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Chosing TFM or a Barrier With the Net Present Cost Method

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Choosing TFM or A Barrier With

The Net Present Cost Method

A Brief Guide

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A Introduction

When there is a choice of equally effective methods with similar and acceptable adverse effects, the lower cost method is preferred. For lamprey control, both barrier dams and TFM work. Their adverse environmental affects are not identical, but are tolerable. TFM and barriers are both available, so there is a choice. This note is intended to help lamprey control managers choose when to use which method, in order to get the most out of the lamprey control budget.

Cost is important. No one likes waste. Staff want to know that they are carrying out their duties efficiently. They do not like waste as it saps confidence in the management and undercuts morale. Savings can be applied to additional control efforts to improve the fishery. And, once control obligations have been met, savings offer an opportunity for reducing costs in government or applying the savings to other programs.

Economists rely on the Net Present Value (NPV) to choose between different uses of funds. The method provides an estimate of the costs and value of each option considered, and this estimate expresses all values in terms of present dollars. The option with the greatest net present value is selected. Or, if more than one option is affordable, those with the highest combined net present value are chosen.

For lamprey control we will assume, based on the advice of biologists and engineers, that barriers and chemical controls work equally well in streams where both are practical and used or applied properly. The value of control will be the same whether it is achieved by TFM or by a barrier. Therefore, the two methods can be compared based on their net present costs (NPC).

Making economic choices with respect to barriers and TFM is rather like buying a house with a mortgage versus renting. Both approaches provide three bedrooms and a lawn to mow. When buying a home, we make assumptions about how long the roof and foundations will last, the mortgage rate and the rate at which house prices will go up. Moreover, we make assumptions about maintenance, water, power and taxes. When renting our assumptions are more to do with the likelihood that rents will go up.

Stream by stream, lamprey control treatment entails costs similar in scale to a family home and managers as the 'buyers' must make similar assumptions about interest rates, maintenance costs and what will be left in the budget when they consider using a barrier or TFM.

The Net Present Cost method treats costs so they are comparable in present terms whenever and however they might be incurred. It allows us to compare renting with buying or barriers with TFM. It is easy to use as major spreadsheet programs such as Microsoft Excel have Net Present Value as a built in function. However, as with other economic methods it is sensitive to the assumptions made when applying it. This note will assist lamprey control managers to ask the right questions and make the needed assumptions based on sound reasons so that the results of the analysis are also reasonable.

A General Problem

Lamprey have partially adapted to chemical control. Maturation periods have shortened and other adjustments such as lentic spawning have been noted.

If we choose dams as our next move, some thought should be given to the lamprey's next likely move. Are we check-mating the lamprey or will be moving ourselves into check? Thought must be given to this predator-prey response problem before going ahead with a major new investment in our hunt for lamprey.

The economist can only raise, not answer this question, but that too may be useful.

B What Is the Right Question?

There is more than one question. Managers want to know whether to treat, how and when to treat.

The first question is "**Are there enough lamprey in the stream to worry about?**". If the stream has no or few lamprey, further questions are unnecessary as control is not required or is relatively unproductive compared to controlling streams with more lamprey. This question is one of relative cost effectiveness. Although relative cost effectiveness can be determined more or less accurately, for the purposes of this note, as long as it is determined in the same way or comparable ways for all streams, the answer is acceptable.

The second question is "**Are both chemical control and barrier control feasible options?**". Chemical control will generally be a proven option, as it will have been done in the past. For barriers to be an option, it must be clear that there is an acceptable barrier site down stream from known and likely lamprey spawning areas. A barrier that does not eliminate or greatly reduce chemical control costs may be technically feasible, but likely offers few savings or other benefits. To be feasible, a barrier must be technically possible, offer the potential of savings by greatly reducing the need for chemical control and not pose unacceptable environmental or public safety risks.

The third question is "**If both chemical and barrier control are similarly effective and practical and both entail acceptable environmental and safety costs, which has the lowest net present costs over the economic life of the contemplated barrier?**". This note addresses this question. The answer depends on the costs pertaining to a particular site and to three assumptions that have to be made to use the net present cost method. This paper focuses on understanding the factors pertinent to a specific stream or site and on the three essential assumptions, before it moves on to discussing and applying the net present value method.

