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Production costs of pike-perch fingerlings (*Sander lucioperca*); a bio-economic model

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Report produced in the framework of the CRAFT project “LUCIOPERCA: bio-economic feasibility of intensive culture of pike-perch”

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Summary

A major object of the project 'Lucioperca' is to estimate economic feasibility of intensive production of pike-perch. An important part of this activity is the reproduction of brood stock and production of fingerling fish for further on-growing. This report describes the specific costs involved in production of fingerlings and is used as subsequent input in the assessment of overall economic feasibility.

The production costs for fingerlings are calculated using an Excel-spreadsheet model containing five different linked sheets. Individual sheet are used for input on feeding and growth, investments, production costs and pricing. In the base-case situation, yearly production is 100.000 fingerlings of 10 gram a piece. By shifting the spawning season, two batches of eggs can be obtained a year which increases efficiency.

Under these assumptions the costs of producing a fingerling amount to 40 eurocents a piece. Major cost items are labour (26%) and capital costs (38%).

Considering the potential market prices for large fingerlings for on-growing or restocking, fingerling production could be interesting.

1. Introduction

One of the aims of the project ‘Lucioperca’ is to assess the economic feasibility of intensive culture of pike-perch. In order to make an assessment, a bio-economic model has been developed in which the economics of the on-growing of pike-perch are described. For on-growing of pike-perch, stocking material is needed (fingerlings). The price of the fingerlings is an input needed in the on-growing model. Production of fingerlings can also be an economic activity on its own with a separate market from on-growing. Therefore, a separate model, the ‘Hatchery Model’ has been developed to calculate the price of fingerlings and the associated design of a hatchery. This report describes the ‘Hatchery Model’ (further referred to as the model) and all the input used.
The parameters and input needed in the model is derived from other activities in the project and literature.

2. Modelling of production costs

2.1 General outline of the model

The model is an Excel workbook with six linked sheets which each cover relevant aspects of the hatchery. In de *Input/Output* sheet the most important input and output variables are presented. The output is generated in the other sheets. The sheet *Feeding schedule* gives a calculation of the amount and costs involved in feeding the fish. In the next sheet, *Hatchery design*, a calculation is given of the physical infrastructure needed to produce the desired numbers of fish. The results are input for the next sheet, *Investments*. In this sheet depreciation is also calculated. In the sheet *Costs* the yearly costs of production are calculated. In this sheet there is a specific calculation on the labour input needed for a certain production. In the last sheet, *Pricing*, a market price for the fingerlings produced is calculated based on the costs for the final product. The separate sheets are discussed in detail below.

2.2 Input/Output

In this sheet (table 1) the number of fingerlings that is produced yearly has to be fed into the model. It is obvious that for an efficient operation of a hatchery, continuous operation is desired. For continuous operation, out-of-season spawning is needed (year-round). For pike-perch this has never been done. From a management point-of -view it is desirable to stock a number of uniform large batches in the system. This is done in turbot culture for example.

Another approach is daily collection of eggs and continuous stocking of the system like is being done in culture of sea bass and bream. In the model the first approach (all-in all-out) is used; the number of batches has to be fed into the model. Theoretically, four batches can be produced in a year with the 90-day rearing period from the feeding schedule. For pike-perch two batches are used as default since this reflects more or the less the current state of technology.

The output given in the Input/Output gives an overview of key economic figures like investments, running costs, feed costs and a market price, all generated in other sheets.

