CAN WE DISTINGUISH ACOUSTICALLY BETWEEN VENDACE STOCK AND STICKLEBACK STOCK IN LAKE PLUSZNE?

LECH DOROSZCZYK[1], BRONISŁAW DŁUGOSZEWSKI[1], MAŁGORZATA GODLEWSKA[2]

[1]Stanisław Sakowicz Inland Fisheries Institute
Oczapowskiego 10, 10-719 Olsztyn, Poland
lechdoro@infish.com.pl
[2]International Institute of the Polish Academy of Sciences, European Regional Centre for Ecohydrology under auspices of UNESCO
Tylna 3, 90-364 Łódź, Poland
margogod@wp.pl

Hydroacoustical monitoring of vendace stocks in lake Pluszne is performed regularly since 90-ties. However, in 2009 the lack of oxygen below the thermocline prevented fish to occupy the hypolimnion, which is its natural habitat. This led to a mixture of vendace and other fish species above the thermocline. The trawl catches accompanying hydroacoustical studies have contained exclusively vendace and stickleback. Investigation of TS have shown two-pick distributions, one corresponding to the size of vendace and one smaller. The two fish species were separated by thresholding. The maps of fish spatial distributions confirmed that vendace was present only in the deepest part of the lake, which is typical for this part of a year, while the other fish were distributed over the whole lake area. The worsening of environmental conditions in Lake Pluszne (increase of eutrophication) leads to declining vendace population.

INTRODUCTION

Over the past few decades, hydroacoustics has become increasingly important to the assessment of fish populations [1]. Fish stock assessment in inland waters is necessary for both: fisheries management and ecological environmental assessments, as a result of EU Water

Framework Directive (WFD) requirements [2]. A wide range of sampling techniques have been developed for the assessment of fish populations in lakes and reservoirs including trawling, gill nets, electrofishing, etc. All the techniques, both fisheries methods and acoustics have their strengths and weaknesses as sampling techniques. Since traditional fishery methods are expensive and labor intensive, whole lake evaluations with these methods are infrequent. By contrast, hydroacoustics allows surveying of large areas within a short time, and is ideal for stock assessment. However, it is not suitable for species identification. When fisheries methods and hydroacoustics are used together, they provide invaluable information about fish populations in lakes [3, 4, 5, 6]. In Poland hydroacoustics is not widely used in inland waters yet. Although more and more lakes have been studied acoustically [7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20] only in Lake Pluszne there is a long term hydroacoustical monitoring, which allows to follow the interannual changes in fish populations and their distribution. The results clearly show that last years vendace population is declining and there is no natural reproduction of this species in a lake. Most probably oxygen deficits observed in late summer are responsible for this situation. In September 2009 the hypolimnion was completely devoid of oxygen and all fish were concentrated within or above the thermocline. This caused a difficulty to estimate vendace stock, since it was mixed with other species. The aim of this paper was to find a way to separate vendace from other species and estimate its abundance and distribution.

1. MATERIALS AND METHODS

The experimental work was conducted in Lake Pluszne (total area 903 ha, mean depth 15 m, max depth 51 m), located in north-eastern Poland. This used to be a mesotrophic lake, with a fish community dominated by vendace (*C. albula* L.). Normally vendace lives separately from other species as it occupies the deep layer below the thermocline, whereas other species, mainly the cyprinids, are located in the upper layer. This makes easy to estimate separately the both stocks. Hydroacoustic measurements were conducted on 8-9 September 2009 from the 5 m long boat "Echo" sailing at constant speed (8 km h^{-1}) along predetermined zigzag transects (Fig.1.).
Data were collected at night, one hour after sunset, when all fish are dispersed. The split-beam echo-sounder, Simrad EY500, 120 kHz with elliptical transducer 4x10 degrees on a towed body, aiming vertically down, was used. The pulse length was set to medium (0.3 ms), the ping interval to as fast as possible, and the TS thresholds to −56 for all fish species and −44 dB for vendace only. The echosounder was calibrated using a copper sphere with a target strength of –40.4 dB according to the Lobe calibration program. Data were analyzed using Simrad EP500 software and Surfer software for mapping.

The water temperature and dissolved oxygen content were measured in a deep part of the lake at 1m intervals from the surface to the bottom using the OXI 196 (WTW).

