International Council for
the Exploration of the Sea

C. M. 1998/U:10
Evaluation of Marine protected
areas as management tools

NORWEGIAN SPRING SPAWNING HERRING (*CLUPEA HARENGUS* L.): PROTECTION OF SPAWNING AREAS IN RELATION TO CHANGES IN MIGRATION PATTERN

by

Ingolf Røttingen and Aril Slotte.

ABSTRACT

The main spawning and fishing areas for the Norwegian spring spawning herring during the last century and the first half of the present century were located south of 60°N. From the late 1940s changes in the migration patterns of the herring led to a northward shift in the location of spawning activities, and by the beginning of the 1960s the spawning occurred only in areas located north of 62°N. Further, in the late 1960s this stock was depleted due to a large increase in fishing effort on all life stages of the herring. At the start of the rebuilding period the spawning occurred north of 62°N. However, in 1989, after an absence of 30 years, the herring began spawning in the historically important areas south of 60°N. A fishing ban was introduced in these areas, and this paper evaluate this spawning habitat protection with regard to a rebuilding of the stock and ecosystem development.

Keywords: herring, spawning, protection, ecosystem.

Ingolf Røttingen and Aril Slotte: Institute of Marine Research, P.O.Box 1870, N-5024 Bergen, Norway [tel: +47 55238500, fax: +47 55238600, e-mail Ingolf Røttingen: ingolf@imr.no, e-mail Aril Slotte: aril@imr.no].

FLUCTUATIONS IN STOCK SIZE AND MIGRATION PATTERN

Spawning of Norwegian spring spawning herring has traditionally taken place along the Norwegian coast from Lofoten in the north to Siragrunnen in the south (Fig. 1), but the relative importance of the different grounds has changed with time. Runnstrøm (1941a) regarded the grounds south of Bergen, particularly the ones to the west and south of the island of Karmøy, as the most significant in the 1930s and also in former periods of rich herring fisheries. Between 70 and 80 % of the landings during the first 3 decades of this century came from the southern grounds (Runnstrøm, 1941b; Røttingen, 1990). Spawning grounds off the Møre district were used regularly during this period, whereas grounds north of Møre seemed to be used for few seasons only and were considered insignificant. The southern grounds were also important in the late 1940s and onwards, but gradually the spawning moved more northwards in the last years of the period 1946-1958 (Devold, 1963). After 1959 the southern grounds were not utilised, whereas significant numbers of yolk sac larvae north of the main fishing areas at Møre indicated that banks north of Møre and even off the Lofoten islands were important in the early 1960s (Dragesund, 1970).

Corresponding with the northern shift in spawning grounds there was a steadily increase in the fishing effort of the stock, and by the late 1960s the spawning stock was depleted due to high fishing pressure on all life stages of the herring (Dragesund et al. 1980). The geographical spawning distribution of the depleted stock were similar as in the 1960s. However, the long range migrations of the herring ceased, and the entire life cycle was spent in Norwegian coastal waters and fjords (Dragesund et al., 1980; Hamre, 1990; Røttingen, 1990).

MANAGEMENT TOOLS IN THE REBUILDING OF THE STOCK

In the beginning of the 1970s drastic management regulation was introduced in order to rebuild the stock. A spawning stock level of 2.5 million tonnes was defined as a rebuilding "target level" (later defined as "safe biological level", "MBAL", and at present as the biomass limit point "B_{lim}").

In order to reach the 2.5 million level, two regulative elements were introduced:
1) A maximum fishing mortality of $F = 0.05$
2) Minimum catch size 25 cm (i.e. approximate the minimum length at first spawning)

In 1988 the strong 1983 year class recruited to the spawning stock. Although there were large uncertainties in the abundance estimation, it was stock size was estimated to a level approximately 2 million tonnes (ICES, 1988). In 1989 the herring reappeared in the spawning areas south of Bergen, after an absence of 30 years (Røttingen, 1989). This was assumed to be a first sign of a changing migration pattern, eventually resulting in a larger fraction at traditional southern spawning grounds.

As an additional element in the rebuilding period, the southern grounds were in 1989 closed for fishing (Fig. 2). Not only the spawning areas had to be protected, but also the immigration and emigration routes to and from the spawning areas. Technically this was a complicated time/area process due to the presence (i.e. wintering) of another herring stock in the same areas, the autumn spawning North Sea herring stock. Thus, the fishery regulations regarding

Norwegian spring spawning herring had to be formulated in a manner which minimised inconveniences for the fishery of the autumn spawning herring (which was regulated by a EU-Norwegian agreement).

ARGUMENTATION FOR PROCTECTING THE SOUTHERN SPAWNING AREAS

As mention above the main management objective was the rebuilding of the spawning stock. In what manner could a protection of these southern spawning areas assist in attaining this aim? There are in fact several biological and historical aspects which emphasise the importance of spawning at the southern grounds with respect to the recruitment of the stock.

Biological aspects

From general biological points of view a geographical extension of the spawning area would be advantageous to the recruitment of the stock. First, a number of studies have emphasised the importance of dispersal in populations under high spatial and temporal environmental variability (Gadgil, 1970; Roff, 1975; Kuno, 1981; Levin et al., 1984; Levin and Cohen, 1991; Cohen 1993). Thus, by spreading the spawning products from north to south, the Norwegian spring spawning herring overcomes the variations in environmental conditions and increases the overall recruitment to the stock (Dragesund, 1970).

