MINNESOTA SEA GRANT PROGRAM

Research Report No. 9
Bait Leech, *Nephelopsis obscura*, Culture and Economic Feasibility

"Bait Leech, *Nephelopsis obscura* Culture and Economic Feasibility"

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The Economic Feasibility of Commercial Bait Leech Production

I. Introduction

The need for basic biological research on the bait leech, Nephelopsis obscura, became apparent in the late 1970's. As a bait organism gaining popularity with midwest walleye fishermen, the total harvest in Minnesota approached 70 tons with an annual revenue of over $3 million. This does not include the commerce involved with terminal tackle. The scarcity of this excellent bait during the late summer, when not obtainable by natural harvest, and the alarming potential for overharvest prompted the Minnesota Sea Grant Institute to fund a project on the biology, management, and economic feasibility for culture of the bait leech. The research efforts to date have yielded information regarding idealized diet, temperature, water quality, light conditions and space needs for the successful culture of leeches. Growth rates have been measured and reproductive data for culture production and survival rates of young leeches have been determined. This report represents the results of an economic feasibility study based on findings of previous biological research.

In order to estimate the economic feasiblity of commercial bait leech production, the following procedures were followed. First, an estimate of the costs associated with natural harvest leech production were obtained. This was accomplished by a questionnaire sent to all commercial minnow dealers in Minnesota, a licensed group which includes leech harvesters. Once the costs of natural production were established, comparisons were made with the costs of producing bait leeches using a modified laboratory setting and a pond type setting. Modified laboratory production setting required a detailed statement of production requirements and a corresponding estimate of the costs of providing these production requirements. The pond setting costs were estimated using information from both the questionnaire and the cost estimates derived from the modified laboratory setting. These costs were then compared with revenue estimates which were obtained from a study conducted by the Minnesota Department of Natural Resources and an examination of the 1980-81 bait market. A comparison of the revenues and costs suggests that commercial

bait leech production is indeed economically feasible. A more detailed discussion of this conclusion is provided in the material which follows.

II. Costs of Natural Bait Leech Production

The costs of natural bait leech production were estimated to provide a benchmark figure for comparison of costs associated with the alternative production methods. Natural production costs were estimated from the information provided by a questionnaire which was sent to 396 commercial minnow dealers licensed by the Minnesota DNR as of June, 1982. For purposes of analysis, the locations of the minnow dealers were divided into six regions within the State of Minnesota. These regions were consistent with the administrative boundaries of the Minnesota DNR. As Figure 1 shows, Region 1 is headquartered in Bemidji, Region 2 in Cloquet, Region 3 in Brainerd, Region 4 in New Ulm, Region 5 in Rochester, and Region 6 in the Twin Cities metro area. Of the total 396 questionnaires sent, 137 were returned, a response rate of 34.6 percent. The response rate by region varied from a low of 20 percent for Region 6, to a high of 60 percent for Region 5. Of the total 137 returns, 38 percent (52 responses) were from natural leech harvesters or trappers. According to Floyd Hennagir, Commercial Fisheries Coordinator-Minnesota DNR, about one-third of the total licensed minnow dealers in Minnesota are also involved in trapping or harvesting leeches. Thus, the results of the questionnaire were reasonably consistent with current practice in the state.

The costs of natural bait leech production were estimated in two different ways. The first method was based upon a detailed breakdown of annual operating costs associated with leech harvests by individuals trapping leeches. Total operating costs were divided into a number of different expense categories such as vehicle, fuel, insurance, traps, lease, and labor expenses. The labor expenses included wages paid to others, but did not include the value of the labor provided by the harvester himself. By examining these various cost categories, an estimate of the total annual costs of harvesting leeches was determined. By comparison of these cost figures with the actual volume of leeches

