

The state of whitefish populations along the Estonian coast

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Summary. Analysis of gill raker counts (data since the 1950s) indicates that there are at least four different forms (species?) of whitefish in coastal waters of Estonia. Abundance of sparsely-rakered sea-spawning whitefish (mean number of gill rakers 22-23) which formed many local spawning populations, has declined substantially. Recent increase in abundance of whitefish in western Estonia and in the Gulf of Finland is due to another (probably hybrid) form, which gill raker count is similar to that in Finnish waters. Anadromous sparsely-rakered whitefish (23-24 gill rakers) spawns in the Pärnu River, and its stock has been partly recovered probably due to stocking. Anadromous higher gill raker count whitefish (> 30 gill rakers) inhabits the Gulf of Riga, and similar form occurs also in the Gulf of Finland. Fishery, eutrophication, stocking, as well as differences in life history pattern of forms) have probably influenced the abundance of whitefish and the proportion of different forms.

INTRODUCTION

Both sea-spawning and anadromous forms of whitefish were earlier widely distributed and abundant along the Estonian coast (Sörmus & Turovski, 2003). The annual commercial catch was the highest during 1951-55, 205 t in average (maximum 279 t in 1952). After that period, catches declined. Annual catch was 28-75 t in the 1970s, 7-24 t in the 1980s and 2-10 t between 1990-95 (Vetemaa, Eero & Järv, 2002). This decline was probably due to eutrophication of coastal waters and intensive fishery. However, during some recent years, abundance of whitefish has increased in the Gulf of Finland, and western and northwestern coastal areas of Saaremaa Island (Verliin, 2002; Eschbaum *et al.*, unpubl. data). Also commercial catches have slightly

increased, to 20-22 t in 1996-98, and >30 t in recent years (Vetemaa, Eero & Järv, 2002).

The taxonomic status of whitefish forms in the Estonian waters remains unknown. The aim of this investigation was to summarise available data on the distribution of different forms of whitefish in the Estonian waters.

MATERIAL AND METHODS

We analysed available data on gill raker counts (from the first left gill arch) of whitefish from the Estonian coastal waters collected between 1957 and 2002. Earlier data were mostly from commercial gill-net catches, sometimes from commercial seine catches in the spawning grounds, or experimental trawl catches in the Gulf of Riga. Recent data were collected during coastal fish monitoring in May-October 1999-2002 using gill nets of 17-60 mm mesh size, mostly in summer period, from different regions of the sea. Altogether over 2000 whitefish were analysed. Earlier data are available for the Gulf of Riga (Ruhnu Island, Kihnu and Manilaid Islands, Pärnu Bay, Häädemeeste, southern coast around Abruka and Allirahu Islands), western Saaremaa (bays of Kihelkonna and Kuusnõmme) and the Väinameri (Moonsund). The most of recent data (1998-2002) originate from the Gulf of Finland (Vaindloo Island, Käsmu Bay and Äksi Island, Paldiski and Pakri Islands, etc.), and western and northwestern coastal areas of Saaremaa Island (bays of Kuusnõmme, Uudepanga and Küdema) and the Gulf of Riga (Häädemeeste) (Fig. 1). Only a few specimens have recently been analysed in other areas of the Gulf of Riga and in the Väinameri.

RESULTS AND DISCUSSION

Gulf of Riga

There are three forms of whitefish in the Gulf of Riga, which can be distinguished by the numbers of gill rakers. These forms differ also by some other morphological features (Sõrmus & Turovski, 2003).

The typical (and still rather strong) population of the **form 1** (sparsely rakered sea-spawning whitefish) inhabits coastal waters of Ruhnu Island. This population has the lowest number of gill rakers within the form (15-28, mean 21.7 ± 2.08 SD, $n = 279$). This form also predominated in the southern coast of Saaremaa (around Abruksa and Allirahu Islands) (Fig. 2).

Form 2 is anadromous low gill-raker count whitefish, which spawns in the Pärnu River. This form has 19-28 gill-rakers, sample means are 24.0 ± 1.80 ($n = 171$) in Pärnu Bay and 24.7 ± 1.98 ($n = 93$) in Häädemeeste (close to the Latvian border).