Simultaneously with hydroacoustical measurements control fishing with a pelagic trawl was conducted at depths above the thermocline. The trawl inlet area was 15 m^2 (3x5), and water filtration was 1200 m^3 min^{-1} at a trawling speed of 80 $m \cdot min^{-1}$. A total number of 3 hauls were made and a random sample of 200 fish from the catch were measured and weighted.

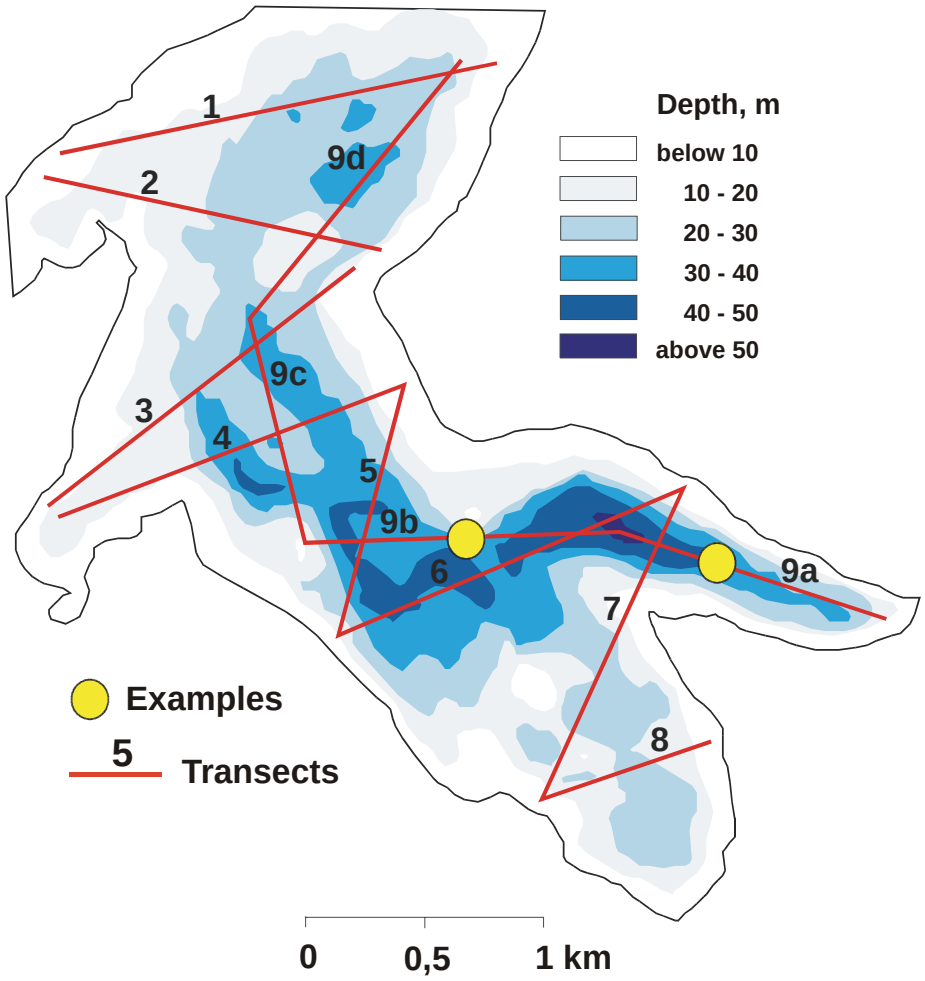


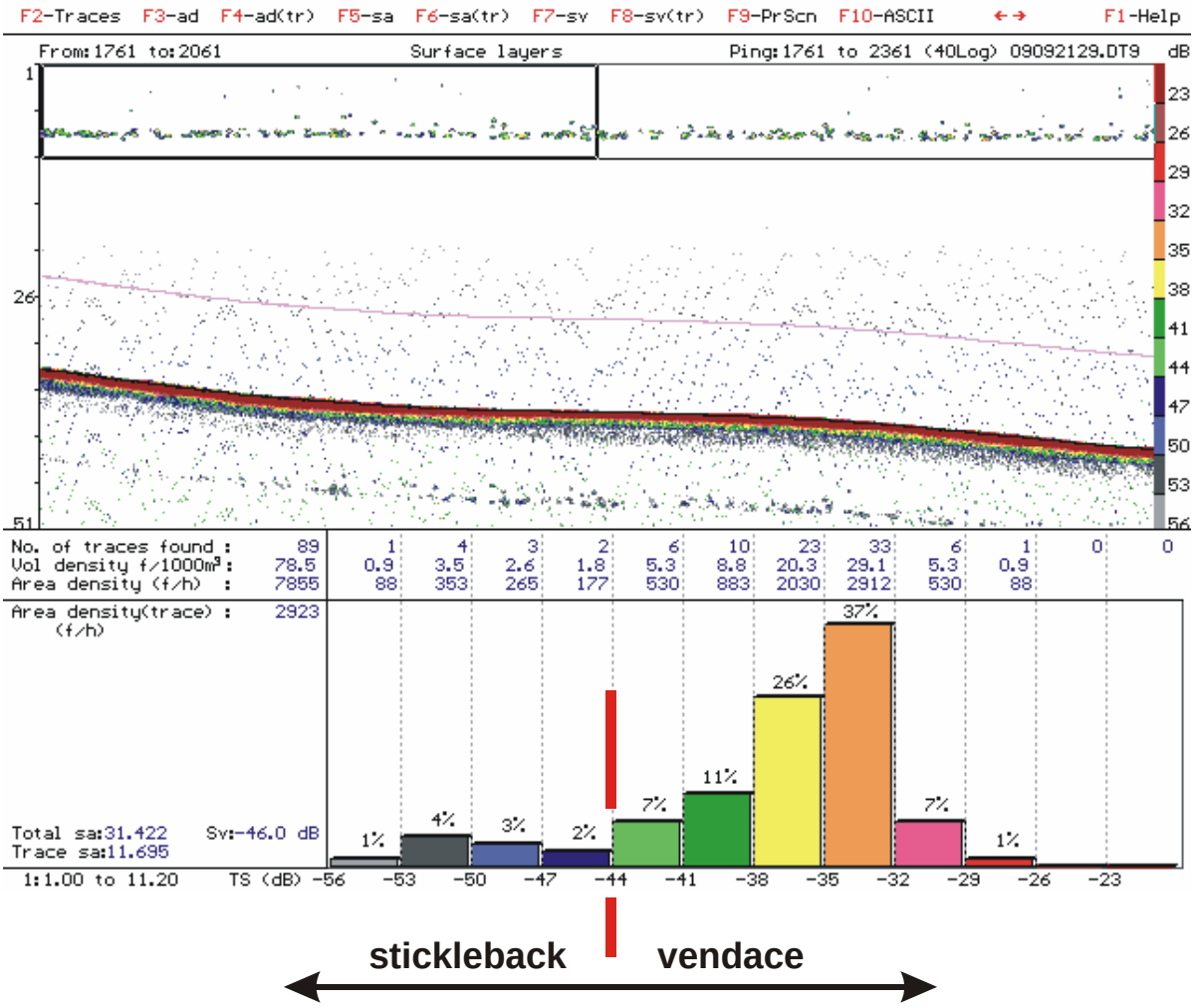
Fig.1. Lake Pluszne bathymetry with hydroacoustic zig-zag transects and example points corresponding to data analysis presented in a paper

2. RESULTS AND DISCUSSION

The hydrological situation of Lake Pluszne in September 2009 was very unusual. There was a strong thermocline between 8 and 10 m depth, and hypolimnion was completely devoid of oxygen (Fig.3). As a consequence all fish species, including vendace, were distributed in the upper layer, within or above the thermocline. The presented examples of transects 9a and 9b show that fish size distributions differed between the transects (Fig.2). Over the deep areas, (transect 9a) larger fish were dominating, while in areas with smaller total depths (transect 9b), smaller fish were more abundant. In the trawl only two fish species were caught, vendace and stickleback. The average size of vendace was 19 cm (Fig.4), while size of all stickleback was 3-4 cm. It has been assumed that the line corresponding to -44 dB, which divides the two picks in the fish size distribution also splits the vendace and stickleback populations (Fig.2). As can be seen from Fig.3, the two species differed also in their depth distributions, vendace was concentrated in the thermocline and just above it, while stickleback was found mainly in the upper layer, just below the surface. Of course one can not exclude, that apart from the stickleback, other small

species could be distributed in the surface layer, as well as could be some large fish different than vendace. Since none other species were caught in the trawl, one may assume that they were not numerous and calculated abundances may be attributed to these two species only. The total number of fish (calculated with thereshold -56 dB) was 2 875 780 individuals which makes average density equal to 4700 fish ha^{-1}(investigated area 616 ha). This includes both, vendace and stickleback. Vendace alone (calculated with threshold -44 dB) accounted to 262 950 individuals, which makes average density just above 600 fish ha^{-1} (over area 415 ha). This is very low indeed as compare to the estimates from previous years. It seems that vendace population in lake Pluszne has collapsed. The maps of fish spatial distribution (Fig. 5) show that vendace was occupying the deepest part of the lake (as it did in late summers in previous years), while stickleback was distributed over the whole area of the lake. Replacement of vendace and other fish species by stickleback must threat the fisherman, since this fish species has no economic value, but it competes with others for food resources. Lack in the catches of the 0+ vendace does not give any hope for the natural improvement of the situation.