FIGURE 1

Minnesota DNR Administrative Boundaries

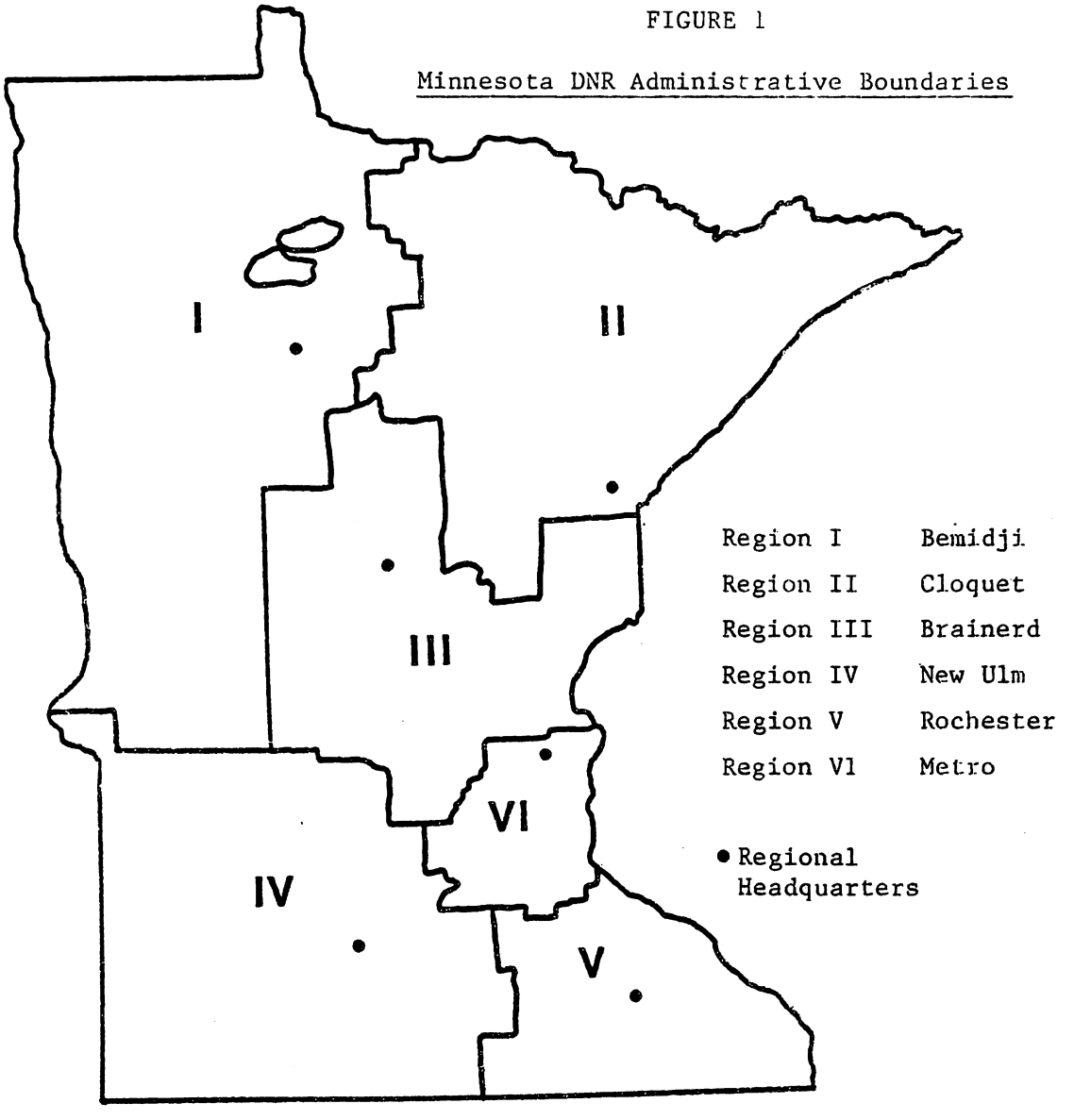


FIGURE 2

Cost of Harvested Leeches

(By Breakdown of Expense Categories)

DNR Region	Average Cost	Average Volume (in pounds)	Cost (per pound)
I	$3194.20	2466	$1.295
II	4656.47	1044	4.460
III	2138.58	964	2.218
IV	3650.00	1150	3.174
V	3000.00	550	5.455
VI	3700.00	1200	3.083
TOTAL	$2790.37	1229 lbs.	$2.270

harvested, a cost per pound of leeches harvested was obtained. This information, provided in Figure 2, shows that the average cost per pound of leeches harvested in the State of Minnesota was $2.27. It should be noted that the annual harvest cost per pound varied widely among the six regions. Region 1 had the lowest per pound cost, ($1.30) while Region 5 had the highest per pound cost ($5.46). Approximately 73 percent of the leech harvesters or trappers who responded to this questionnaire provided their operating costs based on this breakdown scheme.

