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Production costs of perch (*Perca fluviatilis*) juveniles

Final report for task 5, WP7

Securing juvenile production of Eurasian perch by improving reproduction and larval rearing

Percatech
Proposal number : 512629

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Summary

Within the project Percatech the cost price of perch juveniles was assessed for three hatcheries within the project consortium. For this purpose a hatchery model was developed. The model is an Excel workbook with 6 linked sheets which each cover relevant aspects of the hatchery. The model includes production, feeding and growth, hatchery design, investments and costs including depreciation. In the last sheet, Pricing, a market price for the fingerlings produced is calculated based on the costs for the final product.

Data were collected in cooperation with hatchery management for Rybarstvi Nove Hrady Ltd (RNH), which applies two systems, hatchery and pond production and PDS Irish Waters Perch Ltd (PDS). For each production system the model was completed based on the data provided. This resulted in cost prices of €0.18/pc, €0.48/pc and €0.31/pc for respectively PDS, RNH hatchery and RNH ponds. For each hatchery the cost price was broken down into costs for feed, other inputs, other company costs, labor, depreciation and interest. For all three hatcheries it was found that labor is the most important cost item. The cost price calculation was followed by the modeling of several options for cost price reduction. For all three hatcheries it was found that the cost price is most sensitive to the number of juveniles produced per year. Increasing the production of the hatchery is the most effective way to reduce the cost price. Out of season reproduction is essential for PDS in order to produce sufficient numbers of juveniles per year to keep the cost price low. For RNH hatchery out of season reproduction of perch could be of interest for the increased production. However, possible conflicts with the production of juveniles of other species in the same hatchery need to be considered in relation to out of season reproduction of perch.

Based on the market size and price of consumption sized perch, mortality during ongrowing, expected profit margin on ongrowing of perch and the expected relative contribution of juvenile costs to the total costs of consumption sized perch, the projected market price for perch juveniles was calculated for each hatchery. In addition the projected market price for juveniles was related to the market size and price of consumption sized perch. It was found that the consumption of perch at small sizes (100g) demands production of juveniles at low costs, lower than currently achieved by the hatcheries, due to the relatively high number of juveniles required for 1kg of market sized perch.

At full production (800,000 juveniles/year) PDS is able to produce perch juveniles at relatively low costs. The margin, however, between cost price and projected market price is still small (€0.02) and easily lost when production drops. It is therefore recommended that PDS strives to increase its annual production of perch juveniles. The current cost price of perch juveniles produced at RNH hatchery and RNH ponds seems too high for economically feasible hatchery operation. It is strongly recommended to increase the production of perch juveniles as this is the most effective measure to reduce the cost price.

1.   Introduction

1.1   Background

The project PERCATECH is about securing the production of perch juveniles. A key element of securing juvenile production is a sufficiently low cost price to enable the hatchery to operate economically sustainable. Juvenile production is not secure unless hatcheries are economically sustainable. Therefore the financial aspects of juvenile perch production are as important as the technical and biological aspects. An important aspect of this project on securing juvenile production is therefore the evaluation of the cost price of the current hatcheries

1.2   Objectives & description of work

The general objective of this workpackage is the assessment of the production costs of perch fingerlings in relation to (i) the rearing system employed (extensive vs intensive), (ii) different socio-economic contexts (mainly labour input and costs in the partner states Czech Republic, Denmark, France, Ireland, The Netherlands), (iii) out-of-season production (impacts of additional costs and efforts related to facilities required to implement out-of-season production of larvae) and other management options and (iv) options for future research.
During the first year of the project, a model (Excel spreadsheet) was constructed which can calculate perch production costs under different types of management. This model was based on the outline of the Hatchery model developed for Pikeperch within the CRAFT project Lucioperca (Q5CR-2001-10594). In the second year, the model will be fed by the data collected from the different partners. By running different of scenarios simulations the impact of rearing system, socio-economic factors, out-of-season reproduction and other management options on costs of production will be assessed.

2. Materials and methods

2.1 Calculation of the cost price: the hatchery model

A hatchery model was used to calculate the cost price of juvenile perch produced in hatcheries. This hatchery model is based on the model developed for pike perch juvenile production within the CRAFT project Lucioperca. The original model was constructed for the design and financial evaluation of hatcheries and was adapted to be used for the calculation of cost prices of juvenile perch produced in existing hatcheries.

The model is an Excel workbook with 6 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 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.

In the Data input sheet the user of the model can fill out all the variables that are needed to calculate the different aspects of the costs of production in the following sheets. All other sheets receive the required data from the data input sheet. No data have to be fill out in any other sheet than the data input sheet.

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

In the sheet feeding schedule, the growth of the fingerlings and the feed needed is described for a period of 90 days. Day 1 is the day of first feeding. An exponential model is used to describe growth rate (SGR) in relation to body weight (W): $SGR = a.W^b$. A and B are set at respectively 7.046 and –0.146 as default based on growth data by Melard (Fig. 1). The growth performance of juveniles can be customized to a specific farm by calculating and using A and B values based on the growth performance at the farm.
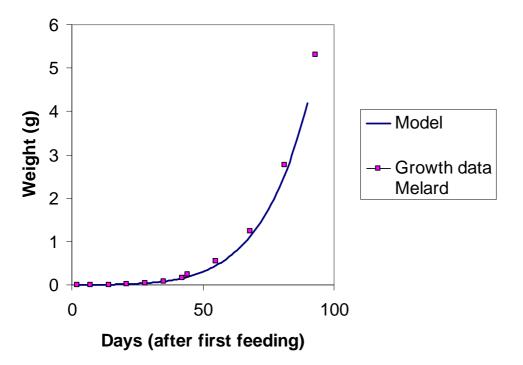
Figure 1. Default growth curve of perch juveniles. Data set 1 (dots) refers to the growth data by Melard. The line represents the resulting modeled growth curve based on data by Melard.

A mortality rate over 90 days has to be fed to the model and is used to calculate the required number of fry 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 perch based on the experience in this project.
During a production cycle different feeds are used. First-feeding is usually done with rotifers or artemia (A) which can also be enriched (+enr). Subsequently different artificial diets are used. 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.
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 (Data input sheet).

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

The sheet hatchery design presents calculations on the equipment needed for every phase in the hatchery. There are 4 different phases identified: broodstock, incubation, first feeding and fingerlings. Live feed culture (Artemia) is also covered; in a separate box the requirements for space (building and land), flow and biofiltration are calculated. Hatchery design was included in this model despite the fact that the model is used to evaluate existing hatcheries and not design of hatcheries. The sheet hatchery design is a useful tool to ensure that the list of required facilities to operate the hatchery is complete. The user can manually adapt calculated dimensions and numbers of facilities to actual situation in the existing hatchery if needed.

The sheet Investments gives an overview of the infrastructure and equipment needed to realize 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.
Despite the fact that the model is used to evaluate existing hatcheries, the sheet Investments is based on hatchery design. This is done to ensure nothing is overlooked and the list of investments is complete. This approach is also useful to split out the different items to the correct depreciation level. It is up to the user to check if the investment breakdown and total the model produces reflects the actual situation of the existing hatchery. In case of deviations the user can manually adapt this by overwriting the calculated figures. As the model uses a linear relation between the level of investment and the number of juveniles produced, the model is not suitable to model the effect of production size on cost price. This however is easily modified if needed by overwriting the imported figures for the dimensions and numbers (column B, Amount) by entering the calculated or actual figures directly in the sheet Investments.

In the sheet Costs 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. 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. 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 €0.80/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. These figures can however by adapted by the users if necessary.

Labour is a very important cost item in a hatchery. In the model there are three categories of labour applied. The default capacity of each category needed is considered to exist of a fixed part (0.05 man-year) and a variable part related to the number of fingerlings produced (0.35, 0.50 and 1 man-year for the respective labour categories). This variable part is difficult to estimate. From literature it is known that the maximum number produced per person is in the order of 1 million fingerlings. For existing farms it is recommended to the user of the model to fill out the actual labour capacity and/or costs at the farm.

Depreciation is copied from the sheet Investments. An interest is calculated over 2/3 of the investment. The interest rate (%) needs to be filled out by the user. No interest in calculated over the fish stock.

The sheet Pricing calculates a market price for the fingerlings produced. Based on the market weight of the final product and the mortality in the ongrowing phase (10%, default), the number of fingerlings needed per kg end product is calculated. The cost price of the end product is roughly estimated from the market price and the margin (20%, default). In general, the costs for fingerlings are a fixed percentage (20%) of the total production costs. This percentage is used to calculate a market price. The user of the model needs to fill out the required data and may overwrite default data.

2.2   Data collection

The model and a user guide were sent to the hatcheries within the consortium in order to be filled out by the farm managers. This way data were collected for two farms within the Percatech consortium:
Partner 5: Rybarstvi Nove Hrady Ltd. (RNH)
Partner 6: PDS Irish Waters Perch Ltd (PDS)
At RNH to different production systems are used (intensive tank system and extensive pond system) and separate models were completed for each.
After initial completion of the model for each farm, the first results were evaluated and discussed with the farm managers involved to check if the results model were realistic and did not include any mistakes.

3.   Results

3.1   PDS Irish Waters Perch Ltd

Introduction
PDS is Irelands first commercial Perch Farm. The company is located at Gowna, Co Cavan in the midlands of Ireland. The farm comprises a purpose built perch hatchery and farm, which is owned and operated by PDS Irish Waters Perch. Presently the farm focuses exclusively on the culture of perch juveniles (1-2g) for ongrowing units in Ireland.

The farm is based on circa 2 hectares and consists of 6 earthen ponds lined with grey clay, a hatchery (15 *362l cylindroconical tanks), weaning unit (15*600l cylindroconical tanks, broodstock unit (8 * 5,000l tanks), Nursery unit (8 * 5,000 l tanks) and offices/storage/chill room. Each unit runs on a separate recirculation system utilising mechanical and biological flters.

Total water volume on site is 9,000m^3 the water is pumped from a borehole to the hatchery and from a nearby stream for the ponds. The water use on the entire site is minimal (<5% volume/week).

Data
The hatchery is designed to produce four batches of 200.000 juveniles each throughout the year, of which three out of season, yielding a total annual production of 800.000 juveniles. The cost price is calculated based on this capacity of the hatchery and not the actual production. The hatchery produces weaned juveniles which are grown to 2g in 65 days.
The complete model for PDS, including the data on which the cost price analysis is based, is attached in Annex 1.

Current situation
 Table 1 provides an overview of the output of the model for PDS.
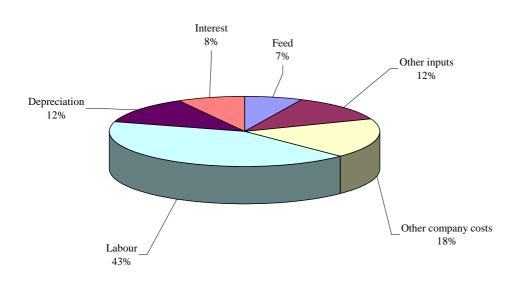
Table 1 Output of the hatchery model for the current situation of PDS

Item	Unit	PDS
Production	(#/year)	800,000
Total investment	€	350,000
Investment per juvenile	€/pc	0.44
Total costs	€/year	143,000
Cost price	€/pc	0.18
Feed costs	€/pc	0.01

Table E in Annex 1 provides a detailed cost breakdown for the production of 800,000 juveniles per year at PDS. Figure 2 presents the breakdown of the cost price into the different components.

*Figure 2 Breakdown of the costs of production of perch juveniles at PDS based on an annual
production of 800,000 juveniles*

Reduction of cost price

Depreciation and *Interest* are fixed at an existing farm while *Other inputs* and *Feed costs* have a
relatively small contribution to the costs price. *Other company costs* are calculated as a fixed
number. Cost price reduction is therefore probably best achieved by focusing on *Labour costs*
and number of juveniles produced. Increased production of juveniles results in cost price
reduction due to fixed costs being split over a larger number of juveniles.

In the following the effect on cost price of increased production and decreased labour costs
are evaluated. This is merely done to demonstrate the potential impact on cost price. Practical
achievement has not been taken into account. As a result some of the presented results may
not be realistic.