After spawning whitefish leave the Pärnu River and disperse in the northeastern part of the Gulf of Riga. In Pärnu Bay mature specimens occur mainly in the period of spawning migration (late September, early October). The range of the growing area of juveniles as well as the range and directions of feeding migrations of adult whitefish are not known.

Abundance of this form became very low by the 1990s but has somewhat increased in recent years, probably due to stocking.

Low gill rakers count whitefish feeding to the west of Pärnu Bay, in the Kihnu-Sorgu-Manilaid area, has an intermediate number of gill rakers (23.3 ± 1.99 , $n = 407$) (Fig. 2). Probably both form 1 and 2 whitefish forage in this area.

Form 3 is a higher gill-raker count whitefish, which is probably anadromous, and spawns in the Latvian rivers (Sõrmus & Turovski, 2003). It has the highest gill raker

number among forms inhabiting the Estonian waters (28-42, means of three samples 33.4 ± 2.00 , $n = 128$, 33.5 ± 2.33 , $n = 171$, and 34.0 ± 2.35 , $n = 171$). This form is predominating in Häädemeeste but it is abundant also in Pärnu Bay and around Kihnu (Fig. 2). Rarely specimens of this form have been captured near southern coast of Saaremaa and around Ruhnu Island (Fig. 2).

Western and northwestern coast of Saaremaa Island

Western bays of Saaremaa Island (Kihelkonna and Kuusnõmme) were formerly important spawning grounds of the sparsely rakered sea-spawning whitefish (form 1). Gill rakers of 1019 whitefish were counted in October-December 1960-1971; the sample means varied between 22.04 and 22.93 (count limits 16 and 28). Only one specimen had more gill rakers (35). As revealed by tagging of spawning fish in the 1960s, feeding areas of Kihelkonna-Kuusnõmme population included Väinameri, and a few specimens were recaptured even in the Gulf of Finland.

Our recent samples from Kihelkonna Bay and bays of Uudepanga and Küdema from the same region include 127 specimens captured in July 1998-2002. Only 18 of these fish obviously belonged to the form 1 (gill raker count up to 25, mean 22.50 ± 2.90 SD). Most of feeding whitefish in this area belonged to another form (**form 4**) with up to 35 gill rakers (mean 29.80 ± 2.32 SD, $n = 109$).

Väinameri (Moonsund)

Local spawning populations of form 1 whitefish investigated in this area in the 1960s had 17-27, in average 22.7-23.2 gill rakers. Specimens captured in 2001-02 in the central part of the Väinameri had 20-26 gill rakers (mean 24.0 ± 1.85 SD, $n = 8$). However, two specimens captured in November 2000 near Vormsi Island (northern boarder of the Väinameri) with 32 and 34 gill-rakers obviously belong to another form.

Gulf of Finland

According to our data, form 4 predominates in the Gulf of Finland. Form 4 may be a hybrid of sparsely-rakered sea-spawning and higher-raker-count anadromous whitefish (Svårdson, 1957). Actually, the latter form may still occur in the Gulf of Finland and western coast of Saaremaa (modal number of gill rakers 32, Figure 3). Anadromous whitefish (rare nowadays) still ascends the Narva River and some other rivers in the Gulf of Finland. There were only a few specimens with <26 gill rakers which obviously belong to the form 1, most of them have been captured in Käsnu Bay. During spawning season, low gill raker count whitefish with running gametes were captured near Paldiski in autumn 2002.

The mean gill raker count of whitefish with > 25 gill rakers is from 28.7 ± 1.77 *SD* ($n = 10$) near Mohni Island to 30.0 ± 2.14 *SD* ($n = 30$) near Vaindloo Island, 29.6 ± 2.14 *SD* ($n = 194$) in average. Recent gill raker counts of whitefish from the Estonian waters of the Gulf of Finland and Saaremaa are similar to that in Finnish waters (Fig. 3). Whitefish collected from the northern coast of the Gulf of Finland in 1977-80 had 29.6 ± 2.24 *SD* ($n = 560$) gill rakers (Lehtonen, 1981).