Table 1. Key figures for input and output of the hatchery model

THE HATCHERY MODEL

Species: Pike-perch

Input

Production	100,000	#/Y
Batches	2	#/Y

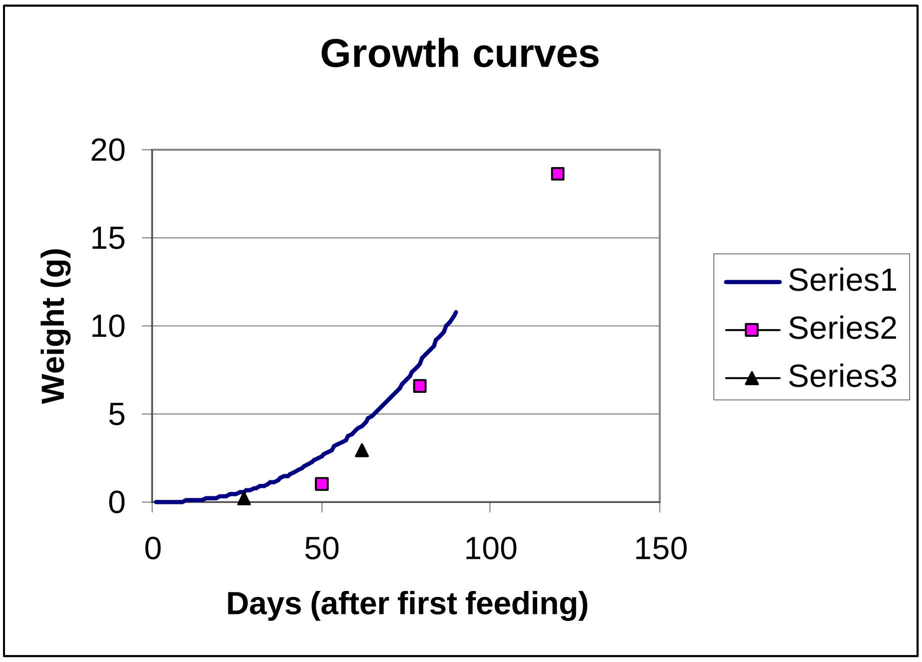
Output

Investment	€ 129,751	
Investment	€ 1.3	/pc
Costs	€ 40,069	total/Y
Costs	€ 0.4	/pc
Feed cost	€ 0.04	/pc
Market price	€ 1.25	/pc

2.3 Feeding schedule

In the feeding schedule (table 2), the growth of the fingerlings and the feed needed is described for a period of 90 days. Day 1 is first feeding which is for pike-perch usually about three days after hatching. An exponential model is used to describe growth rate (SGR) in relation to body weight (W): SGR = a.W^b. The growth model has been parameterised and validated using data from literature and experience of the partners in the project (figure 1). A and B are set at respectively 7 and –0.4 as default.

Figure 1. A comparison of growth curves of pike-perch.



The final number after 90 days is taken from the Input/Output sheet. A survival over 90 days has to be fed to the model and is used to calculate the input in numbers on day 1. The daily mortality in the model is concentrated in week 3 and 4 during weaning to artificial diet and calculated from the accumulated mortality fed into the model. This distribution can be changed according to other insights. Using growth rate and mortality, the change in biomass is calculated. The daily amount of feed needed is calculated from the daily change in biomass and a feed conversion. The feed conversion is an important input in the top of the sheet. The default value is 0.7 for pike-perch based on the experience in this project.

During a production cycle different feeds are used. First-feeding is usually done with Artemia (A) which can also be enriched (+enr). Subsequently different artificial diets are used. At the right side of the sheet, the percentage of the daily feed ration covered by each of the diets has to be fed to the model. This schedule can be changed according to the specifications of the user.

The percentages are used to calculate the feed ration for each individual feed. For the Artemia the amount of dry cysts is calculated. The amount of dry matter (as nauplii) produced per gram of cysts is 0.3. The hatching efficiency differs according to the strain of Artemia used; 0.3 is an average for Great Salt Lake Artemia (Creswell 1993).

In a box at the top at the right side, the costs for the different feeds are calculated. The user has to give the price of each feed.

The feeding schedule sheet can also be used as a stand-alone document to calculate the feed ration for individual batches.

Here table 2

2.4 Hatchery design

The sheet hatchery design (table 3) presents calculations on the equipment needed for every phase in the hatchery. There are 4 different phases identified: broodstock, incubation, first feeding and fingerlings. In practice these phases can be combined. For example, in pike-perch culture the first-feeding stage and the fingerling stage could be combined. Live feed culture (*Artemia*) is also covered; in a separate box the requirements for space (building and land), flow and biofiltration are calculated.

The requirements for *broodstock* are calculated using a fecundity of 200.000 eggs per kg female body weight (Deelder & Willemsen, 1964). The fertilisation rate is used to calculate a number of fertilised eggs per female. The number of fertilised eggs needed is calculated from the survival rate in each stage of the hatchery and the final number needed. This number is used to calculate the amount of brood stock and the space requirements for brood stock. Pike-perch usually spawn naturally on an artificial nest. The eggs are allowed to hatch within this tank and the larvae are separated after hatching and transported to a different system. The nest is placed in a tank of app. 2 x 2m and contains one pair of fish.
The number of *spawning tanks (incubators)* needed is then determined by the amount of larvae needed and the survival from spawning. The fertilisation rate is not easy to determine directly and is usually based on the hatching rate. From the experience gained in this project, one pair yields on average 27000 hatched larvae. The fertilisation rate is therefore set at 15% while it is assumed that the survival of a fertilised egg is 100% during incubation.

The *first feeding* phase is defined as the period from day 1 to day 30. For pike-perch a starting density of 100 fry/l is used. The survival is set at 20%. The tank volume needed is calculated base on these assumptions. In this period the fish are weaned to dry feed. At the end of this period the fish have a weight of app. 1 gram and can be moved to another system.