Reduction of cost price – Labour costs

The current labour cost amount €60,000, which accounts for 43% of the total costs. Labour
costs per juvenile can be reduced by increasing the production of juveniles at the hatchery. This
will be addressed below. Presently the mere effect of a reduction of labour costs on cost price
is investigated. Again, practical applicability of has not been taken into account. The effects on
cost price of perch juveniles of reductions of labour costs by 10%, 20%, 40% and 80% are
determined. Table 2 presents the results.

Table 2 The effect of reduced labor costs on the cost price of perch juveniles produced at PDS.

Reduction of costs (%)	0 (current)	10%	20%	40%	80%
Total costs (€/yr)	143,000	137,000	131,000	119,000	95,000
Labor costs (€/yr)	60,000	54,000	48,000	36,000	12,000
Labor costs (€/pc)	0.08	0.07	0.06	0.05	0.02
Labor costs (% of total)	42	39	37	30	13

| Cost price (€/pc) | 0.18 | 0.17 | 0.16 | 0.15 | 0.12 |

From Table 2 it is clear that reduced labor costs can reduce the cost price of a perch juvenile. However, quite large reduction of labor costs is needed in order to have a marked impact on cost price of a juvenile perch.
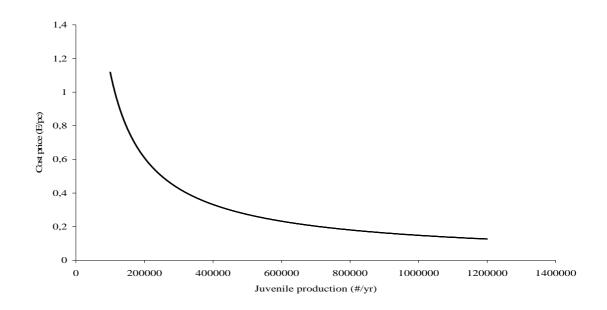
Reduction of cost price – effect of number of juveniles produced

Increased annual production of juveniles results in lower costs per juvenile due to the fixed costs being split over a larger number of juveniles. The effect of the number of juveniles produced was assessed for PDS. The results are presented in Table 3 and Figure 3.

Table 3 Effect of number of juveniles produced annually at PDS on the investment per juvenile, the total annual costs and the cost price of a juvenile.

Juvenile production (#/yr)	200,000	400,000	600,000	800,000	1,000,000	1,200,000
Investment (€/pc)	1.75	0.88	0.58	0.44	0.35	0.29
Total costs (€/yr)	120,000	128,000	135,000	143,000	151,000	158,000
Cost price (€/pc)	0.60	0.32	0.23	0.18	0.15	0.13

*Figure 3 The effect of number of juveniles produced annually at PDS on the cost price of a juvenile. Cost price = 27124 * Number of juveniles per year$^{-0.8769}$, r^2 = 0.99.*

From figure 3 and Table 3 it is clear that number of juveniles produced has a large impact on cost price. As a result annual variation in production has a large impact on the actual cost price and thereby profit margin. The projected production of 800,000 juveniles per year results in a cost price of €0.18/pc. In case of a deviation in annual production of 20%, equivalent to 160,000 juveniles up or down, the resulting cost prices are respectively €0.15/pc and

€0.22/pc. The large relative differences between these cost prices demonstrate the sensitivity of the cost price for differences in annual juvenile production.

The importance of out of season production

The projected production of 800.000 juveniles is based on the production of four equally sized batches of eggs of which three are produced out side the natural reproduction season. Without out of season reproduction the production capacity of the PDS hatchery is reduced to 200,000 juveniles produced in season. The additional investments required to produce out of season are listed in Table 4 and equal approximately €18,100. In the hypothetical situation that PDS only produces in season the total investment in the hatchery is therefore €18,100 lower compared to the current investments. In addition the electrical power consumption would be lower as there is no need to heat or cool broodstock tanks. The currently installed electrical power in the hatchery for year-round production of juveniles is 12 kW. The required electrical power for in season production alone is estimated at 8 kW. The cost price for juveniles was calculated for the scenario of in season production alone, taking into account the reduced production and power consumption compared to year-round production. The results are presented in Table 5.

Table 4 Additional investments installation and operation of out of season broodstock at PDS with a capacity of 800,000 juveniles per year.

Item	Costs
Polytunnel	€ 7,000
Tanks	€5,000
Pumps	€1,500
Piping	€600
Filters	€2,500
Miscellaneous	€1,500
Total	€ 18,100

Table 5 The effect of in season production of juveniles compared to year-round production of juveniles on cost price, total investments and electricity costs at PDS.

		In season production	Year-round production
Total production	#/year	200,000	800,000
Total investment hatchery	€	330,000	350,000
Investment per juvenile	€/pc	1.65	0.44
Total annual costs	€/year	112,000	143,000
Cost price per juvenile	€/pc	0.56	0.18
Electricity costs per juvenile	€/pc	0.04	0.01

From Table 5 it is clear that year-round production of juveniles based on out of season reproduction offers advantages for PDS. The costs per juvenile are approximately 68% lower when juveniles are produced year-round compared to in season production alone. The annual costs are of course higher as the total variable costs increase with increasing numbers produced. The fixed costs however are split over a larger number of juveniles, resulting in a reduced cost price per juvenile.

3.2 Rybarstvi Nove Hrady Ltd (RNH)

Introduction

Petruv zdar spol. s r.o. Ltd. company is tenth biggest traditional fish culture farm in the Czech Republic with 1200 ha of ponds and annual production around 450 t of common carp, 8 t of tench, 2 t of pike, 1 t of pikeperch, 6 t of perch, 40 t of bighead carp, 1 t of European catfish, 8 t of other fish mainly roach. The 70 % of fish production is exported especially to Germany, France, Italy and Poland. Several years ago, the Klatovské Rybá_ství was transformed from state farm to private farm and nowadays is focusing on more pronounced problems as increasing production of non common carp species. One of possibilities is increasing of perch production from today production 6 t up to 15-30 t and first step how to reach this level of production is developing artificial reproduction of perch and intensive pond perch farming. For reproduction of perch was recently constructed hatchery of EU standard of 400 m^2 with 80 thermo-regulate jars each of 10 L, 20 thermo-regulate tanks for sac fry each 200 L, 10 thermo-regulate tanks each of 2000 L for preparation of broodstock, in each jar, tank etc. can automatically controlling temperature and oxygen.

3.2.1 Method 1 Hatchery production

Data

The complete model for the RNH hathery, including the data on which the cost price analysis for the RNH hatchery was based, is included in Annex 2. The hatchery produces 18,000 weaned perch juveniles of 4 to 5g in a period of 90 days.

Current situation
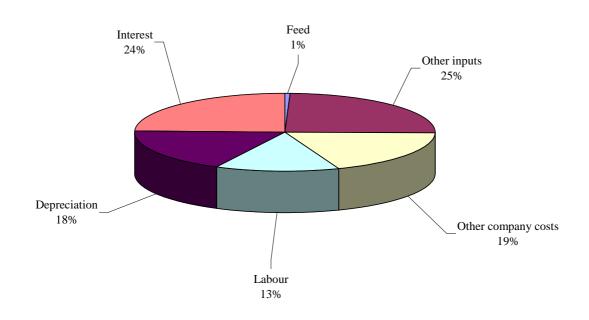
The hatchery produces juveniles of several fish species. These include perch (18,000), pikeperch (5,000), tench (15,000), carp (20,000) and barbel (10,000). As it is very difficult to attribute the total costs to the different species, the cost price is calculated for the total production of 68,000 juveniles and not specifically for perch. Table 6 provides an overview of the current situation at the RNH hatchery.

Table 6 Output of the hatchery model for the current situation of RNH - Hatchery

Item	Unit	Value
Total production	#/year	68,000
Total investment hatchery	€	54,000
Investment per juvenile	€/pc	0.80
Total annual costs	€/year	33,000
Cost price per juvenile	€/pc	0.48
Feed costs per juvenile	€/pc	0.01
Market size juveniles	g	4 to 5

Table J in Annex 2 provides a detailed cost breakdown for the production of 68,000 juveniles per year at RNH. Figure 4 presents the breakdown of the cost price into the different components.

Figure 4 Breakdown of the costs of production of perch juveniles at RNH Hatchery based on an annual production of 68,000 juveniles
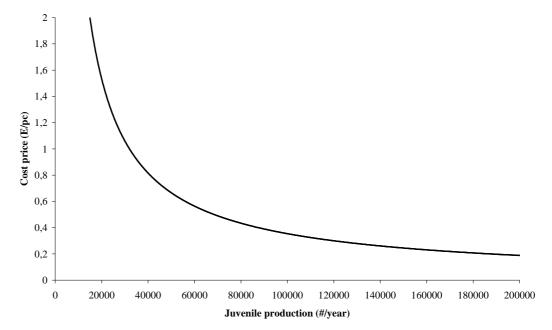
Reduction of cost price – number of juveniles produced
The high investment level per juvenile produced (Table 6) indicates that the first step towards costs price reduction is increasing the number of juveniles produced per year. The effect of an increasing production of juveniles on the cost price is presented in Figure 5. As is clear from figure 5 the cost price drops steeply with increasing numbers of juveniles produced. Table 7 presents the effects of increased juvenile production on investments and costs.

Table 7 Effect of number of juveniles produced annually at RHN hatchery on the investment per juvenile, the total annual costs and the cost price of a juvenile.

Juvenile production (#/yr)	5,000	10,000	20,000	50,000	100,000	200,000
Investment (€/pc)	10.80	5.40	2.70	1.08	0.54	0.27
Total costs (€/yr)	30,000	30,000	31,000	32,000	35,000	40,000
Cost price (€/pc)	5.95	3.00	1.53	0.64	0.35	0.20

Figure 5 The effect of increased production of perch juveniles on the costs price at RNH hatchery. Cost price = 12678* Number of juveniles per year$^{-0.9108}$, r^2 = 0.99.

From figure 5 and Table 7 it is clear that for the RNH hatchery the number of juveniles produced has a large impact on cost price. As a result annual variation in production has a large impact on the actual cost price and thereby profit margin. The projected production of 68,000 juveniles per year results in a cost price of €0.48/pc. In case of a deviation in annual production of 20%, equivalent to13,600 juveniles up or down, the resulting cost prices are respectively €0.43/pc and €0.62/pc. The large relative differences between these cost prices demonstrate the sensitivity of the cost price for differences in annual juvenile production.

Out of season reproduction

Adoption of out of season reproduction enables the hatchery to increase its annual production of juveniles. The RNH hatchery currently produces 18,000 perch juveniles in season. Adoption of out of season reproduction would enable the hatchery to produce perch juveniles year-round. Given the length of the production cycle of 90 days, it is theoretically possible to produce four batches of perch juveniles per year. This would result in a total annual perch juveniles production of 72,000 and a total hatchery production of 122,000 juveniles including the other species mentioned above. The additional investments required are estimated to be the same as for PDS (Table 4). Power consumption is assumed to be four times higher compared to in season production alone. The increased production, additional investments and power consumption were fed into the model for the RNH hatchery.

The results are presented in Table 8.

Table 8 The effect of out of season production of juveniles compared to seasonal production of juveniles on cost price, total investments and electricity costs at RNH hatchery.

		In season production	Year-round production
Total production	#/year	68,000	122,000
Total investment hatchery	€	54,000	74,000
Investment per juvenile	€/pc	0.80	0.61
Total annual costs	€/year	33,000	38,000
Cost price per juvenile	€/pc	0.48	0.31
Electricity costs per juvenile	€/pc	0.01	0.02

From Table 8 it is clear that year-round production of perch juveniles based on out of season reproduction offers advantages for RNH hatchery. The costs per juvenile are approximately 35% lower when juveniles are produced year-round compared to in season production alone. The annual costs are of course higher as the total variable costs increase with increasing numbers produced. The fixed costs however are split over a larger number of juveniles, resulting in a reduced cost price per juvenile. Any conflict between the use of hatchery for out of season perch reproduction and reproduction of other species has not been taken into account. In a worst case scenario the production of juveniles of the other species has to be totally abandoned. In that case the total annual hatchery production equals 72,000 perch juveniles alone. This results in a higher cost price of € 0.50/pc. Clearly conflicts of interest between out of season reproduction of perch and the production of juveniles of other species need to be carefully considered before investments in out of season reproduction are made. A possible solution could be the annual production of two instead of three batches of perch out of season.

