CHARACTERIZATION OF SEX STEROID BINDING SYSTEMS IN EEL PLASMA

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Steroid binding proteins are responsible for sex steroid transport, storage and release to target tissues, and are essential for sex steroid action. Three different binding systems were characterized in plasma from the European eel (*Anguilla anguilla* L.). The two first are binding systems with high affinity and moderate capacity for both testosterone (T) and 17-hydroxyprogesterone (17P) with K_d values of 0.4nM and 9.0nM; and B_{max} 112nM and 216nM, respectively. The high affinity T binding system can also bind other androgens (e.g. androstenedione and 11-ketotestosterone) and estrogens (e.g. estradiol), whereas the high affinity 17P binding system bound mainly progestagens (i.e. 17,20□P, progesterone); the first such system described for fish plasma. Both proteins were isolated from plasma by electrophoresis with molecular weights of 64kDa and 112kDa for T and 17P binding systems, respectively. A third binding system with moderate affinity and high capacity was found for corticosteroids (e.g. cortisol and desoxycortisol), similar to corticosteroid binding systems of higher vertebrates. Owing to the biochemical characteristics of these sex steroids binding proteins, the study of these systems could contribute to the understanding of sex steroid regulation in vertebrates.

A G.I.S FRAMEWORK FOR THE EVALUATION OF AQUACULTURE DEVELOPMENT IN THE WESTERN ISLES, SCOTLAND: OPTIMISING SITE LOCATION BASED ON PHYSICAL ENVIROMENTAL PARAMETERS AND CAGE ENGINEERING DESIGN

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Introduction

Fish farming in the Western Isles, Scotland, has increased considerably over the past ten years and is likely to continue development over the next few years. The implementation of the Water Framework Directive into national legislation means that water quality standards must take full account of the effects of activities on chemical, biological and morphological features of the coastal environment. Current policies for fish cage site selection are usually based around consideration of single sites at a time, within a regimented "yes or no" decision framework. Fish farming must adopt a much more structured approach to site location, using a regional overview of suitable sites and selection criteria that are developed through spatial modelling. GIS (Geographic Information Systems) modelling can take account of a large number of relevant environmental and socio-economic factors, and through a combination of sub-models can allow integration of sophisticated spatial tools for multi-site aquaculture planning and management into a coastal zone management plan.

This study describes GIS sub-models of cage site suitability developed using physical environmental parameters in conjunction with engineering design data for a range of cage types. The work is part of a wider model set developed for decision-making for coastal aquaculture. Defining the physical suitability of an area for fish farming is of great importance as each cage type has its own engineering tolerance levels and is designed to cope with varying levels of weather and hydrographic conditions, water depth, and anchorage stability. Ensuring that cages are sited appropriately for the particular cage system is fundamental for the sustainability of an operation while also maintaining a high level of safety for operators.

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Assessing Cage Site Suitability

Assessing cage site suitability using GIS tools, in this study, follows on from the work of Ross *et al*., (1993) and Perez *et al.*, (2005) and was assessed based upon physical factors related to manufacturers specific cage designs. Three cage specifications were chosen, one designed for hydrodynamically exposed conditions (Kames, C315), another for semi-exposed conditions (Kames, C250) and lastly one designed for sheltered conditions (Kames LMS). Spatial data on numerous environmental factors was collected and modelled, including:

- A sub-model of wave amplitude up to 90m water depth
- A sub-model of wave period up to 90m water depth
- Collected data on Bathymetry
- Collected data on current velocity
- Collected data on sediment type

The data was digitised and converted to a common UTM reference system within a raster spatial database at 30m resolution. The initial physical environmental factors were reclassified in terms of suitability for cage aquaculture and were then aggregated using a Multi-Criteria Evaluation approach within the GIS framework (Fig. 1).