C The Three Essential Assumptions

Using Net Present Cost requires assumptions about three things. These are the:

1 time frame for the analysis
2 the discount rate to be used, and the
3 costs to be included.

These assumptions must be made explicitly. And reasons for making them should be given. *The assumptions should not be averaged for all cases.* It is better to reflect actual information, or barring that informed opinion or gut feelings formed by experience.

An example will assist in being more explicit. The economic life assumed for most projects might be 30 years. To make the same assumption for streams where flow is known or thought to be subject to extreme flooding (large, steep, rapidly channeled basin, with weak foundation soils) would be misleading. The assumptions are never certain. The economic life is an estimate. But to estimate an average economic life (or discount rate or costs), when they are good reasons for believing they would be different, is misleading and prejudices the analysis. Assumptions have to be made. And reasons for them must be provided.

C1 The Time Frame or Economic Life

Lamprey control may have to go on forever. Religion and mathematics can cope with infinities. Economics cannot. There must be an estimate of time frame. The reasonable period to use to compare TFM control with a barrier is the expected economic life of a barrier. This is reasonable because it is the longest period for which we can be certain that there will be a flow of harmful and/or beneficial effects from either TFM or a barrier. If TFM left a residue with a half life of 120 years (which it does not), and the residue had a measurable effect that concerned us, then the time frame used for economic life would be 120 years after the last TFM treatment. This illustrates that the time frame must reflect the longest known cost or benefit.

Leases should be for at least the economic life of the barrier. If the lease is for less than the expected life of the barrier, the economic life for the project is the duration of the lease.

Ordinarily, the economic life of a barrier is that period from when construction costs begin until the barrier requires major maintenance to ensure continuing effectiveness. Some barriers have had to be re-worked early in their history. Based on experience with existing barriers, economic life is often more than 20 years. A more reasonable estimate is likely 30 years depending on design. Estimates of greater than 40 years may be reasonable if they are based on low head dams built to a heavy standard.

A stream that does not offer good foundations should have either a shorter economic life or a design that compensates for this fact. So too, with a stream with a history of washing out dams or bridges, or a history of landslides. These are facts that must influence assumptions about economic life. Any fact or reasonable supposition or significant doubt that will or could effect the expected serviceable lifetime of the structure should be reflected in the assumption made with respect to economic life.

Chemical treatments also have an economic life. This is the period after a treatment until a repeat treatment is needed. It may vary from three to six years according to the temperature of the water, food available for larval lamprey and other factors that influence maturation. A stream specific estimate of economic life for treatments is required.

Economic life is a crucial assumption as the costs avoided by building a barrier are the costs of chemical treatments and assessments that are not needed with a barrier in place. The longer the economic life, the more treatments and assessments avoided. Hence, the choice of economic life is a choice that influences the outcome.

C2 The Discount Rate

A dollar of income today is worth a dollar. If we have to wait until next year for the dollar, we might prefer to take $ 0.95 now. A person going through these thoughts has discounted future income to compare it with present income. This is a key in deciding whether it is better to do something now, or to wait. And, the same approach helps us decide whether it is better to do something once to achieve a result or to do a different thing repeatedly to get the same result. In the case of lamprey control, do we build a barrier now, or use chemicals repeatedly.

A high discount rate reduces the consequence of future costs more than a lower discount rate. Higher discount rates favour chemical control. Lower rates favour barriers. The aim is not to chose a neutral rate, or a fixed rate or one that is easy to use, but to chose the rate which best reflects the actual discounting of the value of money for the time period of concern which is the economic life referred to above.

A simple reasonable discount rate is the rate of inflation minus the real growth rate. This allows discount rates that can be negative.

It is normal to use the same rate for the entire period and for all projects. However, chemical control entails costs three to six times at more or less equally spaced intervals over the economic life. Barrier costs are concentrated up front. Moreover, some projects may be in areas with high inflation or growth because of local booms. Growth and inflation rates may vary with location.

It is preferred therefore to use a project specific discount rate. As construction costs are relatively immediate, local inflation rates if they are known (state or province) less the real growth rate (state or province) can be applied to the barrier costs.