September 2009, Transect 9a



September 2009, Transect 9b

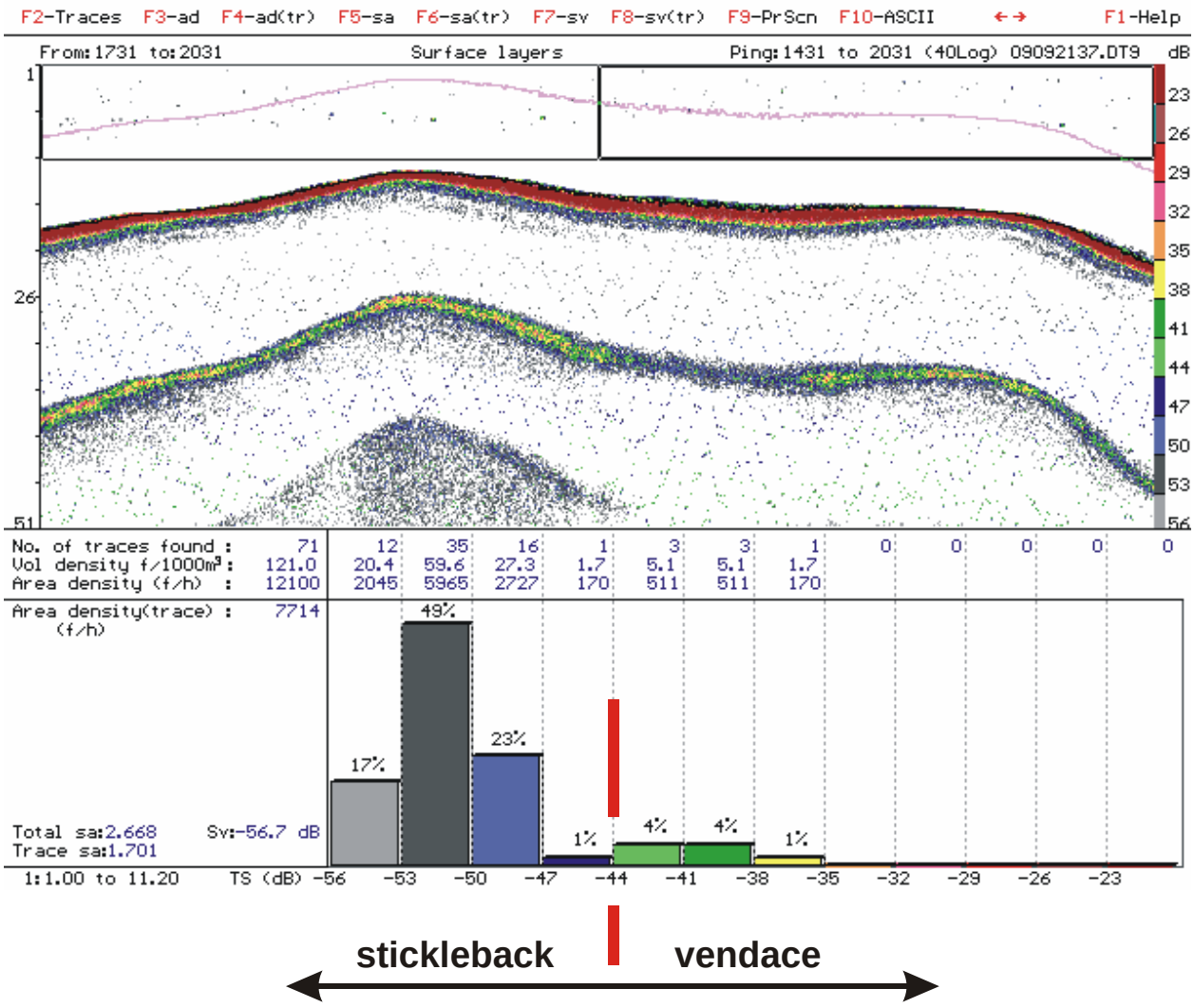


Fig.2. Examples of echograms and fish size distributions in two areas marked on Fig.1. Red vertical line divides histograms between vendace and stickleback populations

