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Ahti Mutenia (peled),
Erno Salonen (vendace and land-locked salmon with native large whitefish)

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Contents

Abstract

Lake Inari is a large, subarctic, oligotrophic and regulated lake. The fish community of the lake is composed of 10 indigenous species, mostly salmonids. Three new species – lake trout (*Salvelinus namaycush*), land-locked salmon (*Salmo salar* m. *sebago*) and vendace (*Coregonus albula*) – were introduced into the watershed in the 1950s and 1960s. Vendace established a self-reproducing population in the lake that expanded dramatically, creating a boom in fisheries and new fishing technology in the area. The stock collapsed in the early 1990s but has rebounded in the 2000s. Lake trout and land-locked salmon have not established self-reproducing populations; the catches of these species are based on stocking.

Two large reservoirs, Lokka and Porttipahta, were created in the region in the late 1960s for the needs of hydroelectric power plants. The fish community in the reservoirs is composed of 14 native species. An alien species, peled (*Coregonus peled*), was introduced in 1972 to utilise the zooplankton production of the new, extensive open water areas. Peled established a self-reproducing population in the reservoirs in the 1980s and expanded rapidly, creating a fisheries boom and stimulating new fishing technology around 1990. Its recruitment and stock subsequently declined dramatically, however, causing problems for fisheries and management. Today, the low peled stock is composed of both a continuously stocked and occasionally naturally reproducing fish population.

The four alien species – lake trout, land-locked salmon, vendace and peled – have not hybridised with native fishes or had any serious ecological impacts on native fish communities. They comprise an economically important, additional catch in both Lake Inari and the reservoirs.

Key words: alien, introduction, Lake Inari, reservoirs

Salonen, E . & Mutenia, A. Alien fish species in northernmost Finland. – Riista- ja kalatalous. Tutkimuksia 2. 16 s.

Tiivistelmä

Subarktinen Inarijärvi on oligotrofinen, säännöstelty suurjärvi. Sen kalayhteisö koostuu 10 alkuperäisestä kalalajista, jotka ovat pääosin lohensukuisia. Järven vesistöalueelle istutettiin 1950-1960-luvuilta lähtien kolme uutta tulokaslajia: harmaanieriä (*Salvelinus namaycush*), järvilohi (*Salmo salar* m. *sebago*) ja muikku (*Coregonus albula*). Muikku muodosti luontaisesti lisääntyvän kannan, joka kasvoi hyvin nopeasti Inarijärvessä. Muikun ansiosta otettiin käyttöön uutta ammattikalastustekniikkaa, ja kalastus ja saalis kasvoivat nopeasti suuriksi. Muikkukanta romahti 1990-luvun alussa, mutta 2000-luvulla kanta alkoi jälleen kasvaa. Harmaanieriä ja järvilohi sen sijaan eivät ole Inarijärvessä muodostaneet luontaisesti lisääntyviä kantoja. Niiden saaliit ovat perustuneet istutuksiin.

Lokka ja Porttipahta, kaksi suurta tekojärveä, padottiin vesivoimatalouden varastoaltaiksi 1960-luvun lopulla. Niiden kalayhteisö muodostui 14 paikallisesta lajista. Tulokaslaji peledsiikaa *(Coregonus peled)* istutettiin vuodesta 1972 alkaen tekojärviin hyödyntämään niiden laajojen selkävesien eläinplanktontuotantoa. Peledsiika alkoi lisääntyä luontaisesti tekojärvissä 1980-luvulla. Uutta ammattikalastustekniikkaa otettiin käyttöön, ja kalastus ja saalis kasvoivat nopeasti huippuunsa 1990-luvun alussa. Sittemmin peledsiian rekrytointi ja kannan koko romahtivat, mikä aiheutti ongelmia kalastukselle ja kalakantojen hoidolle. Nykyään pienentynyt peledsiikakanta koostuu sekä vuosittain istutetusta että satunnaisesti luontaisesti lisääntyvästä kannan osasta.

Tulokaslajit eivät ole risteytyneet tutkimusalueiden alkuperäisten kalalajien kanssa eivätkä ne ole aiheuttaneet vakavia ekologisia seurauksia paikallisissa kalayhteisöissä. Tulokaslajit tuottavat taloudellisesti merkittävän lisäosan saaliissa sekä Inarijärvellä että tekojärvillä.