Results

Fig. 2. shows the outcome for the cage systems designed for sheltered locations, where yellow to red indicate suitable to highly suitable areas compared to blue to dark green which indicate unsuitable to least appropriate areas. For this type of cage design the suitability model shows that ideal locations are restricted to inshore sea lochs to an area of approximately 69km^2. The most appropriate location for this type of cage is in Loch Seaforth as well as Loch Leurbost, Loch Erisort and several small areas of Benbecula. In Loch Roag, siting of this cage type is limited by the physical environment except within the innermost parts. By comparison, the models show that approximately 257 km^2 of inshore waters offer favourable

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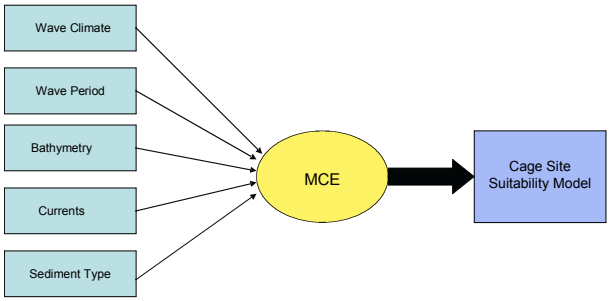

Figure 1: Creation of Cage site suitability model for the Western Isles using the five predefined physical parameters.

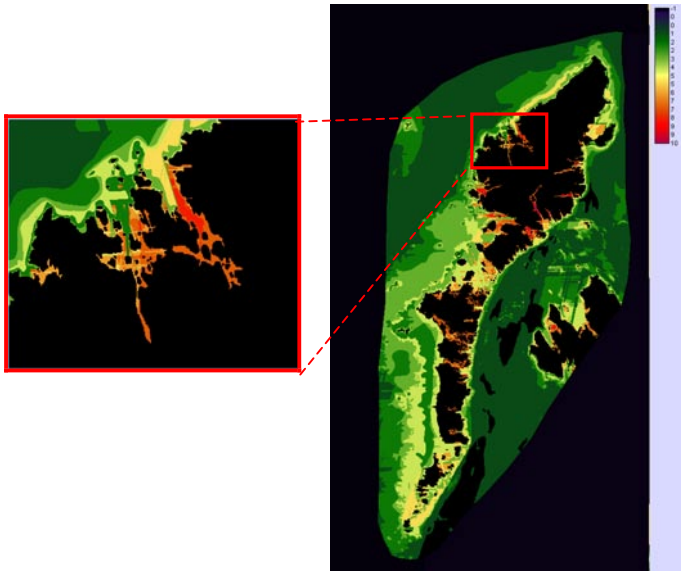

Fig. 2: *Cage Suitability Model for C250 circular sea cages designed for sheltered environments.*

conditions for fish cages designed for semi exposed locations.Most of these areas can be found in the sea lochs and some open coastal areas. Again Loch Seaforth, Loch Leurbost and Loch Erisort show favourable conditions, and some parts of West- and East Loch Tarbert and Loch Resort . Greater areas of Loch Roag are suitable for this cage type than for the sheltered area cages. Areas of North Uist and Benbecula also appear favourable. The exposed cage type has the greatest suitable areas of the three modelled at approximately 507km^2. Almost the entire coastline apart from Northern Lewis is favourable while most outer parts of sea lochs are extremely favourable. The depth of the nets designed for these cages (15 - 25m) restricts their ability to be placed in shallower seas

The model for semi exposed cages was explored further as research showed that the majority of fish cages in use in the Western Isles are based on this design. Although most do not use the specific cage type under study here, there are many similarities between them. Overlaying the locations of present aquaculture farms with the cage suitability model for semi-exposed cages shows that currently almost all farms are located within areas that are suitable for this cage type.

Discussion

A recent pilot study on site optimization for Loch Roag highlighted that "adequate specification and siting of salmon farm installations in respect of hydrological in particular wave climate" should be taken into account. The cage suitability model designed and implemented here for the Western Isles not only achieves this, in creating a wave climate model for the whole of the Western Isles, but also developed cage suitability models based on manufacturer's guidelines. These physical suitability models show that the current locations of the active fish farms are on the whole appropriate. When considering present and future deployment of fish cages, such as those suggested in the Loch Roag site optimization plan, the positioning of the cages should be guided by spatial models. This will enable the correct technology to be used in the most appropriate environments thus ensuring long term site viability (least cost of repair), creating a safer working environment, and minimizing escaped farmed fish through storm damage. This site suitability can be used for site selection of marine cage aquaculture based on their ability to endure environmental conditions. The models give suitability scores for the different cage technologies, and using these scores environmental managers and regulators can make decisions about siting of cage culture, or alternatively look for other potential locations within a similar locality or management area. This process is in marked contrast to the current EIA process of site selection. It allows a proactive approach to ranking areas and developing options of sites instead of simple "yes or no" scenarios. This type of decision support tool is not intended only as a fixed engine for regulation, but is ideally suited for the exploratory, pre-development stages.