TFM control costs are not as impacted by local considerations. Moreover TFM control costs will continue into the future and there is uncertainty with respect to future costs. Given the long economic life of barriers, and the uncertainty of local economic considerations over that time, it is suggested that TFM control costs be discounted using the United States long-term (30 year) bond rate. This is a market rate (not an economist's estimate) which reflects expectations for inflation on the part of buyers. This rate also reflects the actual costs of borrowing for any part of the program that is deficit financed. (For the detail oriented a 31/69 weighted average of Canadian and USA long term bond rates might be a slightly more precise rate to use for estimating NPC of TFM treatments.)

For TFM treatments, future costs should be discounted at the long-term federal government bond rate, which is currently (June, 1999) 4.31% for U.S. Treasury EE Series. (Updated rates available in most newspapers or the U.S. Treasury web site.)

For barriers, the inflation rate minus the growth rate is appropriate. However, where that yields a negative number or any number less than 2%, it is suggested that a rate of 2% be used. Thus, the discount rate used would be the higher of 2% or the difference obtained when the real growth rate for the state or province is subtracted from the state or provincial inflation rate. The reason for the 2% limit, is that a lower or negative number indicates deflation, and deflation is usually a short-term phenomenon. The barrier and many of its costs are long term considerations and it is likely misleading to do the analysis based on short term opportunities.

In testing, the analysis, both streams can be recalculated using the long-term bond rate to determine whether the absolute differences hold.

Assumptions with respect to discount rates are essential. These assumptions should reflect long-term public sector borrowing costs in the case of TFM treatments and local inflation and growth rates in the case of barrier control efforts.

C3 Essential Assumptions About Costs

As set out earlier, the analysis will compare the costs associated with building and maintaining a barrier with the costs of assessments and TFM treatments avoided if a barrier is built. Accordingly, this section sets out the cost information needed in the Net Present cost method for TFM controls and for barriers and suggests how the information may be developed.

It is impossible to know the exact cost in advance of construction or control. Cost information is therefore assumed. The assumptions are not 'guesstimates'. The assumptions are based on past <u>satisfactory</u> experience with treatments or barriers in the same or similar streams. Cost information from efforts that had unsatisfactory results, should not be used to prepare cost estimates. (Not even to estimate averages.) There are useful things to be learned from setbacks, but one aim is to avoid replicating them.

D Costs To Be Considered With Ongoing TFM Control

In most cases, barriers will be contemplated for streams that have a history of chemical treatments. The history of past costs for chemical, manpower, travel and assessments provide the basis for developing estimates of chemical control costs anticipated if a barrier is not built.

The past figures are accurate. Costs however have changed over the years as more sophisticated instrumentation has been taken into the field. Chemical costs have fallen, and with changes in organization, treatment teams have become smaller. This has brought labour costs down. The lighter field crews and reduced chemical use are in part possible because of improved assessment. And improved assessment has meant higher assessment costs, which have risen as a share of the total.

The historical costs to be relied on in predicting future costs are not an average of all past costs for the stream. The costs used to predict the future should be the most recent costs, modified to anticipate planned levels in staffing.

The major determinants in treatment costs foregone are the economic life of the barrier and the repeat period for treatments. Depending on the economic life and repeat period a barrier might eliminate the need for between three and twelve chemical treatments. This difference can make a four-fold difference to costs potentially avoided.

Estimates of future costs of chemical control rely on the history of chemical treatments made in the past.

The first information requirements are the economic life of the barrier and the repeat period for treatments. This should be used to give estimates of the years in which assessments and treatments are probable in the absence of a barrier. For example, if a barrier with an expected thirty year life is built in the year 2000, and in its absence there would have been treatments in 2005, 2010, 2015, 2020,2025 and 2030 with assessments in each immediately preceding year five treatments and five assessments are avoided. If the repeat cycle is reduced to four years, the treatments avoided rise to six. The history for the stream coupled with information about possible changes in larval maturation periods should be used to provide a sound biological estimate of repeat cycle.