Another benefit of extending the spawning area, could be a decreased density dependent mortality of eggs and larvae. Recruitment has been related to stock density in herring by several authors (Anthony and Fogarty, 1985; Stocker et al., 1985; Winters et al., 1986; Winters and Wheeler, 1987). Development and survival of eggs are inversely correlated with egg density in herring (Taylor, 1971; Galkina, 1971, Hourston and Rosental, 1981), and reduced density may also reduce competition for food among larvae (Kiørboe et al., 1988).

In addition there are several aspects indicating that larvae hatched at the southern grounds will have a higher chance of surviving until the age of recruitment. Slotte and Fiksen (unpublished) have found that the southern larvae will drift northwards with the coastal current in higher temperatures than larvae from more northern grounds (Fig. 3), which ultimately will enhance the survival (Fig. 4).

Larvae hatched at the southern grounds will be dispersed over a larger area, larger range of environments, than larvae hatched further north. For instance, larvae hatched off Karmøy will be spread northwards with the coastal current to nursery areas (in shore areas and fjords) along the entire coast and in the Barents Sea, whereas larva hatched off Lofoten only have fjords in northern Norway and the Barents Sea as nursery areas.

There is also an increasing probability southwards that larvae will drift into coastal areas and fjords, i.e. larva will stay at higher temperatures through the juvenile stage. Warmer water will probably also increase the survival from metamorphosis until the stage of first maturation. In fact it has been suggested that temperature related effects are more important in the late larval - early juvenile phase than in the early larval period, due to the high predation rate in these stages (Anthony and Fogarty, 1985; Sissenwine et al., 1984). There are in fact several studies showing that herring originating from coastal nursery areas grow much faster than individuals in the Barents Sea, and as a result they recruit to the spawning stock 1-2 years earlier (Lea, 1929 a and b; Ottestad, 1934; Runnstrøm, 1936, Holst, 1996). The really large year classes are produced in the Barents Sea, while the nursery areas along the coast function as a buffer; i.e. individuals originating from these areas predominate in years with low recruitment (Holst and Slotte, in press).

Historical aspects

Historical data also emphasise the importance of the southern grounds for the recruitment of the stock. Throughout centuries spawning in these southern areas has been associated with a high and relative stable spawning stock level. We do not know the actual size of the spawning stock of Norwegian spring spawning herring in earlier historical times. However, we can indirectly make some assumptions on stock size from for instance the 1930s when there was a large spawning activity on the southern grounds. The total annual catch in that period was approximately 700 thousand tonnes. By looking at some age distribution of the catches, it can be seen that for instance in 1934 and 1935 approximately 40-50% of the herring were older that 10 years (Runnstrøm, 1941 b). With such a high proportion of old fish in the spawning stock the fishing mortality must have been low. If the fishing mortality was in the order of F=0.1, this may indicates that spawning stock levels in the order of 5-10 million tonnes. Jakobsson et.al. (1996) argue that the recruitment pattern of this stock may have changed. In the earlier part of this century the adult stock and especially the older part of the adult stock consisted of a large number of year classes with relatively little variation in strength compared to the present period Thus the present recruitment pattern with a high probability of reduced recruitment after one or two good year classes may be related with the northern shift in spawning area which took part around 1950.

Also information from earlier “herring periods” indicate high spawning stocks when spawning took place in the southern areas. For instance, an annual catch in the 1860 of 150 thousand tonnes taken in southern spawning areas by land seine and small gill nets indicate considerable amounts of spawning herring in these areas.

STOCK DEVELOPMENT SINCE 1989

When the 1991 and 1992 year classes recruited in 1995-97, the spawning stock biomass increased to approximately 9 million tonnes (ICES, 1998). At this time the rebuilding aim of this stock was definitively reached, and the restrictions on the fishery has been eased accordingly.

However, there are no indications that the large 1991 and 1992 year classes originated from spawning products at the southern spawning grounds. According to acoustical estimates only a minor fraction of the total stock has visited these areas since 1989 (Johannessen et al., 1995) (Table 1). However, the biomass at the southern grounds increased slightly in 1997, only to decrease in 1998.

Herring were tagged annually at the southern grounds during the period 1990-93, and tags were recovered from catches of feeding herring in the Norwegian Sea, wintering herring in the Vestfjorden area, southward migrating and maturing herring and spent herring heading northwards from the southern grounds during the period 1990-96 (Fig. 5). These tag recovery data clearly show that the herring spawning at the southern grounds had a similar migration pattern as the rest of the stock in subsequent years.

It is widely accepted that herring return year after year to the same spawning grounds as they spawned for the first time, regardless whether they were born there (Hourston, 1982; Wheeler and Winters, 1984). The tag recovery data from 1990-96 were not sufficiently supportive to conclude that herring returned to the southern grounds. Only two tags were recovered from the 1983 year class. In addition, three tags were recovered from herring catches in fjords to the south and north of the release sites at Karmøy. These tag recoveries may come from specimens of local coastal or fjord herring populations. Furthermore, many recovered tags were found in maturing herring in February off Møre or farther north, and it is impossible to conclude whether these individuals would continue migration farther south.