Asiasanat: tulokaslajit, istutukset, Inarijärvi, tekojärvet

Salonen, E . & Mutenia, A. Tulokaskalalajit pohjoisimman Suomen kalataloudessa – Riista- ja kalatalous. Tutkimuksia 2. 16 s.

Abstrakt

Den subarktiska sjön Enare träsk är en stor, oligotrof, reglerad sjö. Fisksamhället består här av 10 ursprungliga arter, huvudsakligen laxsläktingar. I sjöns vattensystem har man med början under 1950- och 1960- talen satt ut tre nya fiskarter: kanadaröding (*Salvelinus namaycush*), insjölax (*Salmo salar* m. *sebago*) och siklöja (*Coregonus albula*). Siklöjan bildade i Enare träsk ett naturligt reproducerande bestånd, som ökade mycket snabbt. Tack vare siklöjan tog yrkesfisket i bruk ny fisketeknik och fisket växte snabbt i omfattning liksom också fångsterna. Beståndet av siklöja kraschade i början av 1990-talet, men beståndet började växa till på nytt på 2000-talet. Kanadarödingen och insjölaxen har däremot inte åstadkommit reproducerande bestånd i Enare träsk. Fångsterna har i det fallet baserats på utsättningar.

Lokka och Porttipahta, två stora konstgjorda sjöar, dämdes i slutet av 1960-talet upp som vattenreservoarer för kraftindustrin. Fisksamhället i bassängerna bestod av 14 lokala arter. En främmande art, peledsiken *(Coregonus peled),* sattes med början år 1972 ut i bassängerna, för att dra nytta av produktionen av djurplankton i bassängernas stora öppna fjärdar. Peledsiken började föröka sig naturligt i krafverksbassängerna på 1980-talet. Ny teknik togs i bruk inom yrkesfisket och fisket och fångsterna ökade snabbt och nådde sin topp i början av 1990-talet. Därefter kraschade peledsikens nyrekrytering och beståndets storlek, vilket förorsakade problem för fisket och fiskevården. Numera består det reducerade peledsikbeståndet både av fiskar, som årligen sätts ut och fiskar som sporadiskt reproducerar sig.

De främmande arterna har inte korsat sig med de ursprungliga fiskarterna och har heller inte förorsakat allvarliga ekologiska effekter i det lokala fisksamhället. De främmande arterna producerar ekonomiskt sett en betydande andel av fångsterna i både Enare träsk och kraftverksbassängerna.

Faktaord: främmande arter, utsättningar, Enare träsk, kraftverksbassänger

Salonen, E . & Mutenia, A. Främmande fiskarter i nordligaste Finland. – Riista- ja kalatalous. Tutkimuksia 2. 16 s.

1. Introduction

Alien fish species are introduced for a variety of reasons, including aquaculture, sport fisheries and improvement of wild stocks, the ornamental trade and biological control. During the 1920s and 1930s, a large number of alien fish species were brought into European fresh waters for general fishery management purposes. The next intensive period was the 1960s and 1970s, the period which saw the introduction of many alien fish species in Finland (Lehtonen 2002).

In freshwater communities, there are numerous examples of negative impacts of the introduction of new fish species (Moyle and Light 1996). Over the last two centuries, the language used to describe biological invasions also has given rise to a diversity of terms, which are often applied inaccurately (Falk-Petersen *et al.* 2006).

Lake Inari, which is regulated, and the two reservoirs Lokka and Porttipahta are important commercial and recreational fishing waters in the northernmost part of Finland. Three alien fish species – vendace (*Coregonus albula*), land-locked salmon *(Salmo salar* m. *sebago)* and lake trout *(Salvelinus namaycush)* – have been introduced into the Lake Inari area for fishing purposes over the last 50 years. In addition to these, one densely rakered whitefish (*Coregonus lavaretus*) form was introduced on an experimental basis from 1976 to 1989. One alien, peled *(Coregonus peled),* was introduced in the reservoirs in 1972.