Conclusion

Thus, there are at least four whitefish forms in the Estonian coastal waters. The most obvious changes during some recent decades are associated with sea-spawning sparsely-rakered whitefish, which abundance has decreased and several local spawning populations off the western coast of Saaremaa Island, in the Väinameri and in the Gulf of Finland are very weak or even lost. This form has been replaced, at least along the western and northwestern coasts of Saaremaa Island, by the form 4.

Rather abundant sea-spawning whitefish populations inhabit the Gulf of Bothnia and Quarken (Lehtonen, 1981). In the coastal zone of the Baltic Sea sparsely-rakered sea-spawning whitefish populations with a mean of 22-24 gill rakers (form 1) live also around the islands of Gotland and Öland. Along southern and southeastern coasts of the Baltic Sea they have been rare already in the first half of the 20th century, nowadays

their occurrence in that part of sea is doubtful (Sõrmus & Turovski, 2003). In the northern parts of the Baltic Sea the mean gill raker numbers of sea-spawning whitefish was are intermediate (26-29) already several decades ago, according to Svärdson (1957) as a result of introgression with the higher-raker-count anadromous form.

Possible reasons for changes in whitefish abundance and in the proportion of different forms in the Estonian waters are:

1. Heavy fishing pressure in the 1960s and 1970s.
2. Eutrophication of coastal waters.
3. Biological features. Fecundity of low gill raker count form (form 1) was lower than that of form 4 (Verliin, 2002). Also earlier data of Sõrmus (1976) confirm this conclusion. The diets of two forms overlapped in large scale. However, the stomach content of the form 4 whitefish consisted in average of bigger number of different taxons, which can be related to higher feeding selectivity of the form 1. Generally, the analysed stomachs of the form 4 whitefish contained more food (Verliin, 2002).
4. Uncontrolled stocking.

Further studies (including DNA analyses) are needed to reveal the taxonomic status of whitefish forms inhabiting the Estonian coastal waters.

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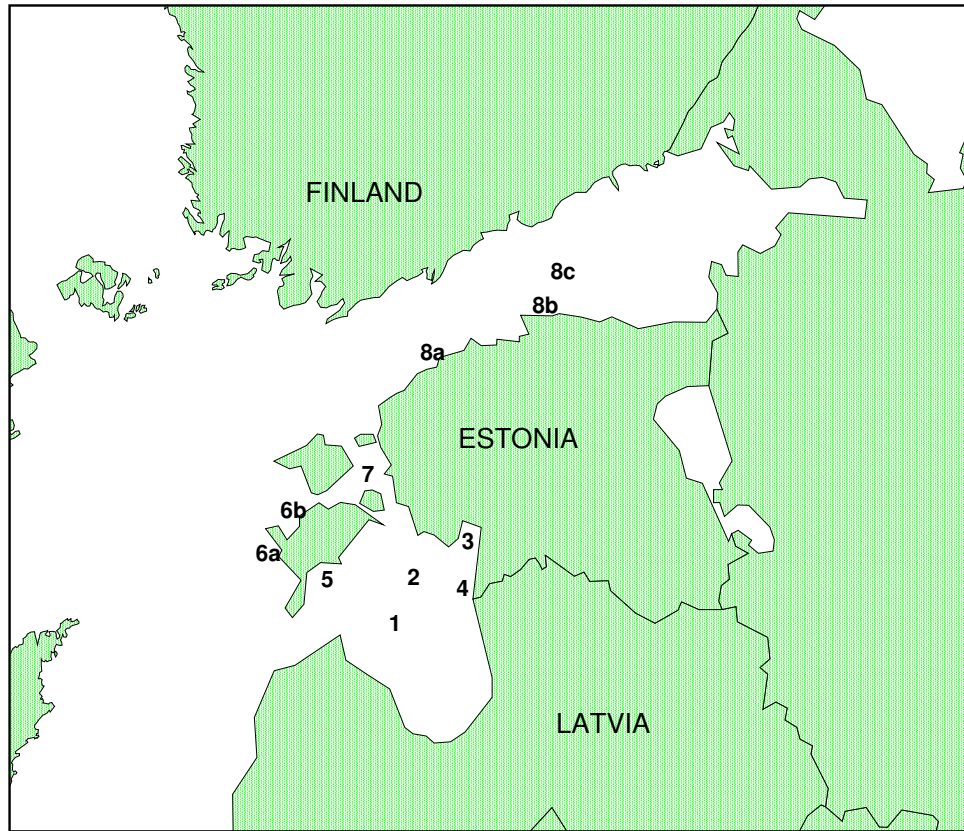