Slotte and Fiksen (unpublished) discussed the possibility of homing in this stock and suggested that a potential homing tendency towards specific spawning grounds is limited by the state of the fish (size, condition), i.e. an individual do not home to a particular spawning ground if this decreases the probability of survival until next spawning, or more specific decreases it's future fitness. The southward spawning migration from the wintering is particularly energy demanding (Slotte, 1996), and constraints on the energy storage may inhibit individuals to migrate the long distance of up to 1500 km to the southernmost grounds. Slotte and Johannessen (1997 a) have shown that the smallest herring and the herring in bad condition (low energy storage) tend to spawn closer to the wintering area.

Thus, the low biomass at the southern grounds during the period 1989-98, could be a releflection of low homing rates and low condition in the stock. In fact the spawning distribution has instead tended to distribute more northwards to the areas Halten, Sklinna, Træna and Lofoten. In 1998 more than half of the spawning population was distributed to the north of Møre (Slotte and Dommasnes, 1998). Another point is that the fishery is size specific and tend to catch the largest fish migrating fastest and arriving the Møre area first (Slotte and Johannessen, 1997 b). This size specific fishery is likely to reduce the fraction aiming for the southern grounds.

NEW ASPECTS OF THE HABITAT PROTECTION

In 1998 the southern grounds were reopened for a very limited herring fishery. The allowed quota in this area was only 5% of the total Norwegian quota of Norwegian spring spawning herring. Thus, these spawning areas still have a status as protected areas. However, the arguments behind the protection have shifted from the original within the realm of the rebuilding aim, to a more diversified ecosystem view.

Firstly, the argument of keeping a large geographical extension of the spawning area to enhance recruitment is still valid. If the entire Norwegian quota on the herring (741 thousand tonnes in 1998) was allowed to be fished on the southern area this would probably decrease (or bring to a total halt) the spawning in the area. This would be regarded as undesirable for the recruitment process.

Secondly, ecosystem viewpoints have come into consideration. There has been carried out systematic investigations on the wood web system of these southern spawning areas (Høines et al., 1995). These show that during most of the year there is rather short food chains leading from phytoplancton to copepods to sandeels and piscivores, which seem to be highly significant for the production of the larger gadoids and place. In spring, in the presence of herring eggs, both piscivores with a planktonic orientation an the benthivores responded by diet shifts. The fish community was able to take advantage of the short term abundance of a food source not produced locally but brought to the area by the immigrating herring spawners. A southern expansion of the herring spawning area is potentially beneficial to the coastal communities since the nutritional input caused by the herring may be significant. It can also be observed that the catch of gadoid species within these spawning areas have tended to increase in later years. Thus, a protection of the herring spawning will contribute to the strengthening of the ecosystem of the area. This in turn will result in a strengthening of the gadoid stocks on which a local fishery is based

CONCLUSIONS

The southern spawning area for herring was originally made a protected area in order to help the rebuilding process of the Norwegian spring spawning herring stock. This stock was later rebuild, probably without the "help" of these southern areas. Further, a significant southern shift in spawning areas have not been observed.

However, a protection of the areas is still valid, but now the emphasis has shifted towards a more ecological approach. This is consistent with principles of modern fisheries management. In the "Statement of Conclusions" from the Intermediate Ministerial Meeting on the Integration of Fisheries and Environmental Issues, Bergen 13.3 - 14.3 1997, it is stated under "Guiding principles" that the management of North Sea fisheries should be guided by following principles:

"…-the identification of processes in, and influences on, the ecosystems which are critical for maintaining their characteristic structure and functioning, productivity and biological diversity;

-taking into account the interaction among the different components in the food-webs of the ecosystems (multi-species approach) and other important ecosystem interactions;…."

By and large, these principles have been followed by the Norwegian fisheries management authorities when they gave the southern spawning areas a protected status by strongly limiting the fishery on Norwegian spring spawning herring in that area. And, as described above, the present rationale behind this decision is two fold:

1) Strengthening recruitment to the stock of Norwegian spring spawning herring

2) Strengthening the total ecosystem in the southern spawning area and by this the local fishery of gadoid species.

REFERENCES

Anthony, V. C., and M. J. Fogarty. 1985. Environmental effects on recruitment, growth, and vulnerability of Atlantic herring (*Clupea harengus harengus*) in the Gulf of Marine region. Canadian Journal of Fisheries and Aquatic Sciences. 42 (suppl.): 158-173.

Cohen, D. 1993. Fitness in random environments. Pp. 8-25 in Yoshimura, Y. and Clark, C. W. (eds.) Adaptation in stochastic environments. Lecture Notes in Biomathematics 98, Springer-Verlag, Berlin.

Devold, F. 1963. The life history of the Atlanto-Scandian herring. Rapport et Procès-verbaux des Rèunions Conseil International pour l'Exploration de la Mer 154: 98-108.

Dragesund, O. 1970. Factors influencing year-class strength of Norwegian spring spawning herring (*Clupea harengus* Linne). Fiskeridirektoratets Skrifter Serie Havundersøkelser 15: 381-450.

Dragesund, O., J. Hamre & Ø. Ulltang. 1980. Biology and population dynamics of the Norwegian spring spawning herring. Rapport et Procès-verbaux des Rèunions Conseil International pour l'Exploration de la Mer 177: 43-71.

