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ON THE PROBLEM OF THE EFFECT OF FISHERIES ON FISH STOCKS

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When we consider the problem how the fisheries affect the fish stocks and their reproduction the most important and principal question arises whether the fish have ever encountered the influence of any factor similar to that of the fisheries. In other words, we ask if the fish have been able to adapt themselves to some influence which can help them to stand the fishing effect, or whether the fisheries are quite a new factor to them, and they are not prepared at all.

In ichthyological literature the effect of fisheries is, to some extent, considered similar to that of predators on the fish stock. The suggestion seems to be true for small sized abundant species which are, in fact, subject to such an influence under natural conditions. However, the fishing and predatory effects differ substantially. The fishery is usually based on the adult portion of the population, and due to longer contacts between the fishery and older age groups the numerical strength of the latter is drastically reduced. The "rejuvenation" process is always a consequence of the fishery. Predators, on the contrary, take younger age groups. The predatory effect never leads to rejuvenation of the population. Thus, the fishing effect is of specific character, and the majority of fish in their development and during the adaptation process to the environment have never encountered influences resembling the fishing effect under natural conditions. Furthermore, many biologically adapted features which are acquired due to evolution and advantageous to the fish under natural conditions are turning into disadvantageous habits, thus increasing the effect of fisheries on the stocks and the reproduction.

This can be illustrated by a number of examples (Table 1). In many fish species the bodies are covered with bone knobs, hooks and thorns,

Contribution given in honour of Gunnar Rollefsen at his 70th birthday.

Table 1. Adapted features in fish, their biological significance and negative role under condition of intensive fishing

Adapted features	Biological significance	Negative role under fishing conditions
1. Knobs, hooks and thorns on fish bodies, thorny rays in fins	Protection of fish, especially young from predators	Tangling in nets and difficulty in escaping through meshes
2. Height and width of fish bodies	Lower predatory effect on young fishes	Enmeshing in nets with relatively large meshes
3. Shoaling	Lower predatory effect	Efficient detection of shoals by echosounders and asdics
4. Multiage composition of a population	Increase in the reproductive ability of the population	Decline in the reproductive ability as a result of rejuvenation of the stock caused by intensive fishing
5. Gradually maturation of eggs and spawning in batches	Increase in the reproductive ability of a species	Due to longer stay spawners are more easily caught on spawning grounds
6. Low metabolism in winter during the period of maturation	Savings in energy	Higher accessibility to the fisheries
7. Ability of burying themselves in the ground	Protection from predators	Failure in escaping fish nets
8. Well developed receptive system in tuna	Detection of prey	Increase in the space between hooks and extension of longlines
9. High speed of movement in tuna	Chasing for prey, escape from predators	Spread of the area fished by a longline
10. Habit of avoiding zones with high velocities of water in the river in many anadromous fishes	Savings in energy during anadromous migrations	Better access to the fisheries in shallow localities in the river

and the fins have thorny bone rays. These peculiarities can be looked upon as an adapted protection of the species, especially the young, against predators. Due to these features the bycatch of young increases under intensive fishing since it is difficult for them to escape through the meshes of nets and trawls and easy to get tangled in the meshes of the different gears. The best evidence of the negative role of the morphological peculiarities is tangling of the young of sturgeon in fixed and drift nets. This greatly affects the fish stock.

Great width and height of a fish body protect the fish from predators.

In the fishery, due to the height of the body, young specimens are entangled in nets with rather big meshes. Flounder, bream and some other species may exemplify this fact. The peculiarities of their body form impede selective fishing.

Shoaling can, to a certain extent, be considered a means to protect the fish from predators. However, the fishery with modern scouting techniques is facilitated by the shoaling and yields good catches.

A multiage composition of a spawning population leads to some increase in the reproductive ability of a species. Intensive fishing may result in a rejuvenation of the stock by reduction in the older age groups in the spawning population and finally, lowering of the reproductive ability of the species.

The fecundity of fish increases when the eggs mature gradually and is spawned in batches. This enables the fish to use much more of the energetic resources of the body as compared to the case where all the eggs ripen at the same time. Under fishing conditions a gradual maturation makes females stay on the spawning grounds much longer, chances for catch, thus, increases.

A lower rate of metabolism in winter, in the period of gonad maturation is observed in many species of fish. The phenomenon enables a species to save some energy for spawning. Low mobility of fish in this period makes them more vulnerable to fishing gear. The winter fishery for carp is based on this peculiarity as the fish are taken in deeper hollows.

Many species of flat fishes bury themselves in the ground to escape predators. The same reaction in fish to a coming trawl is observed, but all their efforts are in vain when the trawl is too near.

Tuna possess a well developed receptive system which enables them to locate prey over a radius of several dozen meters. Owing to this peculiarity hooks can be arranged with wider spaces, say 70–100 m apart, and the longline stretched to over 100 km.

The great swimming speed of the tuna causes an expansion of the efficient area of a longline, and the efficiency increases in proportion to the speed of the tuna moving over the area. As a result, a harmless gear, as it may seem at first sight, turns into one of the efficient means in the marine fisheries. Let us assume that the average speed of tuna is as low as 5 km per day when the longline is arranged in the water; a longliner then can cover the area of 500 square km. Even if not more than 20% of the fish inhabiting the area are caught, the catch per day per longliner will correspond to a yield from an area of 100 square km. Actually, the tuna is moving much faster.

The sturgeons moving upstream to their spawning areas, avoid zones with high velocities of water. To save their energy they migrate over

shallow places where they are more easily caught by seines than in deeper places of the river.

It is very likely that far more examples can be given as evidence for how adapted features, biologically advantageous, may turn into disadvantageous habits under the condition of intensive fishing.

All these facts reveal that the effect of fisheries on fish stocks is related not only to the technical progress and its excessive scale, but also with the aspect that some adapted features in fish is counteractive under conditions of intensive fishing, thus making the effect of fisheries more pronounced.

Programmes of further investigations should include examination of adapted features in fish which tend to have counteractive effect under fishing conditions, as well as comparative studies of these features under natural and fishing conditions.

SUMMARY

It is demonstrated by examples that morphological, physiological and behavioural features of fish developed evolutionary and normally of protective value are directly disadvantageous to the fish when subjected to intensive fishing.

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