Some harvesters were unable to provide a detailed breakdown of their annual operating costs, and for those individuals, the questionnaire method provided a second opportunity to estimate annual costs. This alternative method requested that harvesters provide an estimate of their total annual operating costs associated with harvesting leeches. Approximately 27 percent of the harvesters or trappers who responded to the questionnaire used this method. Figure 3 indicates that the results of this alternative method were very similar to the results of the more detailed method described in Figure 2. For the state as a whole, the per unit cost of harvesting leeches, based on annual operating cost estimates, was equal to $2.35 per pound, compared with a $2.27 per pound based on the detailed questionnaire response. Once again, the costs varied rather significantly among the six regions within the state. Region 1 had the lowest cost ($1.04 per pound) using this alternative approach, while Region 5 had the highest costs, ($5.46 per pound).

The questionnaire results are useful for a variety of purposes. First, they provide a benchmark figure for comparison of the costs associated with alternative methods of leech production, such as modified lab and pond methods. Secondly, they show that the harvest cost of leeches does not differ significantly whether one uses a detailed estimate of annual operating costs or a simple gross figure. This is true for individual regions in the state as well as the state as a whole. Thirdly, they show that the costs of natural leech harvest vary significantly within the state; an important factor when one attempts to make comparisons between

FIGURE 3

Production Cost of Leeches

(By Estimate of Annual Operating Costs)

DNR Region	Average Cost	Average Volume (in pounds)	Cost (per pound)
I	$2533.89	2439	$1.039
II	4940.83	1044	4.733
III	1171.53	964	1.215
IV	3400.00	1150	2.957
V	3000.00	550	5.455
VI	500.00	200	2.500
TOTAL	$2490.30	1057.8 lbs	$2.354

natural harvest costs and costs incurred in commercial methods of leech production.

III. Costs of Commercial Bait Leech Production

In order to estimate the cost of production for the bait leech using the modified lab setting, it was first necessary to organize a production scheme and to gather the necessary technical data for operations. A mock or simulated facility was developed and from it, a list of equipment and capital expenditures was obtained. From that list, cost estimates from various sources were made for each item in the production scheme. The biological requirements for culture of leeches were the primary consideration. This was determined over the last three years. In most cases, the production requirements and the costs incurred were direct functions of the biological nature of leeches.

The basic production process simulated in the modified lab setting involved the holding of small unmarketable size leeches until growth reached marketable size. This was followed by sale at the wholesale level. Experimental grow-out procedures indicate that 6 to 7 pounds of juvenile leeches will yield 20 pounds of marketable size leeches in nine to ten weeks. This biological information suggests that the juvenile leeches can be grown out under an overlap production schedule described in Figure 4.

Figure 4

Leech Production Schedule
Modified Lab Setting

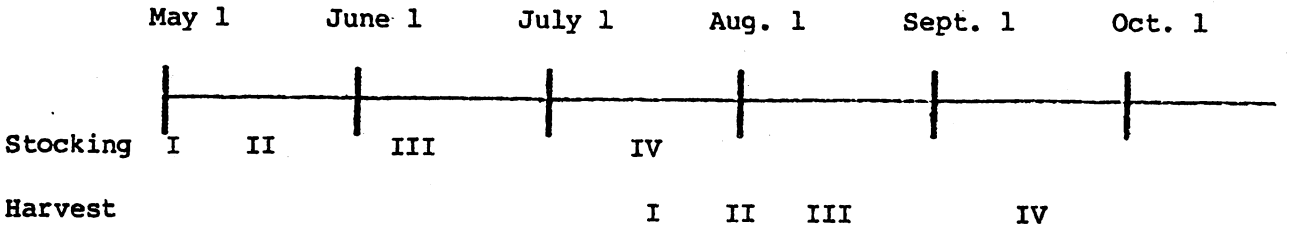


Figure 4 suggests that there are four periods in which juvenile leeches can be placed in the production setting. These juvenile leeches, held for a period of nine to ten weeks under optimal growth conditions can be then sold as marketable size leeches. Figure 4 suggests four possible starting or "stocking" periods, the beginning of May, mid-May, mid-June, and mid-July. Four harvest periods follow, in mid-July, the beginning of August, mid-August, and the third week of September. This production time-table is based on an annual projected harvest of 4,000 pounds of marketable leeches.