Chemical costs per unit and labour costs will rise. Inflationary pressures in North America are rising on the wage side. However, open or free trade arrangements continue to repress the potential for wage increases. It is reasonable to forecast a continuation for the next ten years of low inflation. That is a rate near 1.5% to 2%. Beyond 10 years, inflation is less consequential because of discounting. For the period beyond ten years, the estimates can be run with 2% inflation and then with 4% as a test. Historically, lamprey control cost increases have lagged well behind inflation in Canada and the USA. There is no reason to assume that this will change. Using higher rates of inflation is accordingly unwarranted.

Chemical use should be based on the second highest recorded use after the introduction of temperature and pH monitoring. This rate will be above average, but avoid the extreme. If there are only two such years, 115% of the average will provide a cautious estimate.

Chemical costs should be based on cost in the year of replacement, not in the year purchased or used. Chemical costs should include a charge that provides for storage for at least 60% of the inventory replacement cycle. For example, if inventory is replaced every 50 months, a storage charge of 30 months should be applied to chemical costs.

Inflation of chemical costs is more difficult to estimate. However, unless the program moves to produce its own chemical in a program controlled facility, chemical supply will be competing to get space and time in plants that could otherwise be used to produce pharmaceuticals and agricultural chemicals. These are subject to growing demand and higher rates of inflation. In addition, currency speculation is entailed.

To adjust for the higher inflation rate for chemicals, the inflation rate for chemicals should be 1.5 times the rate assumed for labour in low inflation years (under 3%) and 2 times the rate for labour in high inflation years.

Forward holding of currency can eliminate the currency factor. The GLFC can hold half of its needs for foreign supplied chemicals in the appropriate foreign currency. This would remove the currency vagary. This is suggested as an appropriate business practice in any event and can be accommodated readily within normal banking practices.

Labour costs for treatments and assessments should be based on current team configurations. In addition, the stand by costs of labour that is held over the winter or in periods of flood or spawning when treatments have to be avoided or delayed should be included. This standby cost might be reduced if the labour is being used for other nontreatment purposes, such as barrier maintenance or construction.

E Costs To Be Considered With Barrier Control

Barrier costs are considered in the order that they are likely to occur.

Barrier design during the experimental period has been treated largely as a sunk cost or program overhead rather than a barrier specific cost. In future, each barrier should have a design cost assigned, based on the number of months of professional time spent in developing the site plan and the costs of the people involved. For purposes of estimating design costs for an anticipated barrier, design costs should be based on the time required to develop plans for a similar non-experimental design at a comparable site.

Site costs should be considered at purchase price unless there is a clear and definite gift offer of the site. Leases should be for at least the economic life of the barrier. If the lease is for less than the expected life of the barrier, the economic life for the project is the duration of the lease. For the purpose of estimating site costs, the site should consist of a lot on each bank of the stream, at least one with road access. Land access costs may be estimated using house lot or cottage lot costs in the area which will include an access cost.

Construction access costs should be estimated based on likely distance given possible sites and existing roads. Basic farm lane development costs with an access control gate are sufficient.

Materials requirements will ultimately be site specific. However, for purposes of estimates, the costs of concrete, reinforcement steel, sheet piling, rock, gravel, gabions are all known and the amounts needed for a barrier with a given height, width and foundation needs can be estimated.

Labour requirements are also readily estimated as it is known how long it takes to place and remove forms, pour cement, drive piles and so on. Allowance can be made for, bad weather or other circumstances that add to costs.

Construction costs will also require some equipment rental. These costs can be estimated based on past experience with similar structures and adjusted for local rates. Very remote sites and sites in or near areas with building booms will likely have higher costs.

Construction cost estimates should reflect hydrologic information on peak and average flow, stream profile, foundation potential, and distance to nearest labour supply.

If the design is to retrofit an existing structure to make it lamprey proof, the estimates should reflect the lower costs entailed.

A barrier will require maintenance. The cost estimates should schedule maintenance based on past experience. Minor maintenance should be provided for on an annual basis with greater costs every fourth year every fifth year according to past performance.

Barriers and related fish ways may have an annual operating cost depending on the anticipated operating agreement. These are normally low but should be accounted for according to the design. Typically, the costs should not exceed a number of hours of contracted labour each day for a period of weeks each year.