From Lake Inari, vendace has spread downstream into the Pasvik watercourse, Norway and Russia (first observation 1989) (Fig.1); in Norway in particular, it is considered an unwanted invasive species (Amundsen *et al.* 1999). Since the invasion, vendace has caused negative effects on zooplankton and native whitefish morphs in the Pasvik river system (Bøhn and Amundsen 2004). Peled has also migrated a distance of at least 100 km downstream from the Porttipahta reservoir into the Kemijoki watershed. No negative effects of the invasion have been documented (Huttula and Autti 2006).

The purpose of introducing these new, alien species differs considerably in our two study areas. This is the first case study in which the background, establishment, sustainable use and impacts of these new alien resources in both areas – Lake Inari and the reservoirs – are explored together.

2. Study area and fish communities

Lake Inari (Fig. 1) is a subarctic oligotrophic lake that has been regulated (max. range 2.36 m) since the 1940s. The lake flows into the Arctic Ocean via the River Pasvik. The surface area of the lake is 1 102 km^2 (Marttunen *et al.* 1997, Salonen 1998). The fish community has 10 indigenous fish species, most of which are salmonids.

Lokka, the largest reservoir in the European Union, and Porttipahta were created around 1970 for hydroelectric purposes in the Kemijoki river system, which flows to the Baltic Sea. The boreal reservoirs are regulated (mean range 2.5–3 m) and characterised as meso- to eutrophic. Their maximum combined area is 630 km^2 (Mutenia 1985, Virtanen et.al. 1993, Sutela *et al.* 2002) (Fig. 1).

The fish community of the reservoirs is quite different from that of the adjacent Lake Inari. Many cyprinid species are present in the reservoirs, whereas they are lacking in Lake Inari, with the exception of the minnow (*Phoxinus phoxinus*). The fish community of the reservoirs is based on naturally occurring fish species in the area. There are 14 indigenous fish species in the reservoirs (Sundbäck 1977a,b) and only one alien species, peled.

Fig. 1. Location of Lake Inari and Lake Alajärvi in the Pasvik watercourse, Lokka and Porttipahta reservoirs and the two founder lakes of the vendace introduced in the Kemijoki watercourse.

3. Statistics of stocking, fisheries and catches

We collected statistics on stocking, fisheries and catches in connection with the obligatory monitoring programme of Lake Inari and its tributaries ordered by a Finnish court in 1975. The fisheries and catch data were gathered from the annual records that commercial trawl and trap net fisheries must keep and from yearly surveys of all groups of fishermen (Kaatra and Simola 1985, Mutenia and Salonen 1994, Salonen and Mutenia 2004).

In the case of the reservoirs, stocking data were collected in connection with the monitoring studies by Finnish Game and Fisheries Research Institute. The fisheries and catch data were gathered from the annual records required of commercial trawl and trap net fisheries, surveys of subsistence fishermen and the statistics kept by local fish buyers (Mutenia 1995, Salonen and Mutenia 2004).

4. Introduction and goals

Vendace (*Coregonus albula*) originating from the Kemijoki watershed, in particular Lake Kelujärvi (Fig. 1), escaped from an Inari fish farm into the Lake Inari in 1956. Vendace from Lake Sinettäjärvi also entered the lake from nearby Lake Alajärvi (Fig. 1), where the species was introduced between 1964 and 1966. The original goal of introducing a vendace population into Lake Alajärvi was to study the interactions between vendace and local dwarf whitefish (*Coregonus* sp.) stocks in small lakes (Mutenia and Salonen 1992).

Land-locked salmon *(Salmo salar* m. *sebago)*, originating from the Vuoksi watershed in Southern Finland, was introduced into the Lake Inari in 1971. Because of the damage to fish stocks caused by regulation of the lake, a Finnish court ordered large-scale obligatory stocking in 1975. Land-locked salmon was stipulated as a complementary species to native brown trout (*Salmo trutta* m. *lacustris*) (Kaatra and Simola 1985). A second, subsequent aim, of the stocking was to establish a self-reproducing population of land-locked salmon, generally endangered in Finland, in the Ivalojoki River, which flows into Lake Inari (Heinimaa, P., pers. comm.).

Lake trout *(Salvelinus namaycush)* was translocated from Lake Superior in North America to Finland in 1955 and has been stocked in Lake Inari since 1972. The 1975 court decision prescribing obligatory stocking stipulated that lake trout be stocked as a complementary species to native arctic char *(Salvelinus alpinus)*. High numbers of lake trout were stocked in the lake in the 1970s and 1980s (Mutenia *et al.*1982, Mutenia and Salonen 1994). The goal of introducing lake trout as well as land-locked salmon was to compensate for the decline in the catches of salmonids, i.e., native brown trout and arctic char, and to diversify an ecosystem that was quite species-poor and had been altered due to regulation of the lake.