3.2.2 Method 2 Pond culture

Data
The complete model for the RNH ponds, including the data on which the cost price analyses for the RNH ponds were based, is included in Annex 3. Juvenile production in this system relies on natural food in the ponds. Feed costs are in fact costs for pond fertilization.

Current situation
At present 120,000 perch juveniles are annually produced in the pond system. The average final weight of the juveniles is 2.5g which is reached in approximately 90 days. Table 9 provides an overview of the current situation at the RNH ponds.

Table 9 Output of the hatchery model for the current situation of RNH - Ponds

Item	Unit	Value
Total production	#/year	120,000
Total investment hatchery	€	144,000
Investment per juvenile	€/pc	1.20
Total annual costs	€/year	37,000
Cost price per juvenile	€/pc	0.31
Feed costs per juvenile	€/pc	0.01
Market size juveniles	g	2.5

Table O in Annex 3 provides a detailed cost breakdown for the production of 120,000 juveniles per year at RNH ponds. Figure 6 presents the breakdown of the cost price into the different components.
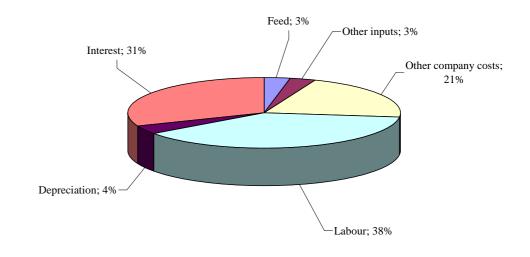
Figure 6 Breakdown of the costs of production of perch juveniles at RNH Ponds based on an annual production of 120,000 juveniles.

Reduction of cost price – number of juveniles produced
As in the RNH hatchery, the high investment level per juvenile produced (table 9) indicates that the first step towards costs price reduction is increasing the number of juveniles produced per year. The effect of an increasing production of juveniles on the cost price is presented in Figure 7. As is clear from figure 7 the cost price drops steeply with increasing numbers of juveniles produced. Table 10 presents the effects of increased juvenile production on investments and costs.

Table 10 Effect of number of juveniles produced annually at RHN ponds on the investment per juvenile, the total annual costs and the cost price of a juvenile.

Juvenile production (#/yr)	10,000	50,000	100,000	120,000	140,000	240,000
Investment (€/pc)	14.37	2.88	1.44	1.20	1.03	0.60
Total costs (€/yr)	33,000	34,000	36,000	37,000	37,000	41,000
Cost price (€/pc)	3.27	0.68	0.36	0.31	0.27	0.17
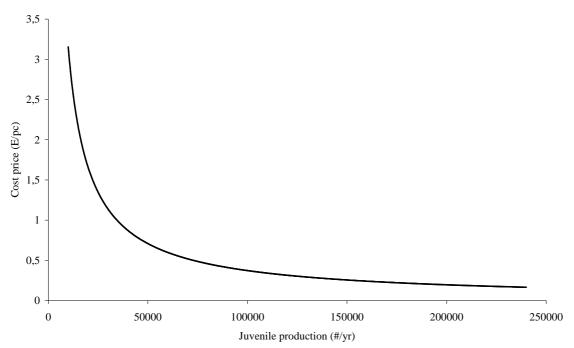
Figure 7 The effect of increased production of perch juveniles on the costs price at RNH hatchery. Cost price = 16278 * Number of juveniles per year$^{0.9282}$, r^2 = 0.99.

From figure 7 and Table 10 it is clear that for the RNH ponds the number of juveniles produced has a large impact on cost price. As a result annual variation in production has a large impact on the actual cost price and thereby profit margin. The projected production of 120,000 juveniles per year results in a cost price of €0.31/pc. In case of a deviation in annual production of 20%, equivalent to 24,000 juveniles up or down, the resulting cost prices are respectively €0.27/pc and €0.39/pc. The large relative differences between these cost prices demonstrate the sensitivity of the cost price for differences in annual juvenile production.

Reduction of cost price – Labour costs

The current labour cost amount €14,000 and account for 38% of the cost price, which is thereby the most important cost item. Labour costs per juvenile can be reduced by increasing the production of juveniles at the hatchery. This has been addressed above. Presently the mere effect of a reduction of labour costs on cost price is investigated. Again, practical applicability of has not been taken into account. The effects on cost price of perch juveniles of reductions of labour costs by 10%, 20%, 40% and 80% are determined. Table 11 presents the results.

Table 11 The effect of reduced labor costs on the cost price of perch juveniles produced at RNH ponds.

Reduction of costs (%)	0 (current)	10%	20%	40%	80%
Total costs (€/yr)	36,746	35,346	33,946	31,146	25,546
Labor costs (€/yr)	14,000	12,600	11,200	8,400	2,800
Labor costs (€/pc)	0.12	0.11	0.09	0.07	0.02
Labor costs (% of total)	38%	36%	33%	27%	11%
Cost price (€/pc)	0.31	0.29	0.28	0.26	0.21

From Table 11 it is clear that reduced labor costs can reduce the cost price of a perch juvenile. However, quite large reduction of labor costs is needed in order to have a marked impact on cost price of a juvenile perch.

3.3 Projected market price for perch juveniles

A projected market price for a perch juvenile is a good reference for the calculated cost price. The market price can be estimated based on:
1) The market weight of the consumption sized fish (g);
2) Mortality rate during ongrowing (%);
3) The market price of the consumption sized fish (€/kg);
4) The desired margin between cost price and market price of consumption sized fish (%);
5) The relative contribution of juvenile costs to the cost price of consumption sized fish (%).

The market weight (1) and the mortality during ongrowing (2) yield the number of juveniles required to produce 1kg of market sized fish. The market price (3) and desired margin (4) yield the cost price for consumption sized fish. This combined with the contribution of juvenile cost (5) to the cost price yields the projected market price for juveniles. The projected market prices for perch juveniles vary between hatcheries as a result different ongrowing procedures and final products of the customers of the hatcheries. This is presented in Table 12.

Table 12 Calculation of the projected market price of perch juveniles for PDS, RNH hatchery and RNH ponds compared to the actual costs of production.

Item	Unit	PDS	RNH hatchery	RNH ponds
Market weight consumption sized fish	(g)	200	100	100
Mortality during ongrowing	(%)	15	40	40
# Juveniles	(#/kg)	5.8	14	14
Market price consumption sized fish	(€/kg)	7.20	1.50	1.50
Profit margin	(%)	20	35	35
Cost price	(€/kg)	5.76	0.98	0.98
Costs juveniles	(% of cost price)	20	20	20
Projected market price juveniles	(€/pc)	0.20	0.014	0.014
Actual cost price juveniles	(€/pc)	0.18	0.48	0.31

From table 12 it is clear that in case of PDS the projected market price of juveniles is €0.02 higher than the cost price (based on 800.000 juveniles produced per year). As shown above the cost price is sensitive to the actual number of juveniles produced. This means that the current margin is easily lost in case produced numbers drop. From Figure 3 it can be derived that a cost price of € 0.20 is reached at a production of 720,000 juveniles or a deviation of the projected production of 11%. It is therefore recommended, in general, that the market price for juveniles is linked to the production of the hatchery.

In the case of pikeperch juvenile production in an intensive hatchery in The Netherlands the projected market price was calculated to be € 1.25/pc based on a market price of € 6.00/kg and a market size of 1.5kg, whereas the cost price was estimated at €0.40/pc. Clearly a considerable margin exists between cost price and market price: € 0.85/pc or 213%. Based on this margin it was concluded that pikeperch juvenile production is an interesting business opportunity (Kamstra, 2003).

Such margin between costs of production and market price does not exist in the case of perch production despite considerably lower costs for the production of perch juveniles at PDS compared to pikeperch. The determination of the minimal required margin between cost price and market price of perch juveniles that would make a hatchery economically viable lies beyond
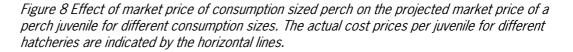
the scope of this project. It is however interesting in this respect to investigate the possibilities to enlarge this margin. This can be achieved by either reduction of the cost price, increasing the market price for juveniles or both. The latter will assessed below while means to reduce the cost price have been assessed above for the different hatcheries.
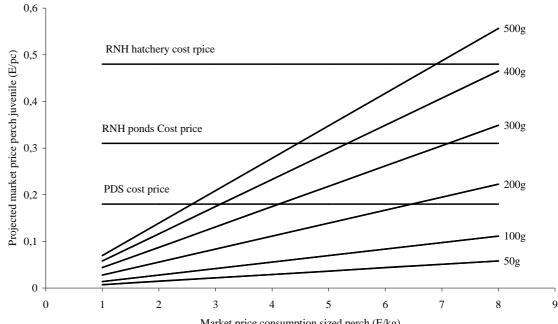
The main difference between the variables determining the projected market price for perch juveniles and pikeperch juveniles is the market size of the consumption sized fish, or, in other words the number of juveniles required per kg of consumption sized fish. Clearly perch will always be sold at smaller sizes than pikeperch while the market prices for consumption sized fish lie within more or less the same range. This means that the margin between cost price and market price for juveniles will always be smaller for perch compared to pikeperch. Given the relatively large range of potential market sizes for consumption sized perch (100-500g) it is interesting to assess the effect of market size on the projected market price of juveniles for perch.

The effect of market price of consumption sized fish on the projected market price for juveniles was calculated by the model for different market sizes of the consumption sized fish. The mortality rate during ongrowing, the desired margin between cost price and market price of consumption sized fish and the contribution of juvenile costs to the cost price of market sized fish were fixed at respectively 10%, 20% and 20%. The results are presented in Figure 8. From Figure 8 it is clear that for a given market price larger consumption size results in a higher projected market prize for juveniles in all cases. The actual cost prices of juvenile production at the three hatcheries are also indicated in Figure 8 by horizontal lines. The intersections between these lines and the relations between projected juvenile price vs. market price consumption sized fish represent the minimal required market price for consumption sized fish for a given market weight. The minimal required market price is defined as the market price for consumption sized perch that yields a projected market price for juveniles equal to the cost price. Mortality during ongrowing, profit margin on consumption sized fish and the relative contribution of juvenile costs to the total cost price are fixed at respectively 10%, 20% and 20%. The results are summarized in Table 12. Figure 8 and Table 12 make clear that production of juveniles for the production of perch of 100g or smaller is not an interesting business opportunity for all hatcheries. Assuming a maximal market price for consumption sized fish of €8/kg, PDS should be able to sell juveniles for ongrowing to 200g and more, RNH ponds 300g and more and RNH Hatchery to 500g and more.

Table 12 Minimal required market prices (€/kg) of consumption sized perch for the three hatcheries to obtain a projected market price for juveniles (€/pc) higher than the cost price (€/pc).

Market weight (g)	PDS	RNH hatchery	RNH Pond
50	24.7	65.8	42.5
100	12.9	34.5	22.3
200	6.5	17.3	11.2
300	4.1	11.0	7.1
400	3.1	8.3	5.3
500	2.6	6.9	4.5

Figure 8 Effect of market price of consumption sized perch on the projected market price of a perch juvenile for different consumption sizes. The actual cost prices per juvenile for different hatcheries are indicated by the horizontal lines.

4.   Discussion

4.1   Comparison between juvenile production at PDS and RNH

Cost price

Large differences exist between the three hatcheries in this study regarding the costs of production per perch juvenile. The cost price of perch juveniles at the hatcheries within Percatech ranges from €0.18/pc at PDS to €0.48/pc at the RNH hatchery. The pond production of juveniles by RNH ponds results in a cost price of €0.31/pc.

Surprisingly the use of a low cost, extensive pond system combined with relatively low costs for labor does not result in the lowest cost price. This is due the relatively low number of juveniles produced. Doubling of the production from 120,000 to 240,000 juveniles results in a cost price lower than the current cost price at PDS at a production of 800,000 juveniles annually (table 10).

The RNH hatchery has the potential to produce perch juveniles at low costs. The total investment in the hatchery is the lowest, the labor costs are low and the hatchery produces other species as well which splits fixed costs of a larger number of juveniles. Despite this, the cost price is the highest for RNH hatchery. This is first of all due to the low number of juveniles produced.

