at the time of fishing, these cohorts would have been approximately six and three years old, respectively.

Compared with the ice-fishing samples collected at Selkä-Sarvi, the adipose-fin-clipped sea-spawning grayling from Krunnit exhibited faster growth and corresponded in size approximately to the upper 10th percentile of the length distribution of three-year-old grayling from Selkä-Sarvi. Based on age and growth data reported by Enholm (1937) for grayling in the Quark area, two-year-old individuals are approximately 150 mm in length, three-year-olds approximately 23 cm, and four-year-olds approximately 31 cm. It is therefore plausible that grayling currently exhibit faster growth rates than those reported nearly 90 years ago by Enholm.

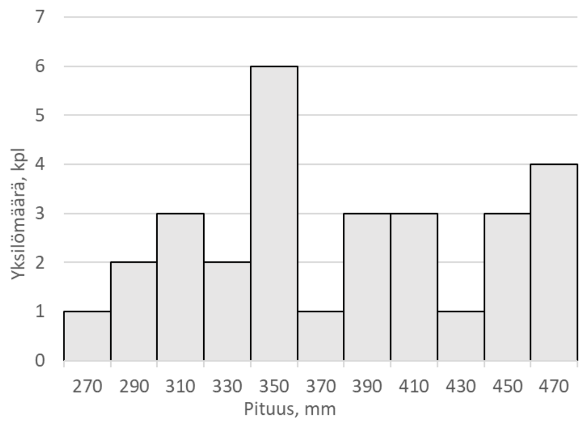

Figure 6. Lengths of sea-spawning grayling captured during experimental fishing at Krunnit.

4. Next steps

Stocking activities cannot be continued in 2026, as the hatchery facilities of the Natural Resources Institute Finland (Luke) currently lack a broodstock population producing eggs. A broodstock of Krunnit origin maintained at the Taivalkoski aquaculture facility produces only a limited quantity of eggs, which will most likely be used for egg stocking in connection with spawning habitat restoration carried out in the Valassaaret area. Renewal of broodstock is planned through capture efforts in spring 2026, provided that ice conditions allow grayling capture by ice fishing. Luke's hatchery facilities have experienced problems with water mould infections, resulting in the culling of part of the reared juvenile grayling and broodfish.

Based on the experimental fishing results, stocked juveniles have survived in the Krunnit area and now constitute part of the local grayling population. As grayling captured during experimental fishing were released, their age could not be verified, and potential origin from earlier stockings of newly hatched larvae could not be confirmed. Fishing methods were comparable across all key areas; therefore, the absence of sea-spawning grayling at Valassaaret and Merikarviamay indicate unsuccessful stockings at these sites. Experience from Krunnit suggests that grayling are readily captured by rod-and-line methods when present in an area. However, no grayling smaller than 270 mm were captured during experimental fishing at Krunnit, indicating that some individuals may still be below the size threshold for capture by active fishing gear. These individuals are likely to reach sizes vulnerable to perch or whitefish gillnets only at approximately 4–6 years of age, implying that an appropriate monitoring period for the stockings extends through 2026–2027. In 2026, grayling originating from the 2023 stockings of newly hatched larvae will also be three years old and thus potentially of catchable size, if they have survived.

It is therefore justified to repeat experimental fishing in the Merikarvia and Valassaaret areas in August 2026 to obtain a more reliable assessment of the apparent absence of stocked juveniles. Experimental fishing in 2026 should also be extended to the Raahe area. If adipose-fin-clipped grayling are detected in Raahe but remain absent from Merikarvia and Valassaaret, this would support the interpretation that current conditions for grayling survival in the Bothnian Bay are more favorable than in the more southern marine areas. Future targeting of stocking efforts should be planned accordingly.

A notable observation in the experimental fishing catches was the high proportion of perch and ide. Both species are potential predators of grayling juveniles at age 0+ or 1+. Ide have been documented to feed on whitefish juveniles (Oulu 1970; Lappalainen et al. 2002; Järvalt et al. 2003). In addition to the ide captured, large shoals of ide were observed visually during the surveys. Unfortunately, no historical data are available on ide occurrence in outer archipelago areas, making it impossible to determine whether their presence represents a normal distribution pattern or a more recent expansion potentially linked to eutrophication and long-term warming of coastal waters.

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