Peled *(Coregonus peled)* was introduced into Finland from Lake Endyr in the River Ob watershed, Russia, in 1965 (Salonen and Mutenia 1992). The reservoirs Lokka and Porttipahta

are inhabited by fish species occurring naturally in the area, these including only one coregonid, a native, river-spawning whitefish *(Coregonus lavaretus)*. There are no native, purely planktivorous fish species. The planktivorous, lake-spawning peled have been stocked in the reservoirs since 1972 to utilise the zooplankton production (Mutenia 1985).

5. Establishment, development and consequences

5.1. Lake Inari

Vendace established a self-reproducing population in the lake through escapers coming from inflowing rivers. The species was observed in the lake for the first time in 1973 (Mutenia and Salonen 1992) and strong year classes have been born since 1983 (Salonen 1998). The vendace stock grew very rapidly and yielded a maximum catch of over 300 tonnes in 1989, which was over 50% of the total catch for the lake. This dramatic fisheries boom was followed by an abrupt collapse. However, a solid increase in the vendace population has been observed again in the 2000s (Salonen *et al.* 2007) (Fig. 2).

The large variation in the vendace stock seems to affect its native counterpart, the pelagic dwarf whitefish (‘reeska’ in Finnish). The most recent data from winter seine fisheries, collected in connection with long-term monitoring, show that both the amount and the proportion of vendace in the catches are increasing. Today, vendace comprises most of the winter seine

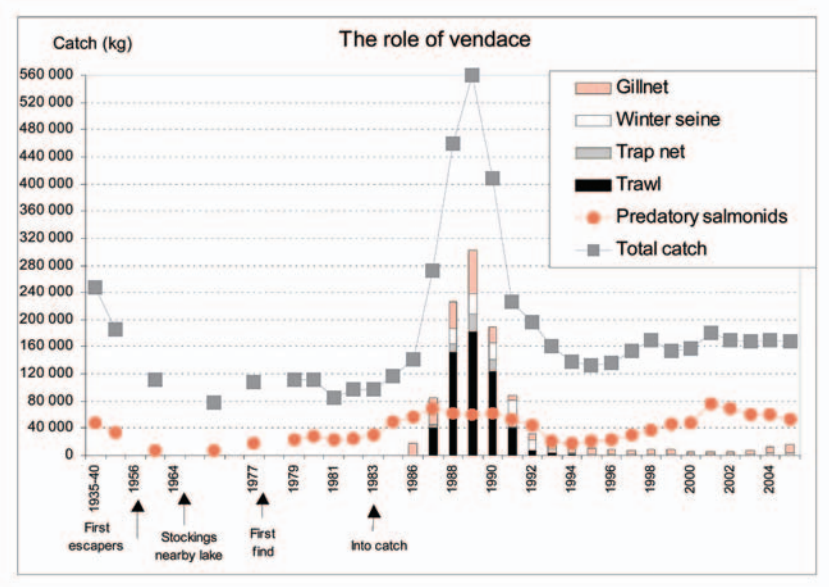

Fig. 2. Vendace catch by year compared with total and predatory salmonid catch for Lake Inari.

