

The Atlantic Halibut

A Potential Species for Fish Farming in Shetland

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Introduction

The potential for farming Atlantic halibut, *Hippoglossus hippoglossus* (named after 'horse tongue') has been studied in Norway, the UK and Canada. These studies have reached a stage that strongly indicates farming of halibut will become commercially and technically viable. The Shetland Fish Farming industry is therefore provided with an opportunity to augment their successful farming of Atlantic salmon. This note briefly reviews the halibut farming process to date.

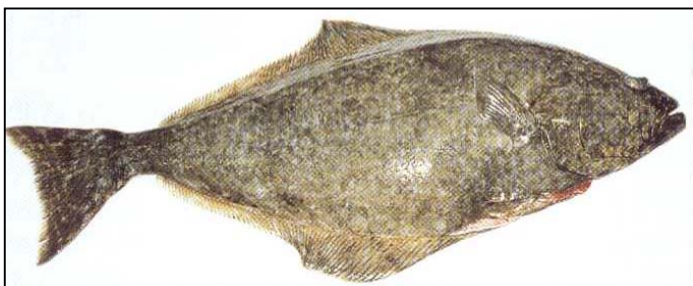


Figure 1. The Atlantic Halibut

The Atlantic Halibut

Atlantic halibut (Figure 1) can reach an age in excess of 50 years and such fish may grow to a length of up to 4 m, weighing over 300 Kg. More commonly, fish from the wild average 5 - 10 Kg.

Halibut are mainly distributed off the Norwegian, Faeroese, Icelandic and Greenland coasts but this demersal species can be found from the Arctic and Northern Atlantic to as far south as the Bay of Biscay and New York.

Atlantic halibut were once common around Shetland (Figure 2) and were even sighted and caught along the quays of Lerwick harbour. Then they were quite unmarketable as they could not be salted satisfactorily. In fact, our Shetland ancestors used large halibut to help haul their boats ashore on, or to keep more 'valuable fish' dry by using as a cover. Around the turn of the century, export links with the mainland were strengthened and halibut were then shipped fresh; particularly when ice

became available for chilling. As a result, the demand for halibut increased.

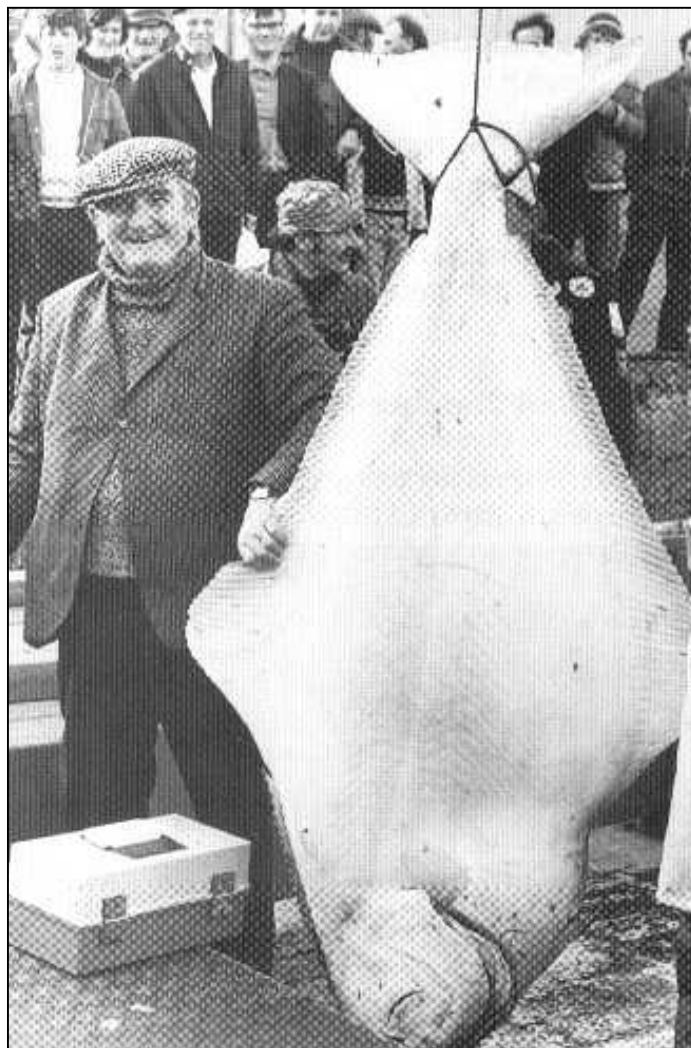


Figure 2. 189lb (86kg) Halibut 1975 Viking Festival.
Photo by Dennis Coutts,

The Farming Opportunity in Shetland

Fishing by long-lining and non-specific trawling has largely depleted Atlantic stocks of halibut. Catches of wild fish are therefore sporadic and those caught are of variable size and quality. With demand high due to the