The lowest cost price combined with the highest total investments, total annual costs and total labor costs at PDS and the sensitivity for this cost price to changes in number produced, demonstrate that a perch hatchery can produce juveniles at relatively low costs despite these facts as long as large numbers of juveniles are produced. Figure 9 presents for each hatchery the required production of juveniles per year to yield a cost price of €0.20/pc. Clearly the high total investment, total annual costs and total labor costs at PDS compared to the two RNH hatcheries demand a far higher production of juveniles per year in order to obtain a cost price of €0.20/pc.
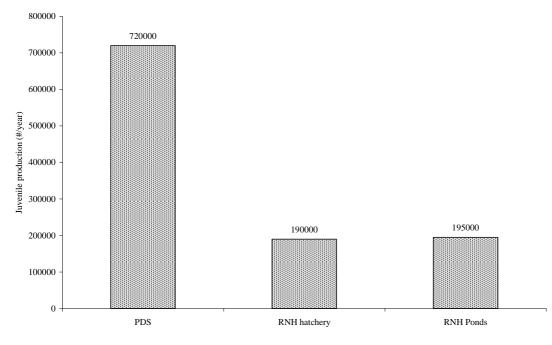
Figure 9 Annual juvenile production (#/year) required to yield a cost price of €0.20/pc for PDS, RNH hatchery and RNH ponds.

Breakdown of cost price

Figure 10 presents the breakdown of the absolute cost price of perch juveniles for the three hatcheries. The relative contributions to the cost price of the different cost items are shown in Figures 2 (PDS), 4 (RNH Hatchery) and 6 (RNH ponds). For each cost item the differences between the hatcheries will be discussed below.

Feed

Absolute feed costs do not differ between the three hatcheries. Feed costs are proportional to the actual juvenile production and the feed costs per juvenile are therefore not affected by the total number of juveniles produced.

Other inputs

Other inputs are lowest for the pond production system of RNH. This is due to the fact that this system does not consume electricity. For both PDS and RNH Other inputs is the second largest cost item after Labor. The total costs for Other inputs are more than twice as high for PDS compared to RNH Hatchery (Table E, Annex 1 and Table J, Annex 2). However, the costs per juvenile are lower at PDS due to the larger number of juveniles produced. For the PDS this cost item consists mostly of electricity costs whereas for RNH Hatchery the costs mainly consist of cost for gas.

Other company costs

For all three hatcheries the other company costs are the third largest contributor to the total costs. The Other company costs consist of maintenance and insurance costs which are proportional to the total investments and of general costs which is mainly proportional to the number of juveniles produced. PDS has the highest total investment but the lowest investment per juvenile produced (Table 1, 6 and 9). As a result the Other company costs per juvenile are lowest for PDS.

Labor

Labor costs are generally the most important cost item in hatchery production. The three perch hatcheries are no exception. However, large differences in labor cost per juvenile exist between the hatcheries. Labor is far more expensive in Ireland (PDS) compared to the Czech republic (RNH) and total labor costs are more than four times higher at PDS compared to the two RNH hatcheries (Tables E, J and O). However, due to the large number of juveniles produced at PDS compared to RNH the labor costs per juvenile are lower at PDS. This underlines the importance of the production of large numbers of juveniles for economic feasibility.

Depreciation and Interest are a large part of the cost price per juvenile at RNH hatchery and RNH ponds compared to PDS. This is due to the difference in interest level between the Czech republic and Ireland, 12% and 5% respectively. Next to this, again the number of juveniles produced is an important reason for the cost per juvenile being lower at PDS.
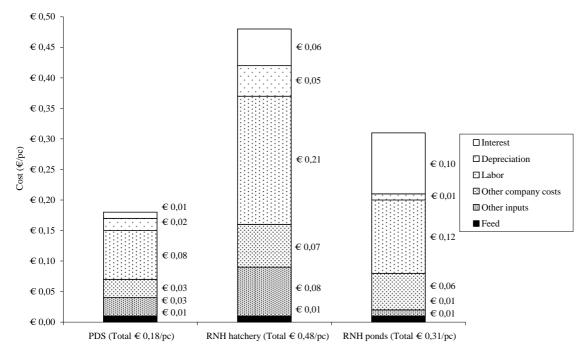
Figure 10 Breakdown of the cost price of perch juveniles produced at PDS, RNH hatchery and RNH ponds. For each cost item the costs per juvenile are presented next to the bar.

4.2   Cost of production compared to other species

Costs of production of juveniles of other species can be a useful reference. Table 13 provides breakdown of costs for seabass, pikeperch and perch. Seabass hatchery technology can be considered as relatively well established and therefore largely optimized. Pikeperch juvenile production on the other hand is relatively new as is perch juvenile production and therefore likely to be not fully optimized yet. Objective comparison between these three hatchery productions may not be possible due to differences in production scale and socio-economic conditions such as labor costs. However, such comparison can still provide useful in the current status of perch hatcheries and the potential room for improvements. From Table 13 it appears that the production costs of seabass juveniles and perch juveniles at PDS are not very different despite the fact that seabass hatchery technology is fully established and perch hatchery technology is not. Both hatchery technologies are comparable in terms of live food requirement which is reflected by the similar costs for this item. The main difference is the total costs for labor. It is however not known whether this difference results form differences in labor demand per juvenile or differences in costs of labor. Based on the comparison between costs of production for perch and seabass it seems that the projected cost price for perch juveniles is not unrealistically low at €0.18 and can be expected to decrease with further optimization of hatchery technology.

Table 13 Comparison of the breakdown of costs (€/pc) between 2g seabass juveniles (France), pikeperch (Netherlands) and perch (PDS)

Cost item	Seabass	Pikeperch	Perch
Interest + depreciation	0.03	0.15	0.03
Feed	0.06	0.04	0.02
Labor	0.03	0.11	0.08
Other inputs & costs	0.03	0.10	0.05
Total	0.15	0.40	0.18

5.   Conclusions

The cost price of perch juveniles at the hatcheries within Percatech ranges from €0.18/pc at PDS to €0.48/pc at the RNH hatchery. The pond production of juveniles by RNH ponds results in a cost price of €0.31/pc.

For PDS and RIVH Ponds labor costs are the most important costs in perch juvenile production. This is common to most hatcheries.

For all three hatcheries the cost price is sensitive to the actual number of perch juveniles produced. Increased production is in all cases the most effective way to reduce the cost price.

As a result of the sensitivity of the cost price to the production, annual variations in production result in large differences in cost price between years. It is therefore recommended that the market price of perch juveniles is directly related to the annual production.

Small consumption size of perch demands production of perch juveniles at low costs. At present the cost price of a perch juvenile produced by any of the three hatcheries is too high to for ongrowing of perch to small market sizes (100g).

Out of season reproduction of perch juveniles is a necessity for PDS as in season reproduction alone results in a low juvenile production and a high cost price. The increase in juvenile production associated to out of season reproduction results in a lower cost price despite the demand for additional investments and higher operational costs.

For the RHN hatchery the situation is more complex as this hatchery also produces juveniles of other species. Incase out of season production of perch does not conflict with the production of juveniles of any of the other species the cost price is reduced. However, in case adoption of out of season reproduction of perch means abandoning the production of the other species, the cost price increases. This means that adoption of out of season reproduction of perch should be carefully considered in light of the other productions.

It is possible to produce perch juveniles at relatively costs in a hatchery that requires high total investment, high total annual costs and high total labor costs, provided the production of the hatchery is high.

6.   Recommendations to the SME's

<u>PDS</u>

At full production (800,000 juveniles/year) PDS is able to produce perch juveniles at relatively low costs. The margin, however, between cost price and projected market price is still small (€0.02) and easily lost when production drops. It is therefore recommended that PDS strives to increase its annual production of perch juveniles.

<u>RNH Hatchery and RNH ponds</u>

The current cost price of perch juveniles produced at RNH hatchery seems too high for economically feasible hatchery operation. It is strongly recommended to increase the production of perch juveniles as this is the most effective measure to reduce the cost price.

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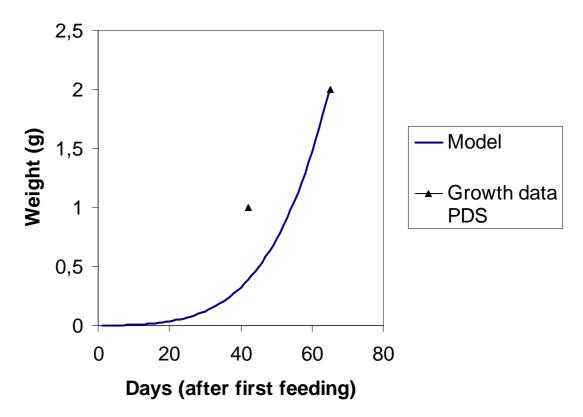
Date: 30 October 2006

Annex 1 Completed Hatchery model for PDS

Table A Input - Output

Species:	Perch	
Input		
Production	800.000	#/Y
Batches	4	#/Y
Output		
Investment	€ 350.136	
Investment	€ ,438	/pc
Costs	€ 142.995	total/Y
Costs	€ 0,179	/pc
Feed cost	€ 0,012	/pc
Market price	€ 0,20	/pc

Figure A Growth curve

Table B Feeding schedule PDS

Species:	Perch				Artemia:						90 days
Number:	1.142.857	initial			Hatching		500	% ww of cysts			sum (kg)
Mortality	30	% cum.			DM		10	% of ww			price (E/kg)
Number:	800.000	final			Eff. Feeding		100	%			cost (E)
					DM/g cysts		0,5				cost (E/ind)
SGR=a.W^b					FCR		0,7	DM-basis			%
a:	7										
b:	-0,2										

Daynr.	W	Mort.	SGR	Biomass	Feed	Rotifers	Artemia	Dana Start 100	Dana Start 300	Weanex 500	Weanex 700
	(g)	(%)	(%)	(g)	g DM	g cysts!	(g)	(g)	(g)	(g)	(g)
1	0,001	0	13,9	1143	120	0	0	0	0	0	0
2	0,001	0	27,1	1314	286	0	0	0	0	0	0
3	0,002	0	25,7	1723	353	706	0	0	0	0	0
4	0,002	0	24,4	2227	431	861	0	0	0	0	0
5	0,002	0	23,2	2842	520	936	104	0	0	0	0
6	0,003	0	22,2	3585	623	997	249	0	0	0	0
7	0,004	0	21,2	4475	740	740	740	0	0	0	0
8	0,005	0	20,3	5532	873	349	1397	0	0	0	0
9	0,006	0	19,5	6779	1023	0	2046	0	0	0	0
10	0,007	0	18,8	8240	1191	0	2382	0	0	0	0
11	0,009	0	18,1	9942	1379	0	2758	0	0	0	0
12	0,010	0	17,4	11912	1589	0	3177	0	0	0	0
13	0,012	0	16,8	14181	1821	0	3642	0	0	0	0
14	0,015	0	16,3	16783	2077	0	4155	0	0	0	0
15	0,017	0	15,8	19750	2360	0	4720	0	0	0	0
16	0,020	2	15,3	23122	2617	0	0	2617	0	0	0
17	0,024	2	14,8	26398	2890	0	0	2890	0	0	0
18	0,027	2	14,4	29988	3179	0	0	3179	0	0	0
19	0,032	2	14,0	33904	3483	0	0	3483	0	0	0
20	0,036	2	13,6	38159	3803	0	0	3803	0	0	0
21	0,042	2	13,2	42762	4138	0	0	4138	0	0	0
22	0,047	2	12,9	47723	4487	0	0	4038	449	0	0
23	0,054	2	12,6	53048	4850	0	0	4365	485	0	0
24	0,061	2	12,2	58743	5226	0	0	4181	1045	0	0
25	0,069	2	11,9	64811	5615	0	0	4492	1123	0	0
26	0,078	2	11,7	71252	6015	0	0	3910	2105	0	0
27	0,088	2	11,4	78063	6425	0	0	3212	3212	0	0
28	0,098	2	11,1	85240	6844	0	0	1369	5475	0	0
29	0,110	2	10,9	92773	7270	0	0	1454	5816	0	0
30	0,122	2	10,7	100652	7702	0	0	0	7702	0	0
31	0,136	0	10,4	108859	8378	0	0	0	8378	0	0
32	0,151	0	10,2	120828	9098	0	0	0	9098	0	0
33	0,167	0	10,0	133825	9862	0	0	0	9862	0	0
34	0,18	0	9,8	147913	10673	0	0	0	10673	0	0
35	0,20	0	9,6	163161	11534	0	0	0	11534	0	0
36	0,22	0	9,4	179637	12445	0	0	0	12445	0	0
37	0,25	0	9,3	197416	13409	0	0	0	13409	0	0
38	0,27	0	9,1	216571	14427	0	0	0	14427	0	0
39	0,30	0	8,9	237181	15503	0	0	0	15503	0	0
40	0,32	0	8,8	259328	16637	0	0	0	16637	0	0
41	0,35	0	8,6	283095	17832	0	0	0	16049	1783	0
42	0,39	0	8,5	308569	19090	0	0	0	17181	1909	0
43	0,42	0	8,3	335842	20414	0	0	0	16331	4083	0
44	0,46	0	8,2	365004	21805	0	0	0	17444	4361	0
45	0,50	0	8,1	396155	23266	0	0	0	15123	8143	0
46	0,54	0	7,9	429391	24798	0	0	0	12399	12399	0
47	0,58	0	7,8	464818	26405	0	0	0	5281	21124	0
48	0,63	0	7,7	502540	28089	0	0	0	5618	22471	0
49	0,68	0	7,6	542667	29852	0	0	0	0	29852	0
50	0,73	0	7,5	585313	31696	0	0	0	0	31696	0
51	0,79	0	7,3	630593	33624	0	0	0	0	33624	0
52	0,85	0	7,2	678628	35639	0	0	0	0	35639	0
53	0,91	0	7,1	729540	37742	0	0	0	0	37742	0
54	0,98	0	7,0	783458	39937	0	0	0	0	39937	0
55	1,05	0	6,9	840511	42227	0	0	0	0	42227	0
56	1,13	0	6,8	900835	44613	0	0	0	0	44613	0
57	1,21	0	6,7	964567	47098	0	0	0	0	47098	0
58	1,29	0	6,7	1031850	49686	0	0	0	0	49686	0
59	1,38	0	6,6	1102830	52379	0	0	0	0	52379	0
60	1,47	0	6,5	1177657	55179	0	0	0	0	55179	0
61	1,57	0	6,4	1256484	58090	0	0	0	0	58090	0
62	1,67	0	6,3	1339470	61114	0	0	0	0	61114	0
63	1,78	0	6,2	1426776	64255	0	0	0	0	64255	0
64	1,90	0	6,2	1518570	67515	0	0	0	0	67515	0
65	2,02	0	6,1	1615020							
	sum	30,0									