Gadgil, M. 1970. Dispersal: Population consequences and evolution. Ecology. 52: 253-261.

Galkina, L. A. 1971. Survival of spawn of Pacific herring (*Clupea harengus pallasi*) related to the spawning stock. Rapports et Proces-Verbaux des Reunions du Conceil International pour l'Exploration de la Mer. 160: 30-33.

Hamre, J. 1990. Life history and exploitation of the Norwegian spring-spawning herring. – Pp. 5-39 in: Monstad, T. (Ed). Proceedings of the 4th Soviet-Norwegian Symposium, 12-16 June 1989, Institute of Marine Research, Bergen, Norway.

Holst, J. C. 1996. Long term trends in the growth and recruitment pattern of the Norwegian spring-spawning herring (*Clupea harengus* Linnaeus 1758). Ph. D. Thesis, University of Bergen, Bergen, Norway. ISBN 82-77444-032-4.

Holst, J. C. & A. Slotte. Effects of juvenile nursery on geographic spawning distribution in Norwegian spring spawning herring (*Clupea harengus* L.) ICES Journal of Marine Science. In press.

Hourston, A. S. 1982. Homing by Canada's west coast herring to management units and divisions as indicated by tag recoveries. Canadian Journal of Fisheries and Aquatic Sciences. 39: 1414-1422.

Hourston, A. S. And Rosental, H. 1981. Data summaries for viable hatch from Pacific eggs deposited at different intensities on a variety of substrates. Canadian Data Reports of Fisheries and Aquatic Sciences. 267: 56 p.

Høines, Å., Bergstad, O.A. and Albert, O.T. 1995. The food web of a coastal spawning ground of the herring (Clupea harengus L.). In Ecology of Fjord and Coastal Waters (eds H.R. Skjoldal, C. hopkins, K.E. Erikstad and H.P. Leinaas), pp.385-40.

ICES. 1988. Report of the Atlanto-Scandian Herring and Capelin Working Group. ICES Council Meeting 1988/Assess:10.

ICES. 1998. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES Council Meeting/ACFM:18.

Jakobsson, J., Jonsson, E. and Gudmundsdottir, A. 1996. The North Icelandic Herring Fishery and the Atlanto-Scandian Herring 1939-1969. ICES Councel Meeting 1996/H:30.

Johannessen, A., Slotte, A., Bergstad, O. A., Dragesund, O. and Røttingen, I. 1995. Reappearence of Norwegian spring spawning herring (*Clupea harengus* L.) at spawning grounds off southwestern Norway. In Ecology of Fjords and Coastal Waters (eds H. R. Skjoldal, C. Hopkins, K. E. Erikstad and H. P. Leinaas), pp 347-363.

Kiørboe, T., Munk, P., Richardson, K., Christensen, V., and Paulsen, H. 1988. Plankton dynamics and larval herring growth, drift and survival in a frontal area. Marine Ecology Progress Series. 44: 205-219.

Kuno, E. 1981. Dispersal and the persistence of populations in unstable habitats: A theoretical note. Oecologia. 49: 123-126.

Lea, E. 1929 a. The herring scale as a certificate of origin, its applicability to race investigations. Rapports et Proces-Verbaux des Reunions du Conceil International pour l'Exploration de la Mer. 54: 1-228.

Lea, E. 1929 b. The oceanic stage in the life history of Norwegian herring. Journal du Conceil International pour l'Exploration de la Mer. 4: 3-42.

Levin, S. A., Cohen, D. And Hastings, A. 1984. Dispersal strategies in patchy environments. Theoretical Population Biology. 26: 165-191.

Levin, S. A. and Cohen, D. 1991. Dispersal in patchy environments: the effects of temporal and spatial structure. Theoretical Population Biology. 39: 63-99.

Ottestad 1934. Statistical analyses of the Norwegian herring population. Rapport et Procès-verbaux des Rèunions Conseil International pour l'Exploration de la Mer 88 (3): 1-45.

Roff, D. A. 1975. Population stability and the evolution of dispersal in a heterogeneous environment. Oecologia. 19: 217-223.

Runnstrøm, S. 1936. A study on the life history and migrations of the Norwegian spring herring based on Analysis of the winter rings and summer zones of the scale. Fiskeridirektoratet Skrifter Serie Havundersøkelser 5 (2): 1-110.

Runnstrøm, 1941 a. Racial analysis of the herring in Norwegian waters. Fiskeridirektoratets Skrifter Serie Havundersøkelser 6 (7): 5-10.

Runnstrøm, 1941 b. Quantitative investigations on herring spawning and its yearly fluctuations at the west coast of Norway. Fiskeridirektoratets Skrifter Serie Havundersøkelser 6 (8): 5-71.

Røttingen, I. 1989. Reappearance of Norwegian spring spawning herring on spawning grounds south of 60°N. ICES Council Meeting 1989/H:22.

Røttingen, I. 1990. The 1983 year class of Norwegian spring spawning herring as juveniles and recruit spawners. - Pp. 165-203 in: Monstad T. (Ed). Proceedings of the 4th Soviet-Norwegian Symposium, 12-16 June 1989, Institute of Marine Research, Bergen, Norway

Sissenwine, M. P., Cohen, E. B. and Grosslein, M. D. 1984. Structure of the Georges Bank ecosystem. Rapports et Proces-Verbaux des Reunions du Conceil International pour l'Exploration de la Mer. 183: 243-254.