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premium consumer image of the fish, market values of around £10 - £12 per Kg (whole weight) are common. This makes it a *very* attractive species for fish farming [in comparison to salmon with farm sales values typically of £2 per Kg].

As a consequence of this market opportunity, there has been over 15 years of heavy investment into aquaculture technology to enable farming of Atlantic halibut.

The Natural Life-Cycle

H. hippoglossus has a complex life cycle - outlined in the inset over. Fortunately, Shetland's geographical location is close to the natural habitat of halibut and provides excellent environmental conditions to enable successful rearing and on-growing of halibut. Constant, cool temperatures and low levels of intense sunlight are perfect for year round halibut growth.

The Halibut Hatchery

As we have seen, the early, fragile developmental stages of the halibut occur under very specific and stable conditions. Yet hatcheries have largely overcome the problems associated with mimicking and maintaining them (refer to Figure 3). In addition, much is also understood about required husbandry practices, but these have proven to be costly. Nevertheless, it is expected that the current (1998) UK price of around £5 per juvenile (of a few grams or less) will plummet as the hatchery stages become even more efficient.

Hatchery work initially began at sea where eggs and sperm were collected from sexually mature fish after being caught. This proved to be extremely inadequate. Broodstock halibut are now taken from the wild and transported to tanks in a marine hatchery. Here the fish are kept under cover in approx. 1 metre of water that is preferably cooled, i.e. chilled from ambient to 6 °C, for example. Scarcity of securing live, wild (female) broodfish has been a limiting factor for the UK hatchery operators. The North Atlantic Fisheries College, in collaboration with a number of Shetland fishing vessels, has successfully overcome the broodstock recruitment problem by establishing a process for on board collection of live fish and transfer to holding units.

In Sept./Oct. Atlantic halibut congregate for spawning in waters 300 - 700 m deep. Work in the '30s & '40s showed that fish return to the same spawning area - possibly returning to their birth-place.



Male and female fish release their sperm and eggs at the turn of the year and the then fertilised eggs float upwards to a depth of 100 - 200 m over a period of time. This deep incubation environment is extremely quiet, dark, cool (5 - 7 °C) and relatively sterile - these provide stable and optimum conditions for the egg's development.



The larvae hatch and each consumes its yolk over 30 - 40 days to the middle of March. The Atlantic halibut yolk-sac-larvae are like a premature baby, relatively fragile and underdeveloped.



After a further 90 days the halibut metamorphose from a 'fish' shape to a horizontal, 'flatfish' shape. This is a very complex stage of larvae development, the body twists and the left eye migrates to the right side of the fish while the upper body becomes gradually pigmented. This brown pigment gives the halibut some camouflage and, as in humans, a degree of UV protection.



Juveniles further develop in shallow (40 - 50 m) nursery grounds that have a sandy bottom. Halibut will remain there for 4 - 6 years.



After nursery, the halibut migrate away with no apparent agenda often to distant areas and not necessarily to deep or offshore waters.



The whole cycle starts again when the fish mature [at 3 - 8 years old depending on area]. The female fish mature at a later age and seem to grow faster than the male Atlantic halibut.

Once the broodfish enter the spawning season (Jan. - Mar.) and the eggs or sperm 'ripen', the halibut are coaxed onto a board and lifted just above the water surface. The eggs or sperm are then '**stripped**' from the fish. Halibut are termed batch spawners and one or approx. 15 batches of eggs/sperm will become ripe and be stripped every 3 days during the spawning season. Broodstock halibut can be kept a long time under hatchery conditions, i.e. 10 - 20 years, and can be stripped once per year.

Natural spawning and fertilisation in the holding tanks has been unsuccessful. Instead, manual **fertilisation** of the stripped eggs by mixing with stripped sperm (as in salmonids) has proven to be very reliable. Sea water is added to activate this fertilisation process.