The *fingerling* phase is defined as the period from day 30 to day 90. A final density of 25 kg/m3 (no reference) is used here as input; there is no significant mortality (5%) during this phase. Total tank volume needed is 22 m^3 for the production of 100,000 pieces.

The facilities for production of *Artemia* are determined by the maximum amount needed, which is taken from the feeding schedule, and the production capacity per unit rearing volume. For provision of enrichment and drying/desinfection three multiplies the volume of incubators.

The total rearing space is calculated by addition of the volume needed for each phase and an average water depth. Apart from fish tanks, space is needed for walkways, water treatment and other facilities.

The space demand is expressed as a ratio between building and tanks. In this case this ratio is estimated to be 2. A building has to be surrounded by some clear area. This is expressed as a ratio between land and building (1,5).

The capacity of the pumps is calculated from the rearing volume and the number of exchanges needed per hour (4, default). The recirculation flow has to be pumped to the tanks and over a trickling filter. The power consumption for both these functions together is estimated at 75 W/m3. The flow in the system will change according to the stocking density; only at the end of a rearing period will the maximum flow be needed. In the cost sheet a correction is made for this fact.

The rearing system is built as a recirculation system, which is a condition for year-round production. The biological filter is this system has to be able to nitrify the ammonium produced from the maximum feed load in the system. A specific load of 2 kg of feed per m^3 biofilter is from experience very well feasible.

Table 3. Hatchery design pike-perch

2.5 Investments

The sheet *Investments* (table 4) gives an overview of the infrastructure and equipment needed to realise a certain production capacity. The investment costs are based on the experience gained in building the pilot system for on-growing of pike-perch. The yearly depreciation is also calculated in this sheet. Some of the investments can be considered 'fixed' in the sense that there is no relationship between production capacity and the investment in this item. This is the case for permits, connection to gas, water, electricity, alarm system, weighing and other equipment. For all the other items a linear relation is postulated between the amount invested and production capacity. For each item the number of units is indicated (e.g. m^2, kW) and multiplied with a unit cost. The amount of land and building space needed is taken from the sheet Hatchery design. The amount of heating, ventilation and lighting is directly related to the size of the building. The costs for an electrical installation are assumed to be directly proportional to the installed pump capacity.
The sizes of the different rearing units are taken from the sheet Hatchery design and multiplied with an estimated unit cost. Investments in a micro screen (drum) and pumps are important and related to the maximum flow needed. There is an allowance made for 10% of the costs being 'unforeseen'.

At the right side of the sheet the depreciation for the different investment item is made (linear). The individual amounts are added to a total yearly amount to be depreciated.

2.6 Costs

In the sheet *Costs* (table 5), the total amount of production costs are calculated including capital costs (depreciation and interest). The *feed costs* are taken directly from the sheet Feeding schedule. The costs for *electricity* are calculated from the installed pump capacity (sheet Hatchery design), a factor for the number of batches (#batches/4), a factor for the capacity used during the rearing of a specific batch (0,75) and a price per kWh (0,08). The costs for heating (*gas*) are calculated from the building area (sheet hatchery design) and a factor relating building area to yearly gas consumption (30 m^3/m^2). This factor is an estimate taken from heating costs of greenhouses (Ekkes, Bakker et al., 1995). Since a borehole is used for water suppletion, the costs for *water* are considered to be 0. The *oxygen* consumption of the fish is related to the feed consumption; a consumption of 1 kg/kg feed is used. The price of the oxygen (including rent for the storage) is estimated to be € 0.8/kg. For *chemicals* and a levy for the *effluent* a small amount of money is needed.

Costs for *maintenance* are estimated to be 2% of the investments. *Insurance* is estimated to be 0.3% of investments. *General costs* are considered to be fixed for an amount of 2000 euro and variable for an amount of 20 euro per 1000 fingerlings.

Labour is a very important cost item in a hatchery (Rivaud 2001; Sweetman 2001). In the model there are three categories of labour applied (high: 50.000,-/Y; average: 30.000,-/Y and low: 20.000,-/Y). The capacity of each category needed is considered to exist of a fixed part (0.2 man-year) and a variable part related to the number of fingerlings produced. This variable part is difficult to estimate. From literature (Rivaud 2001; Sweetman 2001) it is known that the maximum number produced per person is in the order of 1 million fingerlings.

Depreciation is copied from the sheet Investments. An *interest* of 8% is calculated over 2/3 of the investment. No interest in calculated over the fish stock.