Slotte, A. 1996. Relations between seasonal migrations and fat content in Norwegian spring spawning herring (*Clupea harengus* L.). ICES C. M. 1996/H:11.

Slotte, A and Johannessen, A. 1997 a. Spawning of Norwegian spring spawning herring (*Clupea harengus* L.) related to geographical location and population structure. ICES C.M. 1997/cc:17.

Slotte, A. and Johannessen, A. 1997 b. Exploitation of Norwegian spring spawning herring (*Clupea harengus* L.). before and after the stock decline; Towards a size selective fishery. Proceedings of the Second World Fisheries Congress.

Slotte, A. & Dommasnes. A. (1998). Distribution and abundance of Norwegian spring spawning herring during the spawning season in 1998. Fisken og Havet 5. Institute of Marine Research, P.O. Box. 1870. N-5024 Bergen, Norway.

Slotte, A. & Ø. Fiksen. The spawning migration of Norwegian spring spawning herring (*Clupea harengus* L.): a state-dependent trade off? Proceedings of the ICES International Symposium: The Role of Physical and Biological Processes in the Recruitment Dynamics of Marine Populations. ICES Journal of Marine Science. Submitted.

Stocker, M., Haist, V. and Fournier. D. 1985. Environmental variation and recruitment of pacific herring (*Clupea harrengus pallasi*) in the strait of Georgia. Canadian Journal of Fisheries and Aquatic Sciences. 42(suppl. 1):174-180:

Taylor, F. H. C. 1971. Variation in hatching success in Pacific herring eggs with water depth, temperature, salinity and egg mass thickness. Rapports et Proces-Verbaux des Reunions du Conceil International pour l'Exploration de la Mer. 160: 34-41.

Wheeler, J. P., and G. H. Winters. Homing of Atlantic herring (*Clupea harengus harengus*) in Newfoundland waters as indicated by tagging data. Canadian Journal of Fisheries and Aquatic Sciences. 41: 108-117.

Winters, G. H., Wheeler. J. P.. and Dalley, E. L. 1986. Survival of a herring stock subjected to a catastrophic event and fluctuating environmental conditions Journal du Conceil International pour l'Exploration de la Mer. 43: 26-42.

Winters, G. H. And Wheeler. J. P. 1987. Recruitment dynamics of spring-spawning herring in the north west Atlantic. Canadian Journal of Fisheries and Aquatic Sciences. 44: 882-900.