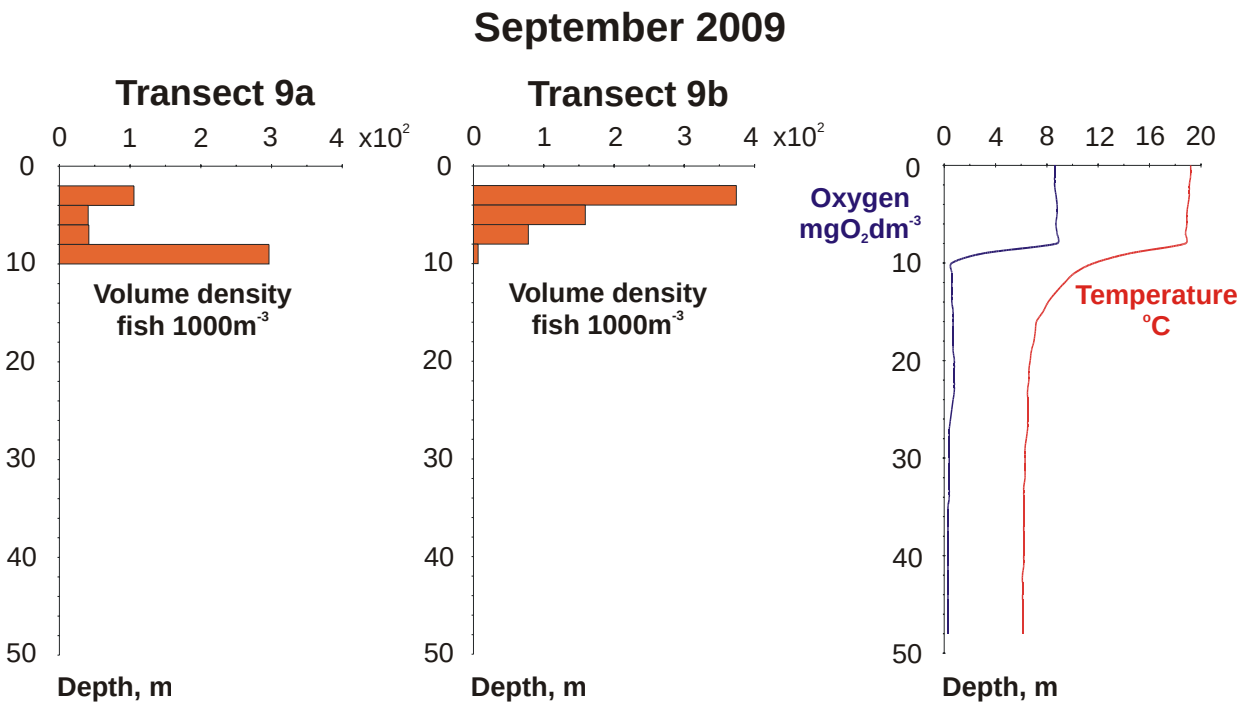


Fig.3. Fish density depth distributions in relation to temperature and oxygen vertical profiles