Table 4. Investments pike-perch

Table 5. Costs pike-perch

Production (#/Y)	100,000							
	Amount							
	euro	*euro/pc*	*%*					
Feed	4,245	0.04	11	*see feed schedule*				
Other inputs								
electricity	1,831	0.02	5	*0.05*	*E/kWh*			
gas	558	0.01	1	*0.23*	*E/m3*	*5*	*m3 gas/m2*	
water	0.00	0.00	0	*borehole*				
oxygen	30	0.00	0	*0.14*	*E/kg*	*1*	*kg O2/kg feed*	
chem., med., etc.	500	0.01	1					
levy effluent	93	0.00	0	*100*	*E/I.E.*			
subtotal	*3,012*	*0.03*	*8*					
subtot. dir. costs	*7,257*	*0.07*	*18*					
Other company costs								
maintenance	2,595	0.03	6	*2*	*% invest.*			
insurance	389	0.00	1	*0.3*	*% invest.*			
general costs	4,000	0.04	10	*2000*		*20*	*fixed+var/1000*	
subtotal	*6,984*	*0.07*	*17*					
Labour						*fixed*	*var/million*	*total*
high	4,000	0.04	10	*50000*	*sal./Y*	*0.05*	*0.3*	*0.08*
average	3,500	0.04	9	*35000*	*sal./Y*	*0.05*	*0.5*	*0.1*
low	3,000	0.03	7	*20000*	*sal./Y*	*0.05*	*1*	*0.15*
subtotal	*10,500*	*0.11*	*26*				*total*	*0.33*
subtotal company costs	*24,741*	*0.25*	*62*				*mill/man*	*0.3*
Depreciation								
5-year	3,636	0.04	9					
10-year	2,144	0.02	5					
20-year	1,698	0.02	4					
building	929	0.01	2					
subtotal	*8,408*	*0.08*	*21*					
Interest								
2/3 investment	6,920	0.07	17	*8*	*% interest*			
fish stock	0	0.00	0					
subtotal	*6,920*	*0.07*	*17*					
subtotal depreciation and interest	*15,328*	*0.15*	*38*					
Total costs:	**40,069**	**0.40**	**100**					

2.7 Pricing

The sheet *Pricing* (table 6) calculates a *market price for the fingerlings* produced. Based on the market weight of the final product (1500 g) and mortality in the ongrowing phase (15%), a number of fingerlings needed per kg end product is calculated. The cost price of the end product is roughly estimated from the market price (6 euro/kg) and the margin (20%). In general, the costs for fingerlings are a fixed percentage (20%) of the total production costs (Rivaud 2001; Sweetman 2001). This percentage is used to calculate a market price. The same calculation is used to estimate the *market price of eggs*. The calculated market price for a fingerling and an egg is 1,25 euro and 0,12 euro/piece respectively.

Table 6. Pricing

REFERENCE POINTS		
Market weight	1500	g
Mortality	15	%
# Fingerlings	0,8	#/kg final prod.
Market price	€ 6,0	kg final prod.
Margin	20,0	%
Cost price	€ 4,8	kg final prod.
Costs fingerlings	20	% of total costs
Price fingerling	**€ 1,25**	**pc**
Mortality	80	%
Margin	20	%
Cost price fingerling	€ 1,002	pc
Costs eggs	15	%
Price egg	**€ 0,12**	**pc**

Table 6 shows that there is an interesting margin between the production cost of a fingerling fish of 10 grams (40 cts) and the potential market price for ongrowing.
At this moment the market price for a fingerling of 10 to 15 cm (10g) is 0.15 €. For large fish of 15-20 cm (20-30g) the price is 2 €/piece for restocking (Tamazouzt, personal communication). Considering the production costs of 0.4 /piece, this means that production of large fingerlings could be of interest.

3. Conclusions

- Based on experience in this project, a hatchery for pike perch with a capacity of 100.000 pieces of 10 gram fish can be developed for an investment of 130.000 euro;
- The annual production costs will amount to 40.000 Euro per year. Labour (26%) and capital (38%) are the most important cost items;
- The production costs per fingerling amount to 40 cent a piece. The potential market price for ongrowing and restocking would allow for a considerable margin. Specialised production of large fingerlings of pike-perch could therefore be an interesting business proposal.

4. References

Deelder C.L., Willemsen, J. 1964. Synopsis of biological data on pike-perch. FAO Fishery Synopsis no. 28, Rome.

Creswell, R. L., Ed. 1993. Aquaculture desk reference. New York.

Ekkes, J. J., J. P. Bakker, et al. (1995). Kwantitatieve informatie voor de glastuinbouw 1995-1996. IKC afd. Glasgroente en Bloemisterij.

Rivaud, C. 2001. Optimising finfish hatchery production - criteria for success. Aquaculture Europe 2001; New species, new technologies, Trondheim, EAS.

Sweetman, J. 2001. How can marine fish hatchery production be optimised? Larview, Gent.

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Species: Pike-perch

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