Feeding schedule PDS continued

	Rotifers	Artemia	Dana Start 100	Dana Start 300	Weanex 500	Weanex 700
	5	25	47	255	827	0
	10	180	14	12	2	1,35
	46	4567	660	3058	1654	0
	0,000	0,006	0,001	0,004	0,002	0,000
	0	46	7	31	17	0
Daynr.	Rotifers	Artemia	Dana Start 100	Dana Start 300	Weanex 500	Weanex 700
	% DM	%	%	%	%	%
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	100	0	0	0	0	0
4	100	0	0	0	0	0
5	90	10	0	0	0	0
6	80	20	0	0	0	0
7	50	50	0	0	0	0
8	20	80	0	0	0	0
9	0	100	0	0	0	0
10	0	100	0	0	0	0
11	0	100	0	0	0	0
12	0	100	0	0	0	0
13	0	100	0	0	0	0
14	0	100	0	0	0	0
15	0	100	0	0	0	0
16	0	0	100	0	0	0
17	0	0	100	0	0	0
18	0	0	100	0	0	0
19	0	0	100	0	0	0
20	0	0	100	0	0	0
21	0	0	100	0	0	0
22	0	0	90	10	0	0
23	0	0	90	10	0	0
24	0	0	80	20	0	0
25	0	0	80	20	0	0
26	0	0	65	35	0	0
27	0	0	50	50	0	0
28	0	0	20	80	0	0
29	0	0	20	80	0	0
30	0	0	0	100	0	0
31	0	0	0	100	0	0
32	0	0	0	100	0	0
33	0	0	0	100	0	0
34	0	0	0	100	0	0
35	0	0	0	100	0	0
36	0	0	0	100	0	0
37	0	0	0	100	0	0
38	0	0	0	100	0	0
39	0	0	0	100	0	0
40	0	0	0	100	0	0
41	0	0	0	90	10	0
42	0	0	0	90	10	0
43	0	0	0	80	20	0
44	0	0	0	80	20	0
45	0	0	0	65	35	0
46	0	0	0	50	50	0
47	0	0	0	20	80	0
48	0	0	0	20	80	0
49	0	0	0	0	100	0
50	0	0	0	0	100	0
51	0	0	0	0	100	0
52	0	0	0	0	100	0
53	0	0	0	0	100	0
54	0	0	0	0	100	0
55	0	0	0	0	100	0
56	0	0	0	0	100	0
57	0	0	0	0	100	0
58	0	0	0	0	100	0
59	0	0	0	0	100	0
60	0	0	0	0	100	0
61	0	0	0	0	100	0
62	0	0	0	0	100	0
63	0	0	0	0	100	0
64	0	0	0	0	100	0
65	0	0	0	0	100	0

Table C Design hatchery

Production	800.000	# 90-d/Y		Rearing volume	30	m3
No. batches	4	#/Y		Water depth	0,8	m
				Rearing space total	38	m2
Broodstock				Ratio building:tanks	2	
ave. weight female	300	g		Building space	75	m2
fecundity	120.000	#/kg F		Ratio land:building	1,5	
fertilisation	95	%		Area	113	m2
fertilised eggs	114.000	#/kg F				
				Pumps		
sex ratio	0	w/w M/F		Ratio recirc.:volume	1,3	
density	5	kg/m3		Recirculation flow	39	m3/h
density	16,7	#/m3		Pump cap. Rel.	15	W/m3
				Total electrical power	12	kW
total weight	13,7	kg				
tank size	2,7	m3		**Biofilter**		
				Max feed load	17	kg
fertilised eggs	1.203.008	#/Y		Load biofilter	10	kg/m3
fertilised eggs per batch	300.752	#		Size biofilter	2	m3
Spawning/Incubation						
density	114.000	#/pair				
fry	1.203.008	#/Y				
fry per batch	300.752	#				
nests/incubators	3	#				
size incubator	1	m2				
First feeding	day 1-30					
density final	40.876	#/m3				
density final	5	kg/m3				
survival	70	%				
density start	58.395	#/m3				
density start	0,1	kg/m3				
weaned fingerlings	842.105	#/Y				
fingerlings per batch	210.526	#				
tank volume	5	m3				
size tanks	1	m3				
tanks	8	#				
Fingerlings	day 30-90					
density final	9.907	#/m3				
density final	20	kg/m3				
survival	95	%				
density start	10.428	#/m3				
density start	1	kg/m3				

weaned fingerlings	800.000	#/Y				
fingerlings per batch	200.000	#				
tank volume	20	m3				
size tanks	5	m3				
tanks	4	#				
Artemia						
max. cysts	249	g				
max density	3,0	g/l				
incubation	83	l				
size incubator	9	l				
incubators	18,5	#				
incubation total	166	l				

Table D Investments

Description	Amount	unit	E/unit	Subtotal	%	Total	Depreciation term			
							5	10	20	30
Land	233	m²	3,50	816	0	816				
Permits				2.500	1					
Hookup electra				2.000	1					
Hookup phone				350	0					
Hookup gas				0	0					
Hookup water				1.000	0					
Hookup sewer				2.000	1					
Well				7.000	2	14.850				
Building	155	m²	1.000	155.000	44		30	0	0	0	5.167
Groundwork	155	m²	20	3.100	1	158.100				
Heating	155	m²	10	1.550	0		5	310	0	0	0
Ventilation	155	m²	0	0	0		5	0	0	0	0
Lighting	155	m²	15	2.325	1		5	465	0	0	0
Electra	12	kW	10	120	0	3.995	5	24	0	0	0
Broodstock tanks	2,74	m²	36	99	0		20	0	0	5	0
Incubators	2,64	l	12.225	32.274	9		20	0	0	1.614	0
First feeding	2,47	m3	600	1.482	0		20	0	0	74	0
Fingerlings	54,71	m3	600	32.826	9		20	0	0	1.641	0
Artemia	212,74	l	20	4.255	1	70.936	20	0	0	213	0
Piping	78	m2	50	3.900	1		20	0	0	195	0
Drum	81	m3/h	150	12.150	3		10	0	1.215	0	0
Pumps	81	m3/h	25	2.025	1		5	405	0	0	0
Filtermaterial	10	m³	250	2.500	1	20.575	20	0	0	125	0
Other										
De-ironing	96	kg feed	0	0	0		5	0	0	0	0
Power aggregate	1,21	kW	400	484	0		10	0	48	0	0
Measurements and control	78	m3	25	1.950	1		5	390	0	0	0
Alarm				1.000	0		5	200	0	0	0
Septic tank				4.000	1		20	0	0	200	0
Feeding equipment	15	# tanks	100	2.500	1		10	0	250	0	0
Weighing equipment				1.000	0		5	200	0	0	0
Sorting equipment				7.000	2		5	1.400	0	0	0
Cooler/freezer				5.000	1		20	0	0	250	0
High pressure cleaner				3.000	1		5	600	0	0	0
Office				5.000	1	30.934	10	0	500	0	0
Out of season facilities										
Polytunnel	1		7.000	7.000	2		5	1.400	0	0	0
Tanks	1		5.000	5.000	1		20	0	0	250	0
Piping	1		600	600	0		20	0	0	30	0
Pumps	1		1.500	1.500	0		5	300	0	0	0
Filters	1		2.500	2.500	1		20	0	0	125	0
Miscellaneous	1		1.500	1.500	0	18.100	10	0	150	0	0
Unforeseen	10%			31.831		31.831				
							5.694	2.163	4.722	5.167
Total initial investment					101	**350.136**				
Production (#/Y)						800.000				
Relative Investment (euro/pc)						**0,44**	Yearly depreciation:		17.746	
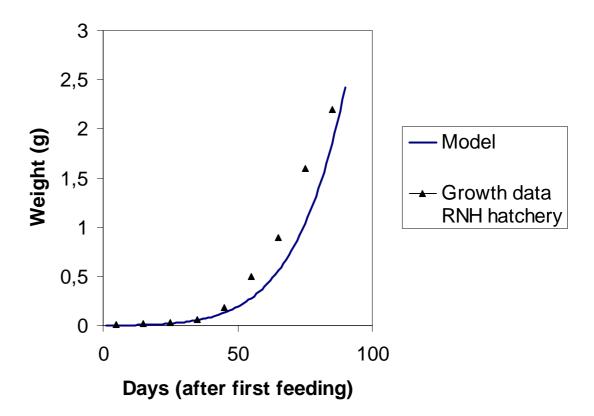
Table E Costs

		Amount						
Production (#/Y)		800.000						
		euro	euro/pc	%				
Feed	total	9.984	0,01	7	see feed schedule			
	Rotifers	46	0,00	0				
	Artemia	4567	0,01	3				
	Dana Start 100	660	0,00	0				
	Dana Start 300	3058	0,00	2				
	Weanex 500	1654	0,00	1				
	Weanex 700	0	0,00	0				
Other inputs								
	electricity	12.614	0,02	9	0,12	E/kWh		
	gas	0	0,00	0	0	E/m3	0	m3 gas/m2
	water	0,00	0,00	0	borehole			
	oxygen	927	0,00	1	0,8	E/kg	1	kg O2/kg feed
	chem., med., etc.	4.000	0,01	3				
	levy effluent	0	0,00	0	0	E/I.E.		
	subtotal	17.541	0,02	12				
	subtot. dir. costs	27.525	0,03	19				
Other company costs								
	maintenance	7.003	0,01	5	2	% invest.		
	insurance	1.050	0,00	1	0,3	% invest.		
	general costs	18.000	0,02	13	2000	20	fixed+var/1000	
	subtotal	26.053	0,03	18				
Labour						fixed	var/million	tota
	high	40.000	0,05	28	40000	sal./Y	1	0
	average	20.000	0,03	14	20000	sal./Y	1	0
	low	0	0,00	0	20000	sal./Y	0	0
	subtotal	60.000	0,08	42			total	
	subtotal company costs	113.578	0,14	79			mill/man	(
Depreciation								
	5-year	5.694	0,01	4				
	10-year	2.163	0,00	2				
	20-year	4.722	0,01	3				
	building	5.167	0,01	4				
	subtotal	17.746	0,02	12				
Interest								
	2/3 investment	11.671	0,01	8	5	% interest		
	fish stock	0	0,00	0				
	subtotal	11.671	0,01	8				
	subtotal depreciation and interest	29.417	0,04	21				
Total costs:		**142.995**	**0,18**	**100**				