Figure 1. Main study areas. 1, Ruhnu Island. 2, Kihnu, Sorgu and Manilaid islands. 3, Pärnu Bay. 4, Häädemeeste. 5, Abruks and Allirahu islands. 6, bays of western and northwestern Saaremaa Island (6a, Kihelkonna and Kuusnõmme; 6b, Uudepanga Bay). 7, Väinameri. 8, Gulf of Finland (8a, Paldiski; 8b, Käsmu Bay and islands of Mohni, Äksi; 8c, Vaindloo Island).

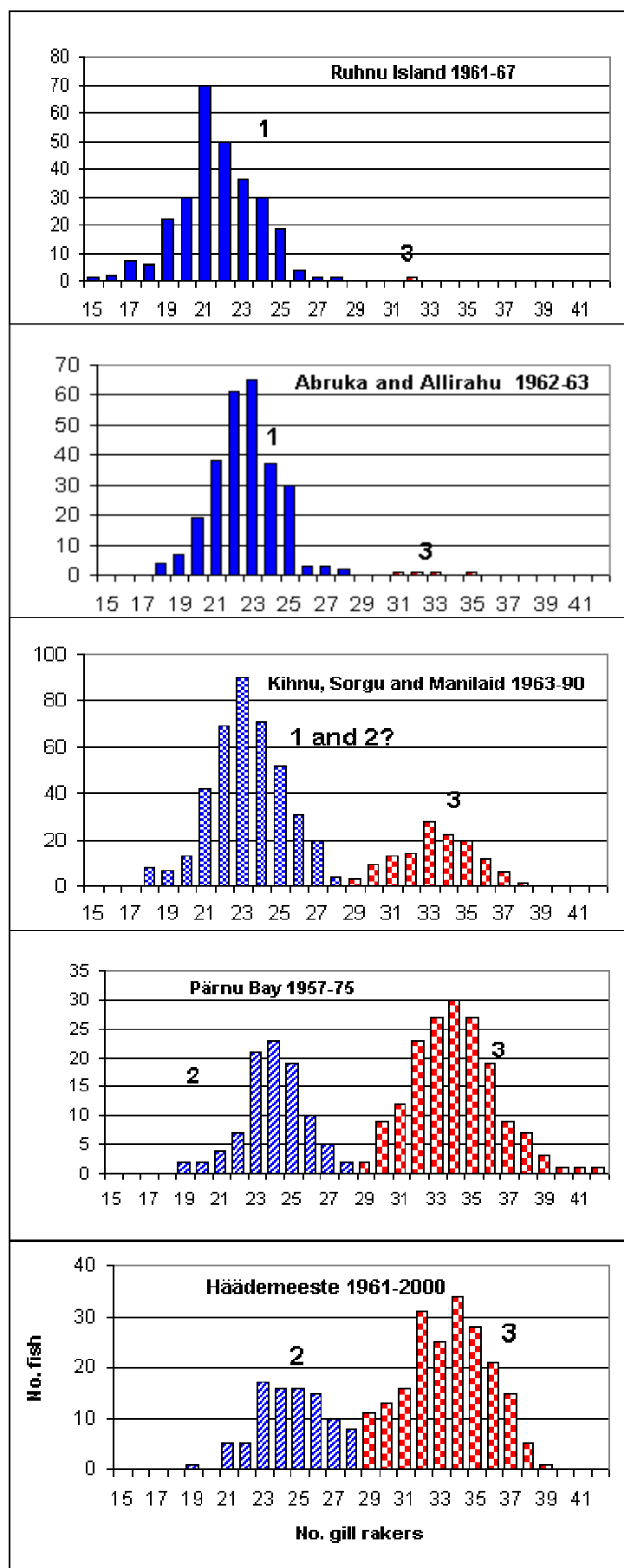


Fig. 2. Gill raker counts of whitefish in the Gulf of Riga. Numbers on figures – forms (see text)