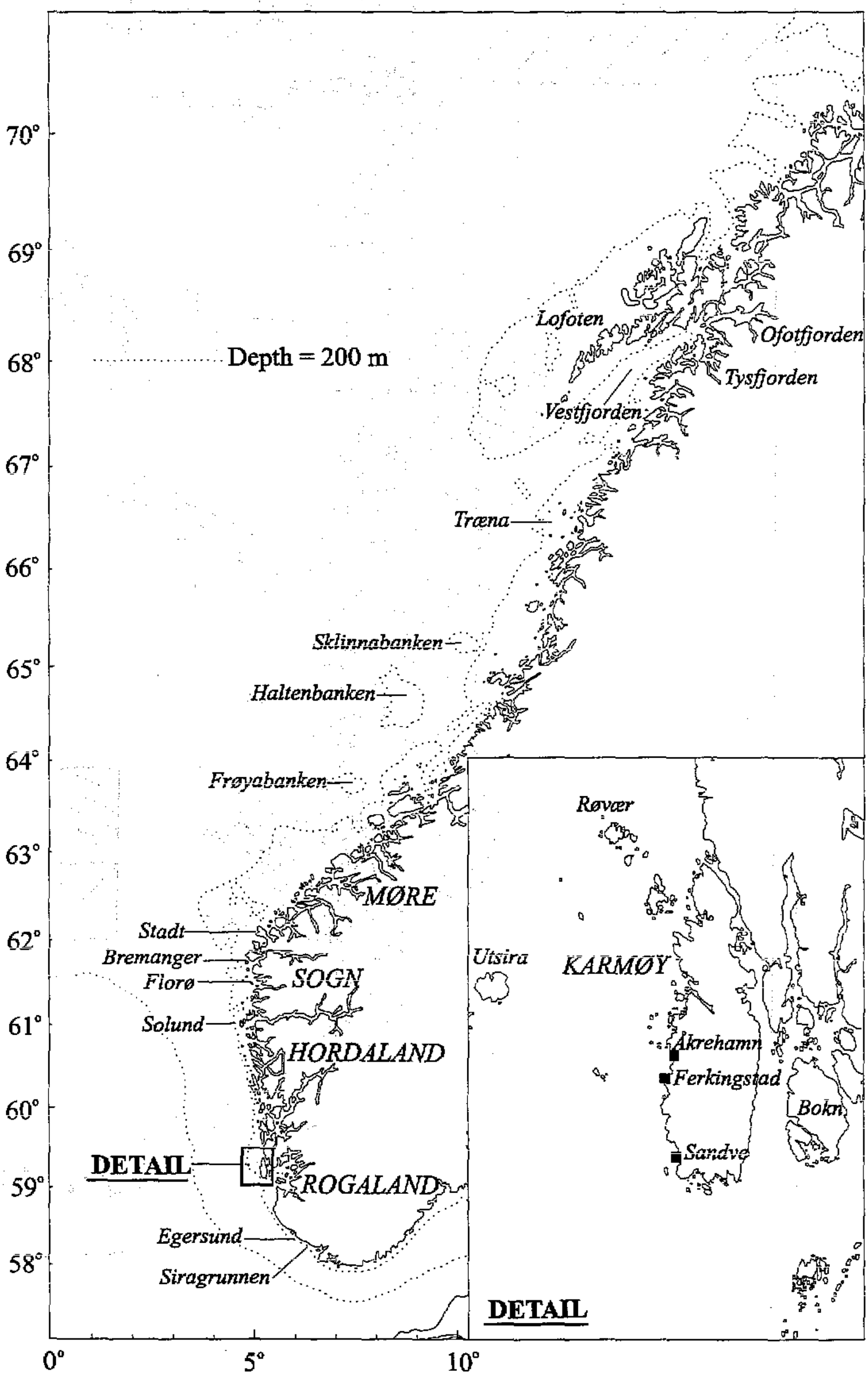

Fig. 1. Important herring districts and locations along the Norwegian coast.

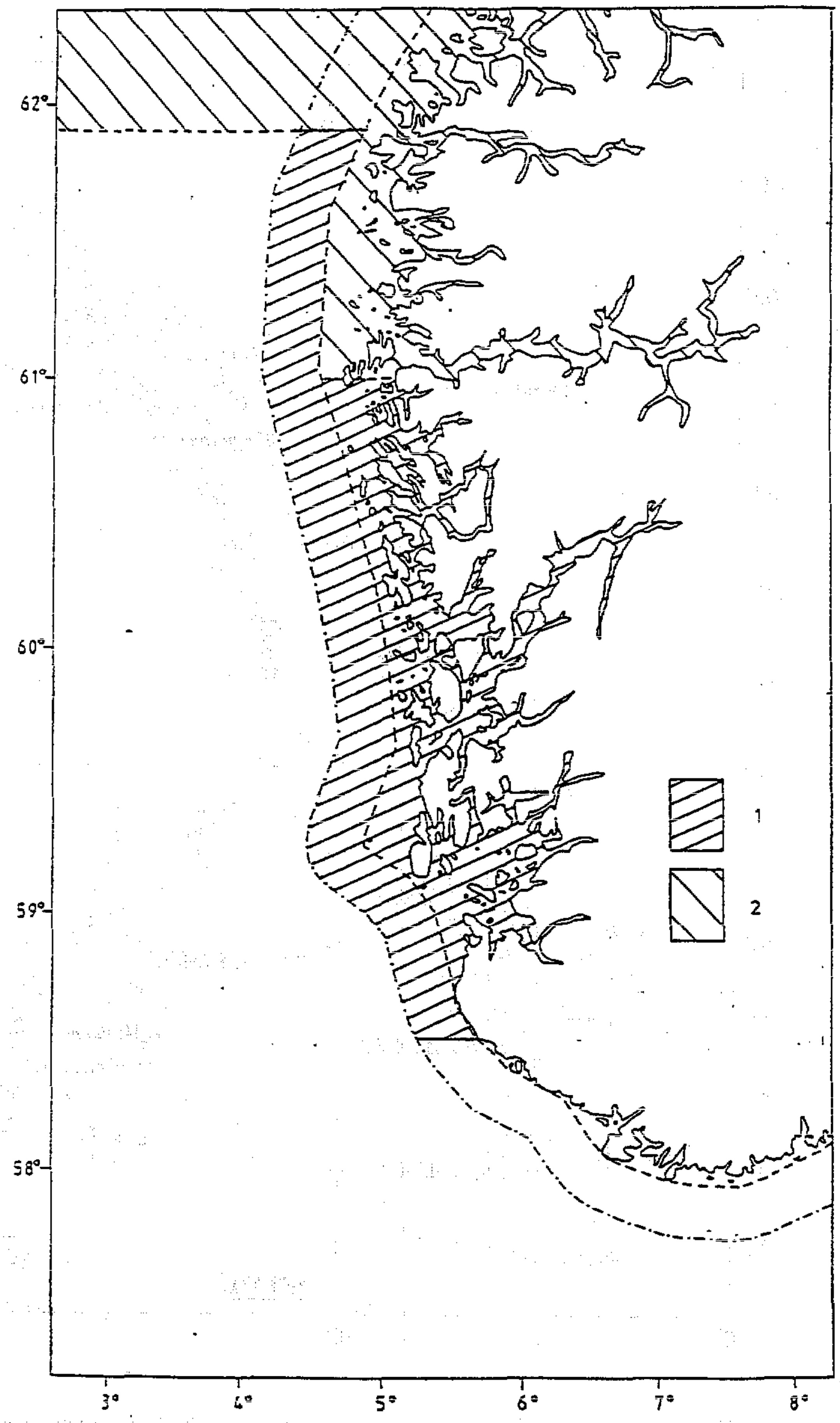

Fig 2.Area regulations for the fishery of Norwegian spring spawning herring in spring 1989. 1) Protected areas. 2)Areas opened for fishery of Norwegian spring spawning herring.