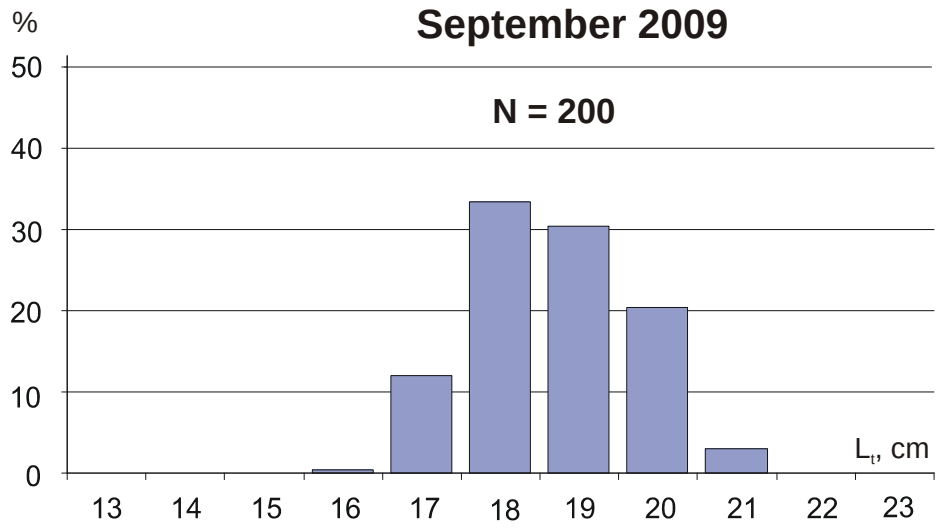


Fig.4. Fish size distribution from the trawl catch

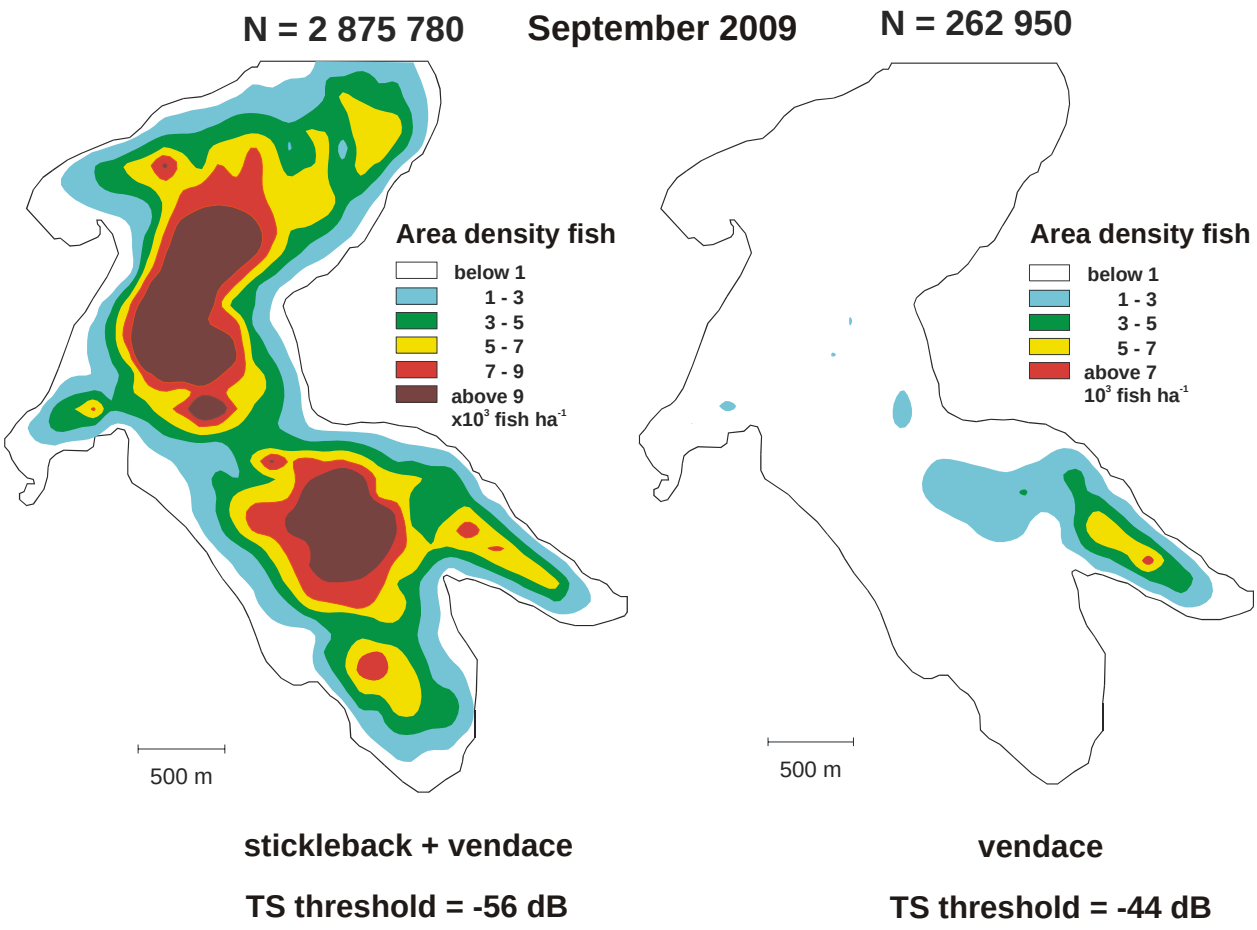


Fig.5. Maps of fish spatial distribution: a) stickleback+vendace, b) vendace only

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