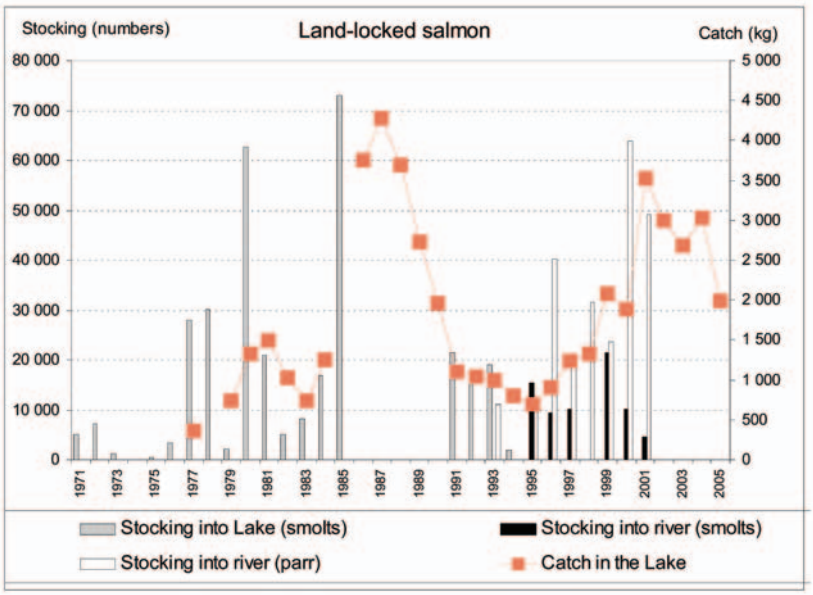

Fig. 3. Stocking and catch of land-locked salmon in the Lake Inari system in the period 1971–2005.

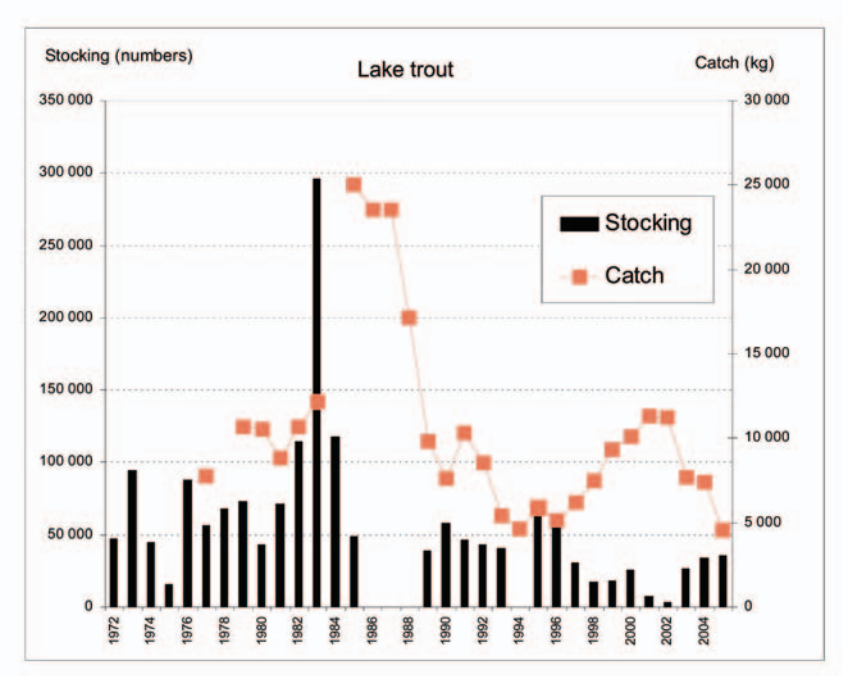

Fig. 4. Stocking (2–3-year-old fish) and the catch of lake trout in Lake Inari in the period 1972–2005.

catch, whereas the proportion of reeska continues to decrease. The opposite was the case during the abrupt decline in the vendace population in the 1990s (Salonen *et al.* 2007 and unpublished data).

The history of stocking of land-locked salmon in the area extends back over 30 years; the most recent stocking was made in the inflowing Ivalojoki in 2001. To date, the species has not established a self-reproducing population. The largest catches of land-locked salmon from Lake Inari, based on a stocked population, were 3 to 4 tonnes/year in the 1980s (Fig. 3).

After 35 years of stocking, lake trout has not established a self-reproducing population in Lake Inari either. Catches of the species are based on stocking, with the highest catch being around 25 tonnes/year in the mid-1980s (Fig. 4). Stocking of the species continues.

5.2. Lokka and Porttipahta reservoirs

At the end of the 1980s, peled began to reproduce naturally in the reservoirs at a high level. It was a new phenomenon in Finland, at least on a large scale (Salonen and Mutenia 1992). As a result of stocking and, thereafter, mainly natural reproduction, the catch of peled rose to as much as 300 tonnes in the years 1992–1994 (60% of the total catch for the reservoirs), but this was followed by a collapse. The recruitment and growth of peled have been extremely variable, whereas the stock of native whitefish is more stable. Peled has not hybridised with local whitefish, because of differences in spawning time and spawning grounds.