Annex 2 Completed hatchery model for RNH Hatchery

Table F Input - Output

Species:	Perch	
Input		
Production	68.000	#/Y
Batches	6	#/Y
Output		
Investment	€ 53.976	
Investment	€ ,8	/pc
Costs	€ 32.956	total/Y
Costs	€ 0,48	/pc
Feed cost	€ 0,01	/pc
Market price	€ ,01	/pc

Figure B Growth curve

Table G Feeding schedule RNH Hatchery

Species:	Perch					Artemia:					
Number:	136.000	initial				Hatching	500	% ww of cysts			
Mortality	50	% cum.				DM	10	% of ww			
Number:	68.000	final				Eff. Feeding	100	%			
						DM/g cysts	0,5				
SGR=a.W^b						FCR	0,7	DM-basis			
a:	6										
b:	-0,142										
Daynr.	W	Mort.	SGR	Biomass	Feed	A	A+SS	Feed1	Feed2	Feed3	Feed4
	(g)	(%)	(%)	(g)	g DM	g cysts!	(g)	(g)	(g)	(g)	(g)
1	0,001	0	8,0	136	8	16	0	0	0	0	0
2	0,001	0	15,8	147	18	35	0	0	0	0	0
3	0,001	0	15,5	173	20	40	0	0	0	0	0
4	0,001	0	15,1	201	23	46	0	0	0	0	0
5	0,002	0	14,8	234	26	52	0	0	0	0	0
6	0,002	0	14,5	272	30	59	0	0	0	0	0
7	0,002	0	14,2	314	34	60	0	3	0	0	0
8	0,003	0	13,9	362	38	68	0	4	0	0	0
9	0,003	0	13,7	416	43	68	0	9	0	0	0
10	0,004	0	13,4	477	48	77	0	10	0	0	0
11	0,004	0	13,1	546	54	70	0	19	0	0	0
12	0,005	0	12,9	622	60	60	0	30	0	0	0
13	0,005	0	12,7	708	67	27	0	53	0	0	0
14	0,006	0	12,4	803	74	30	0	60	0	0	0
15	0,007	0	12,2	910	83	0	0	83	0	0	0
16	0,008	3	12,0	1028	89	0	0	89	0	0	0
17	0,009	3	11,8	1120	95	0	0	95	0	0	0
18	0,010	3	11,6	1217	101	0	0	101	0	0	0
19	0,011	3	11,4	1318	107	0	0	107	0	0	0
20	0,012	3	11,2	1423	114	0	0	114	0	0	0
21	0,014	3	11,1	1531	120	0	0	120	0	0	0
22	0,015	3	10,9	1641	127	0	0	114	13	0	0
23	0,017	3	10,7	1754	133	0	0	120	13	0	0
24	0,019	3	10,6	1867	139	0	0	111	28	0	0
25	0,021	3	10,4	1981	145	0	0	116	29	0	0
26	0,023	3	10,2	2093	150	0	0	98	53	0	0
27	0,026	3	10,1	2203	155	0	0	78	78	0	0
28	0,028	3	10,0	2309	160	0	0	32	128	0	0
29	0,031	3	9,8	2409	164	0	0	33	131	0	0
30	0,034	3	9,7	2501	167	0	0	0	167	0	0
31	0,038	0	9,5	2583	181	0	0	0	181	0	0
32	0,042	0	9,4	2842	196	0	0	0	196	0	0
33	0,046	0	9,3	3122	213	0	0	0	213	0	0
34	0,05	0	9,2	3427	230	0	0	0	230	0	0
35	0,06	0	9,1	3756	249	0	0	0	249	0	0
36	0,06	0	8,9	4111	269	0	0	0	269	0	0
37	0,07	0	8,8	4496	290	0	0	0	290	0	0
38	0,07	0	8,7	4911	313	0	0	0	313	0	0

Feeding schedule RNH Hatchery continued

39	0,08	0	8,6	5358	337	0	0	0	337	0	0
40	0,09	0	8,5	5839	363	0	0	0	363	0	0
41	0,09	0	8,4	6357	390	0	0	0	351	39	0
42	0,10	0	8,3	6915	419	0	0	0	377	42	0
43	0,11	0	8,2	7513	450	0	0	0	360	90	0
44	0,12	0	8,1	8155	482	0	0	0	386	96	0
45	0,13	0	8,0	8844	517	0	0	0	336	181	0
46	0,14	0	7,9	9582	553	0	0	0	277	277	0
47	0,15	0	7,8	10373	592	0	0	0	118	473	0
48	0,16	0	7,7	11218	633	0	0	0	127	506	0
49	0,18	0	7,7	12122	676	0	0	0	0	676	0
50	0,19	0	7,6	13088	722	0	0	0	0	722	0
51	0,21	0	7,5	14119	770	0	0	0	0	770	0
52	0,22	0	7,4	15218	821	0	0	0	0	821	0
53	0,24	0	7,3	16391	874	0	0	0	0	874	0
54	0,26	0	7,3	17640	931	0	0	0	0	931	0
55	0,28	0	7,2	18969	990	0	0	0	0	990	0
56	0,30	0	7,1	20384	1053	0	0	0	0	1053	0
57	0,32	0	7,0	21888	1119	0	0	0	0	1119	0
58	0,35	0	7,0	23486	1188	0	0	0	0	1188	0
59	0,37	0	6,9	25184	1261	0	0	0	0	1261	0
60	0,40	0	6,8	26985	1338	0	0	0	0	1338	0
61	0,42	0	6,8	28896	1418	0	0	0	0	1418	0
62	0,45	0	6,7	30921	1502	0	0	0	0	1502	0
63	0,49	0	6,6	33067	1591	0	0	0	0	1591	0
64	0,52	0	6,6	35340	1684	0	0	0	0	1684	0
65	0,56	0	6,5	37745	1781	0	0	0	0	1781	0
66	0,59	0	6,5	40290	1883	0	0	0	0	1883	0
67	0,63	0	6,4	42979	1990	0	0	0	0	1990	0
68	0,67	0	6,3	45822	2101	0	0	0	0	2101	0
69	0,72	0	6,3	48824	2218	0	0	0	0	1997	222
70	0,76	0	6,2	51993	2341	0	0	0	0	2107	234
71	0,81	0	6,2	55337	2469	0	0	0	0	1975	494
72	0,87	0	6,1	58864	2602	0	0	0	0	2082	520
73	0,92	0	6,1	62581	2742	0	0	0	0	1782	960
74	0,98	0	6,0	66498	2888	0	0	0	0	1444	1444
75	1,04	0	6,0	70624	3040	0	0	0	0	608	2432
76	1,10	0	5,9	74967	3199	0	0	0	0	640	2559
77	1,17	0	5,9	79537	3365	0	0	0	0	0	3365
78	1,24	0	5,8	84344	3538	0	0	0	0	0	3538
79	1,31	0	5,8	89397	3718	0	0	0	0	0	3718
80	1,39	0	5,7	94709	3906	0	0	0	0	0	3906
81	1,47	0	5,7	100288	4101	0	0	0	0	0	4101
82	1,56	0	5,6	106147	4305	0	0	0	0	0	4305
83	1,65	0	5,6	112297	4517	0	0	0	0	0	4517
84	1,75	0	5,5	118751	4738	0	0	0	0	0	4738
85	1,85	0	5,5	125519	4968	0	0	0	0	0	4968
86	1,95	0	5,5	132616	5207	0	0	0	0	0	5207
87	2,06	0	5,4	140054	5455	0	0	0	0	0	5455
88	2,17	0	5,4	147847	5713	0	0	0	0	0	5713
89	2,29	0	5,3	156009	5982	0	0	0	0	0	5982
90	2,42	0	5,3	164554							
	sum	50,0									

Feeding schedule RNH Hatchery continued

90 days	A	A+SS	Feed1	Feed2	Feed3	Feed4	total
sum (kg)	1	0	2	6	40	68	116
price (E/kg)	120	120	15	6	4	2	
cost (E)	85	0	24	34	160	137	440
cost (E/ind)	0,001	0,000	0,000	0,000	0,002	0,002	0,006
%	19	0	5	8	36	31	
Daynr.	A	A+SS	Feed1	Feed2	Feed3	Feed4	
	% DM	%	%	%	%	%	
1	100	0	0	0	0	0	
2	100	0	0	0	0	0	
3	100	0	0	0	0	0	
4	100	0	0	0	0	0	
5	100	0	0	0	0	0	
6	100	0	0	0	0	0	
7	90	0	10	0	0	0	
8	90	0	10	0	0	0	
9	80	0	20	0	0	0	
10	80	0	20	0	0	0	
11	65	0	35	0	0	0	
12	50	0	50	0	0	0	
13	20	0	80	0	0	0	
14	20	0	80	0	0	0	
15	0	0	100	0	0	0	
16	0	0	100	0	0	0	
17	0	0	100	0	0	0	
18	0	0	100	0	0	0	
19	0	0	100	0	0	0	
20	0	0	100	0	0	0	
21	0	0	100	0	0	0	
22	0	0	90	10	0	0	
23	0	0	90	10	0	0	
24	0	0	80	20	0	0	
25	0	0	80	20	0	0	
26	0	0	65	35	0	0	
27	0	0	50	50	0	0	
28	0	0	20	80	0	0	
29	0	0	20	80	0	0	
30	0	0	0	100	0	0	
31	0	0	0	100	0	0	
32	0	0	0	100	0	0	
33	0	0	0	100	0	0	
34	0	0	0	100	0	0	
35	0	0	0	100	0	0	
36	0	0	0	100	0	0	
37	0	0	0	100	0	0	
38	0	0	0	100	0	0	

Feeding schedule RNH Hatchery continued

39	0	0	0	100	0	0	
40	0	0	0	100	0	0	
41	0	0	0	90	10	0	
42	0	0	0	90	10	0	
43	0	0	0	80	20	0	
44	0	0	0	80	20	0	
45	0	0	0	65	35	0	
46	0	0	0	50	50	0	
47	0	0	0	20	80	0	
48	0	0	0	20	80	0	
49	0	0	0	0	100	0	
50	0	0	0	0	100	0	
51	0	0	0	0	100	0	
52	0	0	0	0	100	0	
53	0	0	0	0	100	0	
54	0	0	0	0	100	0	
55	0	0	0	0	100	0	
56	0	0	0	0	100	0	
57	0	0	0	0	100	0	
58	0	0	0	0	100	0	
59	0	0	0	0	100	0	
60	0	0	0	0	100	0	
61	0	0	0	0	100	0	
62	0	0	0	0	100	0	
63	0	0	0	0	100	0	
64	0	0	0	0	100	0	
65	0	0	0	0	100	0	
66	0	0	0	0	100	0	
67	0	0	0	0	100	0	
68	0	0	0	0	100	0	
69	0	0	0	0	90	10	
70	0	0	0	0	90	10	
71	0	0	0	0	80	20	
72	0	0	0	0	80	20	
73	0	0	0	0	65	35	
74	0	0	0	0	50	50	
75	0	0	0	0	20	80	
76	0	0	0	0	20	80	
77	0	0	0	0	0	100	
78	0	0	0	0	0	100	
79	0	0	0	0	0	100	
80	0	0	0	90	0	100	
81	0	0	0	0	0	100	
82	0	0	0	0	0	100	
83	0	0	0	0	0	100	
84	0	0	0	0	0	100	
85	0	0	0	0	0	100	
86	0	0	0	0	0	100	
87	0	0	0	0	0	100	
88	0	0	0	0	0	100	
89	0	0	0	0	0	100	
90	0	0	0	0	0	100	