The targeted annual production level of 4,000 pounds represents a harvest which would enable the grower to maintain gross revenues equal to $25,000, (when measured in terms of 1980-1981 wholesale prices). At the targeted production level with the four stocking periods, the required initial stock of leeches at each period would be about 336 pounds. This would total an aggregate stock of approximately 1,344 pounds for the four periods combined, and given a 3 to 1 growout ratio, would enable 4,000 pounds of marketable size leeches to be harvested during the growth season. These calculations are based on the premise that a 9-10 week growout season is sufficient for juvenile animals to reach marketable size.

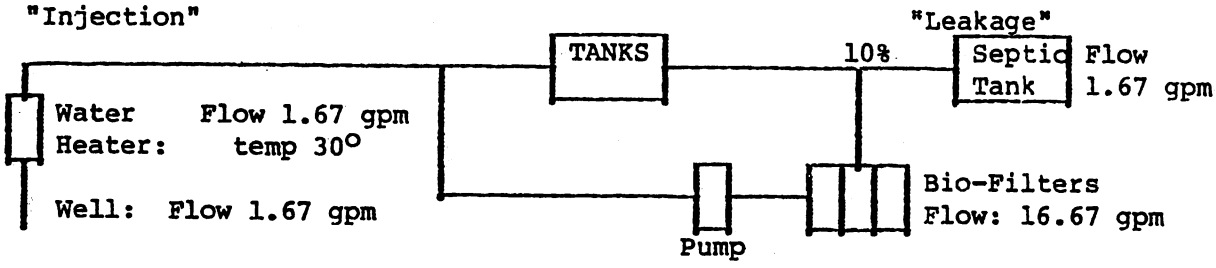
The biological information has determined the ratio between the amount of juvenile stock necessary and the resulting outcome of the production process. For example, for 6 to 7 pounds of juveniles to reach 20 pounds of marketable size leeches in 9-10 weeks, one square meter of bottom surface area is required. A water depth of 6 inches with a flow rate of 8.2 gph is adequate for growth to occur. This suggests that for 4000 pounds of leeches to be grown out during the production period, 200 tanks, approximately one square meter in area and approximately 6 inches deep, must be provided if the targeted production level is to be achieved.

In order to minimize the water requirements for this production level, tanks should be stacked in such a way that water drains via gravity from the highest to the lowest tank in any given column or stack. This arrangement uses a minimum amount of tank space or building space. An adequate building measures 32 feet long by 31 feet wide by 15 feet high. Since leeches grow well around 20^{o}C, heating and/or air conditioning is necessary to maintain this temperature throughout the production period. This again illustrates a biological requirement which specifies the necessary production setting. The growth or production period in the facility extends from May through October. After October the plant could be completely shut down, eliminating all variable costs.

Another important biological requirement that must be met in order to enable adequate growth rates is the level of water quality. In the mock facility, water quality is maintained through a "biofilter" method of purification. This filtration method of purification is described in Figure 5 below.

FIGURE 5

Water Purification Method
Modified Lab Setting



The biofilter method of purification allows bacterial growth on the substrate to recondition water. The water will be pumped from a well, heated to the necessary temperature, and allowed to gravity-feed to the leech holding tanks.

Although a small amount of water will be lost through this process, the bulk of the water will flow into the biofilter system for reconditioning and then will be pumped back into the holding tanks. The proposed biofilter method would involve the use of three modified oil drums, each having a filtering capacity of two gpm per cubic foot of filter bed.

The examples above show that the necessary requirements for adequate leech growout are directly dependent on biological characteristics and requirements of the leech life cycle. In the discussion that follows, a breakdown of the costs of each item necessary for this growth process to occur will be undertaken. Figure 6 summarizes the breakdown of this cost information. The top portion of Figure 6 shows those cost items against which depreciation and interest charges can be levied. The purchase cost associated with these items was obtained through direct contact with local contractors who could provide the necessary equipment and services. Care must be taken in the interpretation of some of these items, especially land costs and septic system costs, since they are dependent upon the location of the production facility. In this analysis, the estimated purchase costs of land and septic systems are typical of a rural area near Duluth, Minnesota, in 1982.