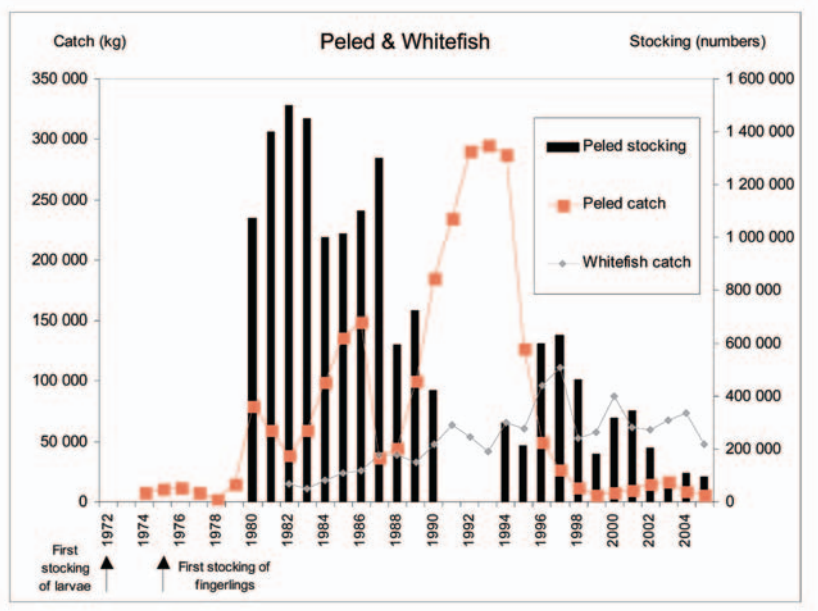

Fig. 5. Stocking of one-summer-old fingerlings and the catch of peled in the period 1972–2005 compared with the catch of native migratory whitefish since 1982 in the Lokka and Porttipahta reservoirs.

Because of diminished natural reproduction and reduced stocking, the peled catch has been low since 1996 (Fig. 5). However, increased stocking of one-summer-old fingerlings may increase and stabilise the peled catch in the 2000s (Mutenia *et al.* 2006).

5.3. Ecological impacts

Of the alien species, vendace and peled have established self-reproducing – albeit strongly fluctuating – populations in their new environment. In Lake Inari, vendace is also a new important prey fish alongside the natural dwarf whitefish, reeska, for predatory fishes, in particular the predatory salmonids that are stocked on a large scale. Downstream migration of vendace has caused some negative effects on native whitefish morphs in the lower part of the Pasvik watershed, Norway and Russia (Bøhn and Amundsen 2004). Interactions between vendace and native dwarf whitefish stock densities have also been detected recently in Lake Inari. In the Lokka reservoir, interspecific competition for zooplankton was detected between peled and roach *(Rutilus rutilus)* and some competition between peled and native whitefish (Niemitalo & Mutenia 1988, Tolonen & Mutenia 1998). Downstream migration of peled has not caused negative effects in the lower part of the Kemijoki watershed (Huttula and Autti 2006). Landlocked salmon and lake trout have not established self-reproducing populations; catches of these species have thus far been based on stocking. Lake trout is a more diversified predator than the native arctic char. With the introduction of these these three new species, 23% of the total number of fish species (13) in Lake Inari are now aliens. During the period studied, these four aliens have not hybridised with native species, with the exception of very few vendace/whitefish hybrids in Lake Inari.

5.4. Socio-economic impacts

Vendace and peled comprised a new target for fisheries and created new fishing technology in both study areas. Strong boom-and-bust development in the case of vendace and peled has brought many kinds of problems for commercial fisheries, e.g., difficulties in predicting and managing fisheries and overinvestment. Lake trout is a new, important catch for both commercial and local subsistence fishermen. Despite occasional criticism of the introduction alien, invasive species, public opinion in our study areas has been mainly positive; the exception is the case of lake trout, which divides opinions among fishermen to some extent.

After examining the ecological and socio-economic impacts, we conclude that the overall effects of these four aliens on fisheries were mainly positive, despite the very large variations in the vendace and peled populations in Lake Inari and the reservoirs.

Lake trout 5 kg in weight. Photo Erno Salonen

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