Table H Design hatchery

Production	68.000	# 90-d/Y		Rearing volume	15	m3
No. batches	6	#/Y		Water depth	0,7	m
				Rearing space total	21	m2
Broodstock				Ratio building:tanks	2	
ave. weight female	220	g		Building space	200	m2
fecundity	100.000	#/kg F		Ratio land:building	1,5	
fertilisation	35	%		Area	300	m2
fertilised eggs	35.000	#/kg F				
				Pumps		
sex ratio	1	w/w M/F		Ratio recirc.:volume	2	
density	7	kg/m3		Recirculation flow	29	m3/h
density	31,8	#/m3		Pump cap. Rel.	75	W/m3
				Total power	2	kW
total weight	17,3	kg				
tank size	2,5	m3		**Biofilter**		
				Max feed load	1	kg
fertilised eggs	302.222	#/Y		Load biofilter	5	kg/m3
fertilised eggs per batch	50.370	#		Size biofilter	0	m3
Spawning/Incubation						
density	35.000	#/pair				
fry	302.222	#/Y				
fry per batch	50.370	#				
nests/incubators	1	#				
size incubator	4	m2				
First feeding	**day 1-30**					
density final	29.001	#/m3				
density final	1	kg/m3				
survival	30	%				
density start	96.669	#/m3				
density start	0,1	kg/m3				
weaned fingerlings	90.667	#/Y				
fingerlings per batch	15.111	#				
tank volume	1	m3				
size tanks	1	m3				
tanks	1	#				
Fingerlings	**day 30-90**					
density final	1.901	#/m3				
density final	5	kg/m3				
survival	75	%				
density start	2.535	#/m3				
density start	0	kg/m3				
weaned fingerlings	68.000	#/Y				
fingerlings per batch	11.333	#				

tank volume	6	*m3*				
size tanks	1	*m3*				
tanks	7	#				
Artemia						
max. cysts	13	*g*				
max density	2,5	*g/l*				
incubation	5	*l*				
size incubator	100	*l*				
incubators	0,1	#				
incubation total	10	*l*				

Table I Investments

Description	Amount	unit	E/unit	Subtotal	%	Total	Depreciation term	5	10	20	30
Land	100	m²	5,00	500	1	500					
Permits				250	0						
Hookup electra				50	0						
Hookup phone				75	0						
Hookup gas				250	0						
Hookup water				250	0						
Hookup sewer				250	0						
Well				200	0	1.325					
Building	75	m²	300	22.500	42		30	0	0	0	750
Groundwork	75	m²	5	375	1	22.875					
Heating	75	m²	5	375	1		5	75	0	0	0
Ventilation	75	m²	5	375	1		5	75	0	0	0
Lighting	75	m²	8	563	1		5	113	0	0	0
Electra	10	kW	175	1.750	3	3.063	5	350	0	0	0
Broodstock tanks	1	m²	2	2	0		20	0	0	0	0
Incubators	2	l	300	600	1		20	0	0	30	0
First feeding	1	m3	200	200	0		20	0	0	10	0
Fingerlings	21	m3	200	4.200	8		20	0	0	210	0
Artemia	24	l	8	180	0	5.182	20	0	0	9	0
Piping	47	m2	20	940	2		20	0	0	47	0
Drum	65	m3/h	50	3.250	6		10	0	325	0	0
Pumps	65	m3/h	15	975	2		5	195	0	0	0
Filtermaterial	1	m³	75	75	0	5.240	20	0	0	4	0
Other											
De-ironing	4	kg feed	25	100	0		5	20	0	0	0
Power aggregate	5	kW	40	200	0		10	0	20	0	0
Measurements and control	47	m3	25	1.175	2		5	235	0	0	0
Alarm				1.000	2		5	200	0	0	0
Septic tank				2.000	4		20	0	0	100	0
Feeding equipment	29	# tanks	40	2.160	4		10	0	216	0	0
Weighing equipment				250	0		5	50	0	0	0
Sorting equipment				500	1		5	100	0	0	0
Cooler/freezer				500	1		20	0	0	25	0
High pressure cleaner				500	1		5	100	0	0	0
Office				2.500	5	10.885	10	0	250	0	0
Unforeseen	10%			4.907		4.907					
								1.513	811	435	750
Total initial investment					101	**53.976**					
Production (#/Y)						**68.000**					
Relative Investment (euro/pc)						**0,79**	**Yearly depreciation:**		**3.508**		
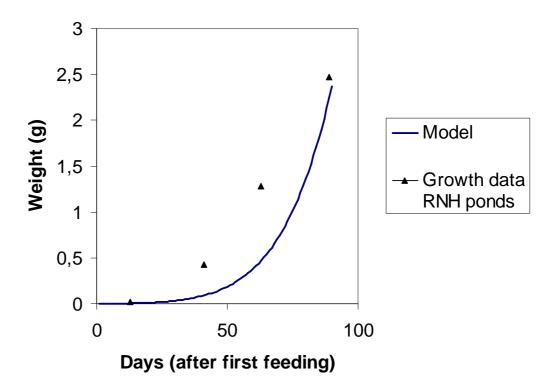
Table J Costs

Production (#/Y)		68.000						
		Amount						
		euro	*euro/pc*	*%*				
Feed		440	0,01	1	*see feed schedule*			
Other inputs								
	electricity	580	0,01	2	*0,02*	*E/kWh*		
	gas	4.454	0,07	14	*0,23*	*E/m3*	*96,83*	*m3 gas/m2*
	water	0,00	0,00	0	*borehole*			
	oxygen	140	0,00	0	*1,2*	*E/kg*	*3,5*	*kg O2/kg feed*
	chem., med., etc.	340	0,01	1				
	levy effluent	12	0,00	0	*33*	*E/I.E.*		
	subtotal	*5.525*	*0,08*	*17*				
	subtot. dir. costs	*5.965*	*0,09*	*18*				
Other company costs								
	maintenance	1.080	0,02	3	*2*	*% invest.*		
	insurance	162	0,00	0	*0,3*	*% invest.*		
	general costs	3.360	0,05	10	*2000*	*20*	*fixed+var/1000*	
	subtotal	*4.601*	*0,07*	*14*				
Labour							*fixed*	*var/million*	*total*
	high	0	0,00	0	*24000*	*sal./Y*	*0*	*0*	*0*
	average	6.000	0,09	19	*12000*	*sal./Y*	*0,5*	*0*	*0,5*
	low	8.000	0,12	25	*8000*	*sal./Y*	*1*	*0*	*1*
	subtotal	*14.000*	*0,21*	*43*				*total*	*1,5*
	subtotal company costs	*24.566*	*0,36*	*76*				*mill/man*	*0,05*
Depreciation								
	5-year	1.513	0,02	5				
	10-year	811	0,01	3				
	20-year	435	0,01	1				
	building	750	0,01	2				
	subtotal	*3.508*	*0,05*	*11*				
Interest								
	2/3 investment	4.318	0,06	13	*12*	*% interest*		
	fish stock	0	0,00	0				
	subtotal	*4.318*	*0,06*	*13*				
subtotal depreciation and interest		*7.826*	*0,12*	*24*				
Total costs:		**32.393**	**0,48**	**100**				

Annex 3 Completed Hatchery model for RNH Ponds

Table K Input – Output

Species:	Perch	
Input		
Production	120.000	#/Y
Batches	1	#/Y
Output		
Investment	€ 143.792	
Investment	€ 1,2	/pc
Costs	€ 36.746	total/Y
Costs	€ 0,31	/pc
Feed cost	€ 0,01	/pc
Market price	€ ,01	/pc

Figure C Growth curve

Table L Feeding schedule RNH ponds

Species:	Perch					Artemia:					
Number:	333.333	initial				Hatching		500	% ww of cysts		
Mortality	64	% cum.				DM		10	% of ww		
Number:	120.000	final				Eff. Feeding		100	%		
						DM/g cysts		0,5			
SGR=a.W^b						FCR		0,7	DM-basis		
a:	6										
b:	-0,14										
						Natural	Natural	Natural	Natural	Natural	Natural
Daynr.	W	Mort.	SGR	Biomass	Feed	food	food	food	food	food	food
	(g)	(%)	(%)	(g)	g DM	g cysts!	(g)	(g)	(g)	(g)	(g)
1	0,001	0	7,9	333	19	38	0	0	0	0	0
2	0,001	0	15,6	361	43	85	0	0	0	0	0
3	0,001	0	15,3	422	49	97	0	0	0	0	0
4	0,001	0	14,9	491	55	111	0	0	0	0	0
5	0,002	0	14,6	570	63	126	0	0	0	0	0
6	0,002	0	14,3	660	71	143	0	0	0	0	0
7	0,002	0	14,1	762	81	145	0	8	0	0	0
8	0,003	0	13,8	877	91	163	0	9	0	0	0
9	0,003	0	13,5	1007	102	163	0	20	0	0	0
10	0,003	0	13,3	1153	114	183	0	23	0	0	0
11	0,004	0	13,0	1316	128	167	0	45	0	0	0
12	0,004	0	12,8	1499	143	143	0	72	0	0	0
13	0,005	0	12,6	1703	160	64	0	128	0	0	0
14	0,006	0	12,3	1931	178	71	0	142	0	0	0
15	0,007	0	12,1	2185	197	0	0	197	0	0	0
16	0,007	4	11,9	2467	209	0	0	209	0	0	0
17	0,008	4	11,7	2661	221	0	0	221	0	0	0
18	0,009	4	11,5	2858	233	0	0	233	0	0	0
19	0,011	4	11,4	3058	245	0	0	245	0	0	0
20	0,012	4	11,2	3258	256	0	0	256	0	0	0
21	0,013	4	11,0	3456	266	0	0	266	0	0	0
22	0,015	4	10,8	3649	275	0	0	248	28	0	0
23	0,016	4	10,7	3833	284	0	0	255	28	0	0
24	0,018	4	10,5	4005	291	0	0	232	58	0	0
25	0,020	4	10,4	4161	296	0	0	237	59	0	0
26	0,022	4	10,2	4295	299	0	0	194	105	0	0
27	0,025	4	10,1	4403	300	0	0	150	150	0	0
28	0,028	4	9,9	4477	298	0	0	60	239	0	0
29	0,030	4	9,8	4512	294	0	0	59	235	0	0
30	0,034	4	9,7	4499	285	0	0	0	285	0	0
31	0,037	0	9,5	4430	310	0	0	0	310	0	0
32	0,041	0	9,4	4872	336	0	0	0	336	0	0
33	0,045	0	9,3	5352	364	0	0	0	364	0	0
34	0,05	0	9,2	5873	394	0	0	0	394	0	0
35	0,05	0	9,0	6436	426	0	0	0	426	0	0
36	0,06	0	8,9	7044	460	0	0	0	460	0	0
37	0,06	0	8,8	7702	497	0	0	0	497	0	0
38	0,07	0	8,7	8411	535	0	0	0	535	0	0