The interest, tax, and annual depreciation cost items were derived using a procedure developed by the United States Forest Service in 1980 to determine costs of operating logging equipment. Although the logging industry is markedly different from leech production, the basic approach used to estimate interest tax and depreciation costs are valid for this industry as well. The approach is based upon a calculation entitled the average value of yearly investment, or AVI. The formula for calculating the average value of investment using straight line depreciation is given by:

$$AVI = \frac{(P-S)(n+1)}{2n}, \quad \text{where } P = \text{purchase cost}, \; S = \text{salvage value}, \; N = \text{useful life}$$

The useful life in the calculation shown in Figure 6 was estimated by the local contractors and service providers. For purposes of simplicity, the salvage value in each case was taken to be zero, an assumption which would tend to overstate rather than understate the actual costs. Given the calculation of the average value of yearly investment, the interest and tax costs can be calculated by multiplying the assumed interest and tax rates times the average value of yearly investment. It should be noted that the tax rates in question are not based upon income or profit. Instead, they refer to such things as property taxes, sales taxes, etc. The interest rate recommended in the 1980 U.S. Forest Service study was 12 percent, and the tax rate recommended was 3 percent. These rates appear in the top half of Figure 6 and lead to a total interest expense of $2,211 and a total tax expense of $558. The straight line depreciation assumption suggests that the value of the equipment decreases continuously from the initial investment to the time its useful life expires. This assumption yields an annual depreciation cost of $1,929 in the current example.

FIGURE 6

Modified Lab Production Cost Estimates
(Low Costs)

Interest, Tax, and Depreciation Estimate

Item	Purchase Cost	Useful Life	Salvage Value	AVI	Interest (12%)	Tax (3%)	Annual Deprec. Cost.
Depreciation Cost:							
Land	500				60	15	0
Building	6700	20	-0-	3518	422	106	335
Wiring	800	20	-0-	420	50	13	40
Plumbing	600	20	-0-	315	38	9	30
Heating	800	20	-0-	440	53	13	40
Air Conditioning	1000	20	-0-	525	63	16	50
Tanks	20000	20	-0-	10500	1260	320	1000
Well	1800	10	-0-	990	119	30	180
Filters	120	5	-0-	72	9	2	24
Pump	250	5	-0-	150	18	5	50
Water Heater	200	10	-0-	110	13	3	20
Septic System	1600	10	-0-	880	106	26	160
	34370				2211	558	1929

Annual Total Cost Estimate

Leech Stock	3134
Insurance	600
Food, Disease, Etc.	200
Gas (water heater and heating)	210
Electric (air conditioning and pump	360
Interest Expense	2211
Tax	558
Depreciation	1929
	9201

Cost Per Pound: $\frac{9202}{4000}$ = $2.30/lb.

The bottom half of Figure 6 combines the interest, tax, and depreciation costs with other necessary costs in the production process. Once again, the insurance, gas, and electric costs were derived by examination of necessary production requirements and contact with local agents and utilities. The leech stock expense was calculated from the results of the harvester questionnaire discussed previously. The questionnaire results showed that the average cost of harvesting leeches in the State of Minnesota is $2.35 pound. Necessary amount of leech stock enabling 4,000 pounds of marketable leeches is 1,334 pounds, at $2.35 per pound, yielding a juvenile stock cost of $3,134. The food, disease, etc. item is a miscellaneous expense account item which reflects food costs or needed medications. Although a ground, specially-prepared diet was fed to leeches during the laboratory experiments, it has been shown that fish entrails and other waste meat products could serve equally as well as food for the leeches. Therefore, this expense item is relatively low. The total annual cost estimate is $9,202. Since 4,000 pounds of marketable leeches are assumed to be produced annually, the cost per pound of growing leeches to marketable size within the modified lab setting is $2.30 per pound.