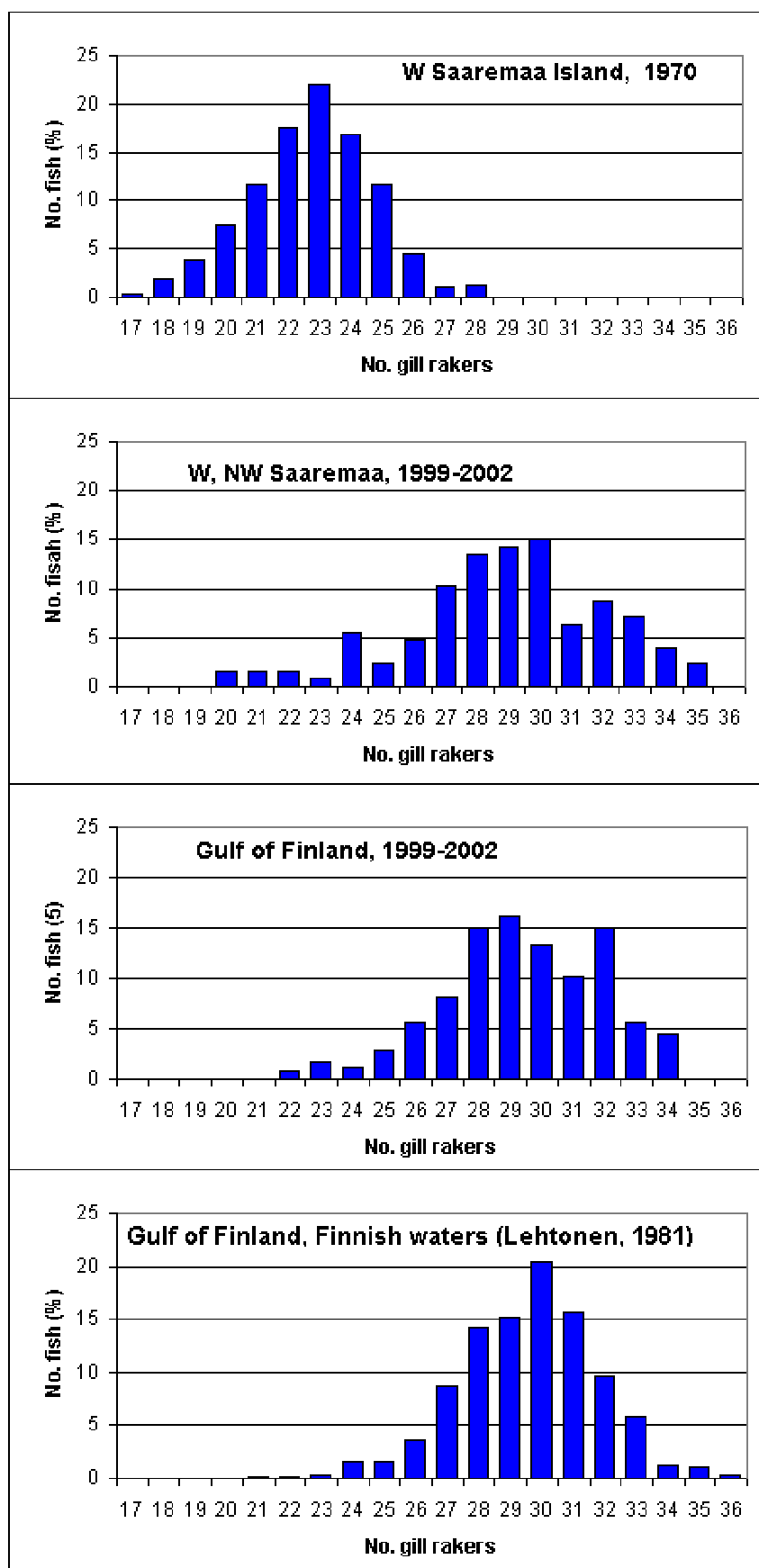


Fig. 3. Gill raker counts of whitefish on the western and northwester coast of Saaremaa, and in the Estonian and Finnish (Lehtonen, 1981) waters of the Gulf of Finland