Feeding schedule RNH ponds continued

39	0,08	0	8,6	9176	577	0	0	0	577	0	0
40	0,08	0	8,5	10000	621	0	0	0	621	0	0
41	0,09	0	8,4	10887	667	0	0	0	601	67	0
42	0,10	0	8,3	11841	717	0	0	0	645	72	0
43	0,11	0	8,2	12865	770	0	0	0	616	154	0
44	0,12	0	8,1	13965	826	0	0	0	661	165	0
45	0,13	0	8,0	15144	885	0	0	0	575	310	0
46	0,14	0	7,9	16408	948	0	0	0	474	474	0
47	0,15	0	7,8	17762	1014	0	0	0	203	811	0
48	0,16	0	7,8	19210	1084	0	0	0	217	867	0
49	0,17	0	7,7	20759	1159	0	0	0	0	1159	0
50	0,19	0	7,6	22414	1237	0	0	0	0	1237	0
51	0,20	0	7,5	24182	1320	0	0	0	0	1320	0
52	0,22	0	7,4	26067	1407	0	0	0	0	1407	0
53	0,23	0	7,4	28078	1500	0	0	0	0	1500	0
54	0,25	0	7,3	30220	1597	0	0	0	0	1597	0
55	0,27	0	7,2	32501	1699	0	0	0	0	1699	0
56	0,29	0	7,1	34929	1807	0	0	0	0	1807	0
57	0,31	0	7,1	37511	1921	0	0	0	0	1921	0
58	0,34	0	7,0	40255	2041	0	0	0	0	2041	0
59	0,36	0	6,9	43170	2166	0	0	0	0	2166	0
60	0,39	0	6,9	46265	2298	0	0	0	0	2298	0
61	0,41	0	6,8	49549	2437	0	0	0	0	2437	0
62	0,44	0	6,7	53030	2583	0	0	0	0	2583	0
63	0,47	0	6,7	56720	2736	0	0	0	0	2736	0
64	0,51	0	6,6	60629	2896	0	0	0	0	2896	0
65	0,54	0	6,5	64766	3065	0	0	0	0	3065	0
66	0,58	0	6,5	69144	3241	0	0	0	0	3241	0
67	0,61	0	6,4	73774	3426	0	0	0	0	3426	0
68	0,66	0	6,4	78668	3619	0	0	0	0	3619	0
69	0,70	0	6,3	83839	3822	0	0	0	0	3440	382
70	0,74	0	6,3	89298	4034	0	0	0	0	3630	403
71	0,79	0	6,2	95061	4255	0	0	0	0	3404	851
72	0,84	0	6,1	101140	4487	0	0	0	0	3590	897
73	0,90	0	6,1	107550	4730	0	0	0	0	3074	1655
74	0,95	0	6,0	114307	4983	0	0	0	0	2491	2491
75	1,01	0	6,0	121425	5247	0	0	0	0	1049	4198
76	1,07	0	5,9	128921	5523	0	0	0	0	1105	4418
77	1,14	0	5,9	136811	5811	0	0	0	0	0	5811
78	1,21	0	5,8	145112	6112	0	0	0	0	0	6112
79	1,28	0	5,8	153843	6425	0	0	0	0	0	6425
80	1,36	0	5,7	163021	6752	0	0	0	0	0	6752
81	1,44	0	5,7	172666	7092	0	0	0	0	0	7092
82	1,52	0	5,7	182798	7447	0	0	0	0	0	7447
83	1,61	0	5,6	193436	7816	0	0	0	0	0	7816
84	1,71	0	5,6	204602	8201	0	0	0	0	0	8201
85	1,80	0	5,5	216318	8601	0	0	0	0	0	8601
86	1,91	0	5,5	228606	9018	0	0	0	0	0	9018
87	2,01	0	5,4	241489	9451	0	0	0	0	0	9451
88	2,12	0	5,4	254990	9902	0	0	0	0	0	9902
89	2,24	0	5,4	269136	10370	0	0	0	0	0	10370
90	2,37	0	5,3	283951							
	sum	64,0									

Feeding schedule RNH ponds continued

90 days	A (natural food)	(natural food)	(natural food)	(natural food)	(natural food)	(natural food)	total
sum (kg)	2	0	4	10	69	118	202
price (E/kg)	5	5	5	5	5	5	
cost (E)	8	0	18	48	344	591	1010
cost (E/ind)	0,000	0,000	0,000	0,000	0,003	0,005	0,008
%	1	0	2	5	34	59	
Daynr.	A (natural food)	(natural food)	(natural food)	(natural food)	(natural food)	(natural food)	
	% DM	%	%	%	%	%	
1	100	0	0	0	0	0	
2	100	0	0	0	0	0	
3	100	0	0	0	0	0	
4	100	0	0	0	0	0	
5	100	0	0	0	0	0	
6	100	0	0	0	0	0	
7	90	0	10	0	0	0	
8	90	0	10	0	0	0	
9	80	0	20	0	0	0	
10	80	0	20	0	0	0	
11	65	0	35	0	0	0	
12	50	0	50	0	0	0	
13	20	0	80	0	0	0	
14	20	0	80	0	0	0	
15	0	0	100	0	0	0	
16	0	0	100	0	0	0	
17	0	0	100	0	0	0	
18	0	0	100	0	0	0	
19	0	0	100	0	0	0	
20	0	0	100	0	0	0	
21	0	0	100	0	0	0	
22	0	0	90	10	0	0	
23	0	0	90	10	0	0	
24	0	0	80	20	0	0	
25	0	0	80	20	0	0	
26	0	0	65	35	0	0	
27	0	0	50	50	0	0	
28	0	0	20	80	0	0	
29	0	0	20	80	0	0	
30	0	0	0	100	0	0	
31	0	0	0	100	0	0	
32	0	0	0	100	0	0	
33	0	0	0	100	0	0	
34	0	0	0	100	0	0	
35	0	0	0	100	0	0	
36	0	0	0	100	0	0	
37	0	0	0	100	0	0	
38	0	0	0	100	0	0	

Feeding schedule RNH ponds continued

39	0	0	0	100	0	0	
40	0	0	0	100	0	0	
41	0	0	0	90	10	0	
42	0	0	0	90	10	0	
43	0	0	0	80	20	0	
44	0	0	0	80	20	0	
45	0	0	0	65	35	0	
46	0	0	0	50	50	0	
47	0	0	0	20	80	0	
48	0	0	0	20	80	0	
49	0	0	0	0	100	0	
50	0	0	0	0	100	0	
51	0	0	0	0	100	0	
52	0	0	0	0	100	0	
53	0	0	0	0	100	0	
54	0	0	0	0	100	0	
55	0	0	0	0	100	0	
56	0	0	0	0	100	0	
57	0	0	0	0	100	0	
58	0	0	0	0	100	0	
59	0	0	0	0	100	0	
60	0	0	0	0	100	0	
61	0	0	0	0	100	0	
62	0	0	0	0	100	0	
63	0	0	0	0	100	0	
64	0	0	0	0	100	0	
65	0	0	0	0	100	0	
66	0	0	0	0	100	0	
67	0	0	0	0	100	0	
68	0	0	0	0	100	0	
69	0	0	0	0	90	10	
70	0	0	0	0	90	10	
71	0	0	0	0	80	20	
72	0	0	0	0	80	20	
73	0	0	0	0	65	35	
74	0	0	0	0	50	50	
75	0	0	0	0	20	80	
76	0	0	0	0	20	80	
77	0	0	0	0	0	100	
78	0	0	0	0	0	100	
79	0	0	0	0	0	100	
80	0	0	0	0	0	100	
81	0	0	0	0	0	100	
82	0	0	0	0	0	100	
83	0	0	0	0	0	100	
84	0	0	0	0	0	100	
85	0	0	0	0	0	100	
86	0	0	0	0	0	100	
87	0	0	0	0	0	100	
88	0	0	0	0	0	100	
89	0	0	0	0	0	100	
90	0	0	0	0	0	100	

Table M Design hatchery

Production	120.000	# 90-d/Y		Rearing volume	137	m3
No. batches	1	#/Y		Water depth	1	m
				Rearing space total	137	m2
Broodstock				Ratio building:tanks	0,015	
ave. weight female	220	g		Building space	2	m2
fecundity	100.000	#/kg F		Ratio land:building	1,5	
fertilisation	35	%		Area	3	m2
fertilised eggs	35.000	#/kg F				
				Pumps		
sex ratio	1	w/w M/F		Ratio recirc.:volume	0	
density	7	kg/m3		Recirculation flow	0	m3/h
density	31,8	#/m3		Pump cap. Rel.	0	W/m3
				Total pump cap.	0	kW
total weight	19,0	kg				
tank size	2,7	m3		**Biofilter**		
				Max feed load	10	kg
fertilised eggs	333.333	#/Y		Load biofilter	0	kg/m3
fertilised eggs per batch	333.333	#		Size biofilter	0	m3
Spawning/Incubation						
density	35.000	#/pair				
fry	333.333	#/Y				
fry per batch	333.333	#				
nests/incubators	10	#				
size incubator	12	m2				
First feeding	day 1-30					
density final	62.651	#/m3				
density final	2	kg/m3				
survival	60	%				
density start	104.418	#/m3				
density start	0,1	kg/m3				
weaned fingerlings	200.000	#/Y				
fingerlings per batch	200.000	#				
tank volume	3	m3				
size tanks	10.000	m3				
tanks	0	#				
Fingerlings	day 30-90					
density final	6.973	#/m3				
density final	17	kg/m3				
survival	60	%				
density start	11.622	#/m3				
density start	0	kg/m3				
weaned fingerlings	120.000	#/Y				
fingerlings per batch	120.000	#				
tank volume	17	m3				
size tanks	10.000	m3				
tanks	0	#				
Artemia						
max. cysts	183	g				
max density	0,0	g/l				
incubation	0	l				
size incubator	0	l				
incubators	0,0	#				
incubation total	0	l				

Table N Investments

Description	Amount	unit	E/unit	Subtotal	%	Total	Depreciation term	5	10	20	30
Land	6.000	m²	10,00	60.000	42	60.000					
Permits				50	0						
Hookup electra				25	0						
Hookup phone				50	0						
Hookup gas				0	0						
Hookup water				50	0						
Hookup sewer				50	0						
Well				50	0	275					
Building	20	m²	50	1.000	1		30	0	0	0	33
Groundwork	6.000	m²	10	60.000	42	61.000					
Heating		m²	0	0	0		5	0	0	0	0
Ventilation		m²	0	0	0		5	0	0	0	0
Lighting		m²	0	0	0		5	0	0	0	0
Electra	5	kW	75	375	0	375	5	75	0	0	0
Broodstock tanks	6	m²	110	660	0		20	0	0	33	0
Incubators	10	l	450	660	0		20	0	0	33	0
First feeding	0	m3	20	0	0		20	0	0	0	0
Fingerlings	0	m3	20	0	0		20	0	0	0	0
Artemia	0	l	0	0	0	1.320	20	0	0	0	0
Piping	0	m2	20	0	0		20	0	0	0	0
Drum	0	m3/h	0	0	0		10	0	0	0	0
Aerators	0	m3/h	0	4.000	3		5	800	0	0	0
Filtermaterial	0	m³	0	0	0	4.000	20	0	0	0	0
Other											
De-ironing	10	kg feed	0	0	0		5	0	0	0	0
Power aggregate	5	kW	0	0	0		10	0	0	0	0
Measurements and control	0	m3	25	0	0		5	0	0	0	0
Alarm				0	0		5	0	0	0	0
Septic tank				0	0		20	0	0	0	0
Feeding equipment	0	# tanks	40	0	0		10	0	0	0	0
Weighing equipment				250	0		5	50	0	0	0
Sorting equipment				500	0		5	100	0	0	0
Cooler/freezer				0	0		20	0	0	0	0
High pressure cleaner				500	0		5	100	0	0	0
Office				2.500	2	3.750	10	0	250	0	0
Unforeseen	10%			13.072		13.072					
								1.125	250	66	33
Total initial investment					101	**143.792**					
Production (#/Y)						120.000					
Relative Investment (euro/pc)						**1,20**	**Yearly depreciation:**			1.474	

Table O Costs

Production (#/Y)		120.000							
		Amount							
		euro	euro/pc	%					
Feed		1.010	0,01	3	see feed schedule				
Other inputs									
	electricity	0	0,00	0	0,02	E/kWh			
	gas	0	0,00	0	0,23	E/m3	0	m3 gas/m2	
	water	0,00	0,00	0	borehole				
	oxygen	242	0,00	1	1,2	E/kg	0	kg O2/kg feed	
	chem., med., etc.	600	0,01	2					
	levy effluent	208	0,00	1	55	E/I.E.			
	subtotal	1.051	0,01	3					
	subtot. dir. costs	2.061	0,02	6					
Other company costs									
	maintenance	2.876	0,02	8	2	% invest.			
	insurance	431	0,00	1	0,3	% invest.			
	general costs	4.400	0,04	12	2000	20	fixed+var/1000		
	subtotal	7.707	0,06	21					
Labour							fixed	var/million	total
	high	0	0,00	0	24000	sal./Y	0	0	0
	average	6.000	0,05	16	12000	sal./Y	0,5	0	0,5
	low	8.000	0,07	22	8000	sal./Y	1	0	1
	subtotal	14.000	0,12	38				total	1,5
	subtotal company costs	23.768	0,20	65				mill/man	0,1
Depreciation									
	5-year	1.125	0,01	3					
	10-year	250	0,00	1					
	20-year	66	0,00	0					
	building	33	0,00	0					
	subtotal	1.474	0,01	4					
Interest									
	2/3 investment	11.503	0,10	31	12	% interest			
	fish stock	0	0,00	0					
	subtotal	11.503	0,10	31					
subtotal depreciation and interest		12.978	0,11	35					
Total costs:		**36.746**	**0,31**	**100**					