It should be noted that this figure compares favorably to the harvest cost estimate obtained from the questionnaire results discussed above. It should also be noted that Figure 6 is entitled a 'low cost' estimate, because the interest and tax rate were taken as suggested in the 1980 U.S. Forest Service study. However, interest rates and tax rates have increased markedly from early 1980 until late 1982. Therefore, a second estimate was made entitled 'medium costs' estimate which appears in Figure 7. In the medium cost estimate, the interest rate was based upon the rate facing small borrowers at commercial banks during the early portion of December, 1982. The tax rates were arbitrarily doubled to 6 percent. Although the tax increase was arbitrarily chosen, it should be recognized that tax rates have risen over this two-year period in many states, including Minnesota. Given the adjustments in the interest and tax expense, the total annual cost estimate of producing 4,000 pounds of marketable size

leeches per year now becomes $10,303. Given the 4,000 pounds production level, this results in an average cost of $2.58 per pound of marketable size leeches produced. Although somewhat higher than low cost estimate, this figure is still close to the Minnesota State average calculated from the questionnaire results, and is well below the natural production costs that exist in four of the six DNR regions within the State of Minnesota.

A 'high cost' estimate was also calculated but is not shown in this report. This estimate is based upon interest rates that may have been realistic during early 1982 (a rate of 20 percent), and a very high tax rate of 10 percent. Using these higher figures, the average total cost of producing 4,000 pounds of marketable leeches rises to $11,955. This results in a cost per pound of $2.99, still below the production costs for natural harvesting in four of the six regions in Minnesota.

The cost of commercial production of leeches in a pond setting was not calculated with the same detail as the case of the modified lab production facility. The costs associated with the pond facility will be less than the modified lab facility, because only a few of the expense items will be needed in the pond facility. The pond production facility involves the placement of undersize leeches trapped from other ponds, in a holding pond. This enables them to grow to marketable size. Assuming that the holding pond is comparable to the ponds in which natural harvesting occurs, no additional expenses need be incurred except those associated with obtaining the juvenile leech stock. Therefore, the cost of production within the pond facility will be less than the cost of production in the modified lab facility. In fact, with an assumed 3 to 1 growout ratio, the cost in the pond facility may even be <u>less</u> than the natural harvest costs discussed above.

IV. Economic Feasibility

The examination of the economic feasibility of commercial bait leech production involves comparison of the production costs discussed perviously with the natural harvest costs. These cost comparisons suggest

FIGURE 7

Modified Lab Production Cost Estimates
(Medium Costs)

Interest, Tax, and Depreciation Estimate

Item	Purchase Cost	Useful Life	Salvage Value	AVI	Interest (15%)	Tax (6%)	Annual Deprec. Cost.
Depreciation Cost:							
Land	500				75	30	0
Building	6700	20	-0-	3518	528	211	335
Wiring	800	20	-0-	420	63	25	40
Plumbing	600	20	-0-	315	47	19	30
Heating	800	20	-0-	440	66	26	40
Air Conditioning	1000	20	-0-	525	79	32	50
Tanks	20000	20	-0-	10500	1575	630	1000
Well	1800	10	-0-	990	149	59	180
Filters	120	5	-0-	72	11	4	24
Pump	250	5	-0-	150	23	9	50
Water Heater	200	10	-0-	110	17	7	20
Septic System	1600	10	-0-	880	132	53	160
	34370				2765	1105	1929

Annual Total Cost Estimate

Brood Stock	3134
Insurance	600
Food, Disease, Etc.	200
Gas (water heater and heating)	210
Electric (air conditioning and pump	360
Interest Expense	2765
Tax	1105
Depreciation	1929
	10,303

Cost Per Pound: $\frac{10,303}{4000}$ = $2.58/lb.

that commercial bait leech production is cost competitive with natural harvest costs. The natural harvest costs range from $2.27 per pound to $2.35 per pound for a state average. The low cost commercial bait leech production using a modified lab setting was found to be $2.30 a pound, certainly comparable to the natural harvest costs. The medium cost was found to be $2.58 a pound and the high cost estimate was found to be $2.99 a pound for commercial bait leech production. These cost figures are somewhat higher than the all-state average for natural harvest costs; however, they are below the natural harvest costs that exist for four of the six DNR regions within the State of Minnesota.

This suggests that commercial bait leech production would be feasible when compared to natural harvest costs when one examines the cost structure only. However, a true economic feasibility study would involve not only cost comparisons, but would look at revenue estimates as well. The revenue cost comparison would allow the profitability of commercial bait leech production to be compared with the profitability of natural harvest production.