One of the proposed projects at the new North Atlantic Fisheries College's Marine Hatchery is to research and develop out-of-season egg production (and thus out-of-season juvenile production). Artificially controlled day-lengths will be used to manipulate the reproductive behaviour of selected broodstock and thus retard or advance their spawning.

Broodstock halibut are held under tightly controlled hygiene and environmental conditions. From this, the broodfish produce quality eggs. These eggs then develop into quality juveniles. Good fertilisation rates (a measure of quality) have been achieved with such broodstock fed on a commercial 'wet' diet.

After fertilisation, the **eggs** are transferred to small (e.g. 80 l) conical shaped tanks and suspended in the water column by carefully manipulating the density and upwelling flow of finely filtered and UV sterilised seawater. The water is chilled to 6 °C and this stage is kept in total darkness.

The eggs **hatch** after approx. 2 weeks, and the **yolk-sac larvae** are moved to larger (e.g. 2000 l) upwelling silos. These tanks are also fed with sterilised seawater at 6 °C. **First feeding** on exogenous food starts as much as 40 days

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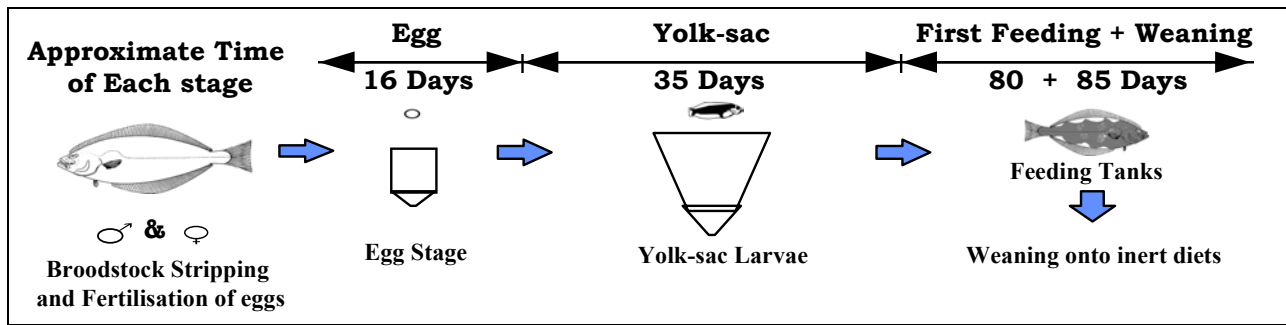


Figure 3. Overview of Halibut Hatchery process

later (c.f. 3 days for cod), once the young halibut larvae have consumed most of their yolk. The halibut at this time of first feeding are very small meaning live feeds - natural and/or cultured planktonic species - are the only suitable food source. Microscopic, *Artemia* nauplii (Sea Monkeys) are used by most halibut hatcheries. When these nauplii are fed with a supplement to enrich their nutritional properties, reasonably good survival success of the young halibut has resulted.

As with other marine species, first feeding is the bottleneck of the hatchery process and 75% mortalities at this stage is common. Water quality, live-feed enrichments and other parameters are being investigated to identify the problem(s) with first feeding and how to overcome them.

Development of the young fish continues with **metamorphosis** where the fish flattens and the left eye migrates to the right. At this stage, the juveniles also settle onto the tank bottom and the water temperature is gradually increased to ambient. The halibut are then progressively **weaned** onto artificial inert diets. Post-weaned fish are quite hardy and they are grown to approx. 5 g in shallow trays or tanks.

Many of the juvenile halibut reared in early trials were malpigmented - i.e. they had blotchy or albino skin. Recent developments in the specific enrichments of live feeds at first-feeding have generally solved this problem.

The whole developmental period of the halibut juvenile is complex and long (~ 34 weeks) compared to other marine species. This produces serious problems for the hatchery operators. Exposing pre-weaned fish, in particular, to stressors of light, temperature fluctuations, poor hygiene/bacterial contamination, changing salinity or handling, it is likely that they will malform or die. Marine species also tend to have a high natural mortality and, as a consequence, only 1 - 2 % survival from viable eggs has been achieved. But this is compensated, in part, by the millions of viable eggs released by the females. In comparison to the turbot industry, for example, the survival rates will only require to be increased by a few more per cent to make the hatchery stage very profitable.