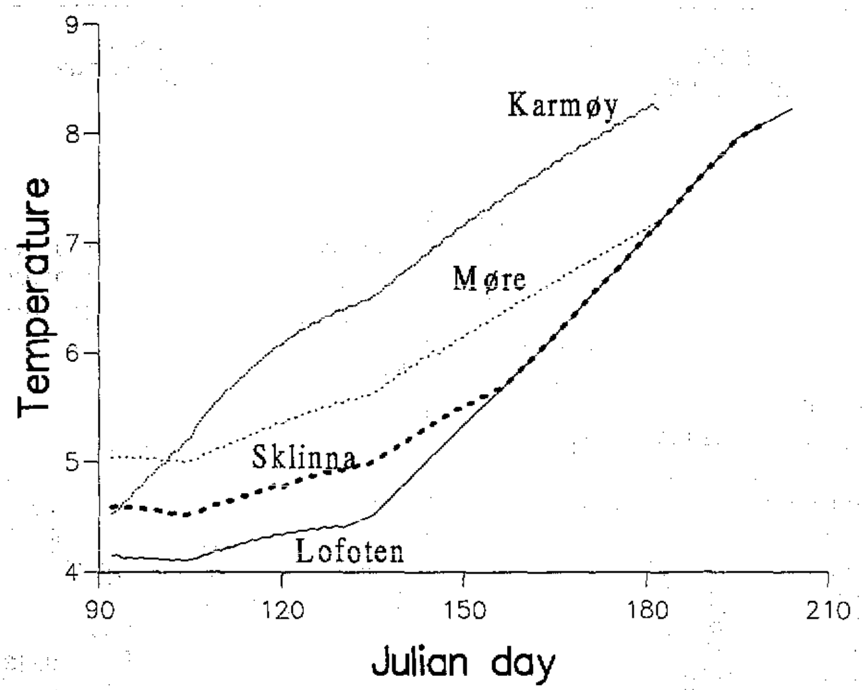

Fig. 3. Temperature trajectories, given a basic drift speed of 12.5 km/day, for larvae hatched at four different spawning grounds (Slotte and Fiksen, unpublished).

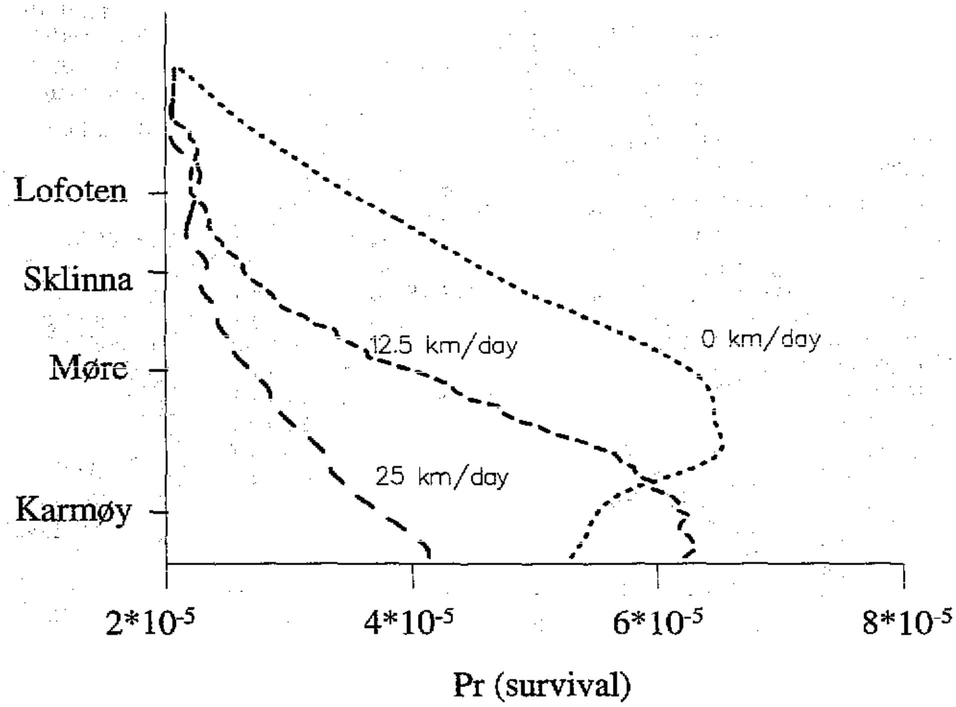

Fig. 4. Survival of larvae (hatched at 1. April) related to hatching site, given three different drift speeds (Slotte and Fiksen, unpublished).