For the purposes of this analysis, revenue estimates were obtained from two sources. The first revenue estimate was contained in the 1980 Minnesota DNR study dealing with the Minnesota live bait industry. That study revealed that the wholesale price of leeches for the year 1978 was equal to $40 per gallon. Using a conversion factor of 8 pounds of leeches per gallon, this results in a per pound revenue figure of $5. This is well above the costs per pound ($2.99) associated with the high cost commercial bait leech estimate in the modified lab setting. Revenues of $5 minus costs of $2.99 results in a profit of $2.01 per pound. The low cost commercial production estimate of $2.30 per pound would yield a profit of $2.70 per pound using the $5 per pound revenue figure in the 1980 DNR study.

The second revenue estimate was provided by a resort owner in northern Minnesota, where the wholesale price paid for leeches during the period of 1980-81 was $50 per gallon. At 8 pounds per gallon, this would yield a revenue of $6.25 per pound. It should be noted that this second

revenue figure would substantially increase the profitability of commercial bait leech production in the modified lab setting. It should also be noted that the cost estimates in the current study were based on the year 1981. Therefore, it appears that the $6.25 per pound revenue figure is more consistent with the cost data used in this study.

On a total revenue basis, the above figure suggests that leech production of 4,000 pounds per year would yield a total revenue of $20,000 to $25,000, depending on the revenue estimate used. The comparable total costs associated with commercial bait leech production for the modified lab setting range from a low figure of $9,200 to a high figure of $11,960, depending on the tax and interest rates used in the cost calculations. In any case, the economic feasibility appears to be high for commercial bait leech production when comparing total revenue with total costs. It must be recognized that all of these profit estimates measure gross profits; that is, profits before income or profit taxes have been deducted (net taxes). Thus, net profits will be less than gross profits by the amount of profit or income taxes paid.

Finally, it should be noted that all of the above revenue and cost comparisons used price estimates figured at the wholesale level. If retail prices were examined, the profitability would be even higher. For example, the conversion figures used by the Minnesota DNR suggest that one pound of leeches will result in thirteen dozen leeches available for sale at the retail level. Using a conservative price of $1.50 per dozen, one pound of leeches could yield $19.50 when sold at the retail level. This represents from $13.25 - $14.50 more per pound that could be earned in comparison to the wholesale level. Therefore, when viewed here at the retail level, commercial bait leech production appears to be even more feasible.

It must be recognized that this is a tentative conclusion. These results were based on true estimates and were derived using certain generalizations and specific assumptions about the production process and the resulting costs and revenues. The economic feasibility of any specific

case would depend upon the particular situations unique to that case. For example,

1) location of the specific production facility can have a major impact on the costs of production and therefore on profitability and economic feasibility. Among the factors likely to be influenced by location of the production facility are land costs, cost of septic system and water, utility costs, and costs of obtaining the necessary stock to begin the commercial bait leech production cycle. Another factor that will influence the specific profitability and economic feasibility of a given case is

2) the production schedule used. Increasing or decreasing the amount of overlap in production scheduling could have a great impact on two of the largest fixed costs involved in the production process. These two fixed costs are interest costs and depreciation. Scheduling may influence the size of the production facility as well as the number of necessary trays.

3) The projected level of production also influences profitability. If the production level differs from the 4,000 pounds per year assumed in this study, costs and revenue differences would likewise change. Also, revisions in state or federal income taxes would alter the profitability of commercial bait leech production.

The most important factor to be examined in any particular case, however, would be

4) the labor costs involved, including managerial or entrepreneurial labor costs. This refers specifically to labor costs associated with the owner/operator of the commercial bait leech production facility. It should be recognized that these costs were not included in the natural harvest costs estimate based on the survey of commercial bait leech harvesters. The survey included only the wages which harvesters paid to others in return for their labor services. Also, labor costs were not included in the cost associated with commercial bait leech production in the modified lab setting. Labor costs are difficult to assess because they depend upon the specific circumstances of the individual engaged in

commercial bait leech production, often called 'opportunity costs', these can vary greatly among individuals. Clearly, it would not be profitable for a person gainfully employed at a salary of $50,000 to risk bait leech culture at a $25,000 projected revenue figure. The opportunity costs here are very high. A retiree, on the other hand, having no alternative use of his labor skills, presents an example of low opportunity costs. Depending then, on the value of one's own labor, the economic feasibility for an individual engaging in bait leech production ranges from low to high.

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