Overall advances resulting from the years of research into the hatchery process has now made it possible to provide sufficient juvenile fish for on-growing.

On-growing

The scarcity of juveniles has meant that on-growing of hatchery-reared halibut has been experimental. The results of these trials have, nevertheless, been extremely positive.

Nursery Stage

A nursery stage has been recognised as an important 'stop-gap' between the hatchery and sea-site stage of the production cycle. The fish are grown from a few grams to 30 - 40 g over approx. 10 months in land based, flow-through tanks, feeding on a commercially available pellet diet (Figure 4).



Figure 4. Juvenile Halibut (few g.) in Nursery Tank. Photo by Karl Scott..

Cage Culture

Post-nursery halibut adapt well to cage culture (Figure 5) and on growing in cages appears to be very effective with low mortalities.

Adapted salmon cages with flat bottom inserts constructed from tarpaulin or knotless mesh has been found to be successful. The bottom of the cage is usually 3 - 4 m deep and is kept taut with a sinker tube, to give the halibut a substrate to rest upon. The cages, being quite shallow, can cause some problems since halibut are quite susceptible to sunburn especially if their skin pigmentation is underdeveloped [see earlier]. To avoid this, it is usual to shade the fish with a suitable cage cover. Increasing the

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productivity of a site by increasing the surface (bottom) area available to the stock may be an important consideration for the future.



Figure 5. *Converted Salmon Cage holding halibut.*

Strong water currents necessary for salmonids, for example, do not appear to be particularly beneficial for halibut culture. This means that some salmon sites *may* not be applicable for halibut and additional sites, not necessarily suitable for salmon, are potentially viable. Halibut cage sites should be quite sheltered to reduce cage bottom movement.

Halibut do not have the same ravenous appetite of salmon, apparently preferring to eat few but large meals. Some on-growers have fed their halibut 2 - 3 times per week whilst others fed every day. Because the fish are relatively docile, there is a very good feed conversion ratio (e.g. 1.1:1), meaning food is efficiently converted to body mass. Trash white fish mixed with vitamins have been used but this has the related problem of disease introduction. Commercial dry pellets have been used successfully, however experience with rearing broodstock has shown that the fish much prefer a moist pellet/sausage.

It is commonly found that (post-nursery) halibut can reach a weight of 1.5 - 7 Kg within 2 years of cage growth [The current market prefers fish of between 5 and 10 Kg although 3 - 5 Kg weight is also thought to be marketable]. The composition of commercial halibut diets has not been optimised but it is anticipated that growth rates will increase when the necessary components are understood, as seen in the salmon industry.

Only 1 - 3 % of the fish's body mass is lost during gutting and yields of around 49 % for fillets is normal.

There is still much to learn for on-growing halibut - stocking densities; feed constituency and rates; harvesting procedure(s), etc., but it appears that cages give good growth prospects and produce farmed fish akin, or better than, wild fish.

Disease

Halibut are susceptible to a range of diseases but they have a well developed immune system. A real concern for hatchery operations, in particular, is the susceptibility of halibut to IPN; this is a fatal infection for the larvae and fry. For the on-grower, halibut are susceptible to a number of parasites and diseases, sometimes the infestation being so heavy that the fish ceases to eat and may die as a result. Atlantic halibut are susceptible to vibriosis but vaccines are available. It is thought that halibut are not affected by ISA.

It is anticipated that veterinary costs will be relatively low for halibut but it is difficult to speculate as disease incidence is bound to increase as farming intensifies.

Sales and Marketing

The European nominal landings for Atlantic halibut are between 3000 and 4000 tonnes (FAO Fishery Statistics Vol. 74). It is predicted that around 1,000 tonnes of farmed halibut will be harvested in the UK alone by the turn of this century. In comparison to the European farmed salmon volumes of over 500,000 tonnes including 30,000 tonnes from Shetland, it appears there is considerable potential for profitable growth. With the various technical and environmental limiting factors for farming halibut it is unlikely that major volumes are likely to be produced in the foreseeable future such that the market will be saturated and price adversely impacted upon. Current thinking is that a sustainable level of farmed halibut price at existing market demands is likely to be £5 - £6 per Kg for a 3 - 4 Kg fish.

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