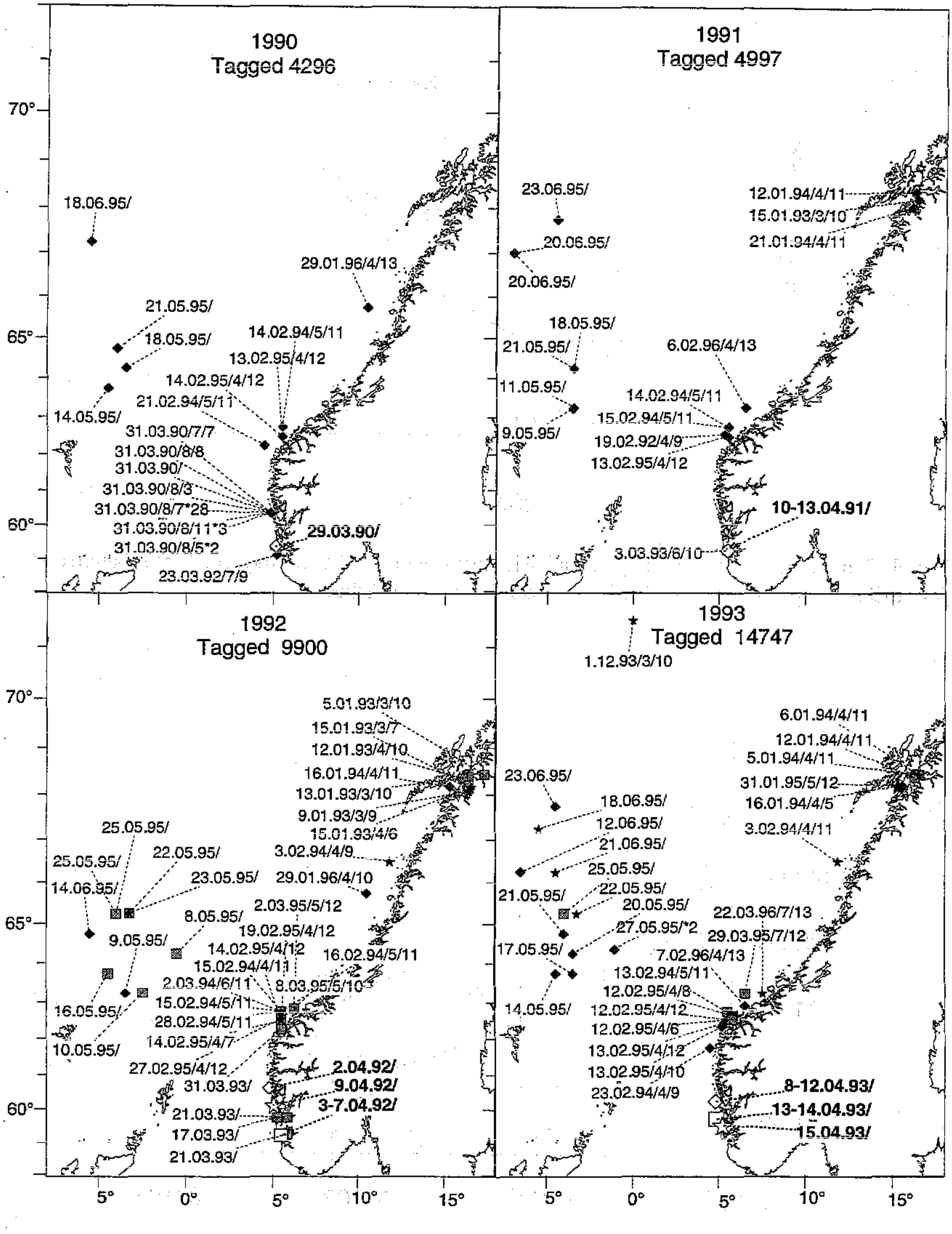

Fig. 5. Results from tagging experiments at southern spawning grounds in the years 1990-93. Open symbols denote the position and date of release, whereas hatched symbols denotes position and date/maturity stage/age * number of individuals of the herring tag recoveries. Numbers of herring tagged are given in the upper part of each panel.

Table 1. Estimates of biomass (in tonnes) of Norwegian spring spawning herrring at Karmøy and Egersund/Siragrunnen in 1990-1998 compared with total spawning stock biomass (SSB). Data of SSB (in thousand tonnes) is taken from VPA-runs, the SSB in 1998 is predicted (ICES, 1998).

Year	Period	Vessel	Biomass	SSB
1990	early March	RV "Eldjarn"	32.255	3.994
1991	5-8 March	RV "Håkon Mosby"	12.200	4.158
	14-18 March	RV "Håkon Mosby"	3.100	
	24 March	RV "Håkon Mosby"	0.920	
1992	15-17 March	RV "Håkon Mosby"	20.000	4.004
	19-21 March	RV "Håkon Mosby"	20.000	
1993	26 February - 1 March	RV "G.M. Dannevig"	4.620	3.864
	4-6 March	RV "Håkon Mosby"	4.830	
	6-8 March	RV "Håkon Mosby"	2.260	
	8-10 March	RV "Håkon Mosby"	16.350	
	10-12 March	RV "Håkon Mosby"	8.040	
	27-30 March	RV "Håkon Mosby"	4.740	
	31 March - 2 April	RV "Håkon Mosby"	5.150	
	4-5 April	RV "Håkon Mosby"	3.810	
1994	19-28 March	RV "Håkon Mosby"	2.000	4.507
1995	23-31 March	RV "Håkon Mosby"	11.000	4.899
1996	9-10 March	RV "Michael Sars"	17.000	5.538
1997	15-18 March	RV "Michael Sars"	215.000	10.149
1998	13-23 March	RV "Michael Sars"	80.000	9.836