Barriers should reduce the need for assessments. Assessments of actual populations above barriers should not be needed. However, presence - absence assessments on a regular basis will be needed to determine that the barrier is working and to determine if there is any need for operating changes or corrective maintenance.

Maintenance, future assessment and operating costs should reflect the same labour inflation rate used for labour costs in chemical treatments.

F Environmental Costs

Environmental costs could be ignored if barriers and TFM treatments had essentially equivalent effects. In general, an estimate of environmental costs should be based on habitats or species or recreational opportunities lost. In streams, that are already degraded, it may be that there are no incremental losses.

TFM impacts can be minimized by minimizing chemical use and by timing treatments to avoid periods when larval stage fish, crustaceans or amphibians would be exposed. There are no monetary costs to this scheduling, but it does limit the available treatment period and hence the number of treatment periods in a year. This in turn will increase the standby cost of labour on TFM treatments.

Barrier impacts can be reduced by variable height designs, fish ways or potentially by designing barriers that can be easily removed once (if) lake wide lamprey eradication is achieved. These options may increase initial costs for design and construction but reduce environmental costs.

It is proper to look at the costs of options such as maximum environmental damage avoidance (e.g. - costs of using inflatable designs versus low head barriers) and at supplements to a program which might improve spawning or fish nursery area or canoe access or swimming in a steam at the same time as a barrier or treatment is considered. These costs should not be used in the final analysis of barrier versus chemical treatment, but they should be considered so the optional improvement can also be considered. To return to the buy a house versus rent a house comparison; it is legitimate to consider houses with a larger garden or two and a half baths. So too, we should consider suitable 'options or add-ons' in lamprey control. Whether they are bought or not, depends on a separate decision, but it is useful to know the cost, particularly if there is a potential partner with an interest in such habitat or recreation 'options'.

G Public Safety Costs

Barriers have been the site of a number of drownings. These accidents are so far exclusively at barriers in or near urban areas. Urban barriers should be built with fencing to keep people away from the water and perhaps with some device to make it easier for people to get out of the water once they are in. This adds to cost. **Again, whether or not the safety measures are built, their costs should be included in the comparisons.**

For purposes of clarity, the costs of safety measures taken in TFM treatments should be identified as well.

In addition, a liability cost should be accounted for. The liability cost should vary with the likelihood of visitors at the site. This will vary with how close to a city the site is and whether the site is in an area with public access such as a park.

H Relative Effectiveness Considerations

Both barriers and chemical treatments are effective. Chemical treatments when they are less than 100% effective tend to be more than 80% effective. Breached barriers or improperly operated barriers however can occasionally have near total failures, which can usually be readily remedied. Overtopped barriers may fail completely if the overtopping occurs during a lamprey spawning run.

Failures can add to the need for assessment and clean-up treatments. Estimating the costs of breaches, overtopping, or inadequate or incomplete chemical applications should be attempted. These costs may include additional assessments, clean-up treatments or barrier repairs.

Thought should be given to whether a stream has characteristics that make it difficult to treat effectively or is of a kind that is more likely to have barrier breaches or overtopping. Where some of these conditions apply, consideration should be given to including a contingency cost in the estimates. Given the record of breaches or failed chemical treatments, the contingency cost should only be considered for streams which are problematic because of some known aspect which makes it difficult to treat or build a successful barrier.

I Analysis of the Cost Estimates

Two cost tables should be prepared in a spreadsheet program, one for the barrier option and one for chemical treatments.

The tables should show each cost and its amount in the year it is to be spent. If each row is a year, and there are columns for the various kinds of costs, cost for each year can be totaled. By building in factors for inflation, labour and other costs can be adjusted for inflation over time. The costs for barriers for each year should be totaled and the costs for chemical treatments for each year should be totaled separately.

These totals should appear in separate columns in the spreadsheet, a column for barrier costs and a column for treatment costs. Each row should be one year in the economic life of the barrier. The Net Present Value function is then applied separately to each column of total costs taking care to apply the appropriate discount rate to each column. In applying the NPV function, the operator specifies the cells to be calculated, and the discount rate.

If the discount rate is varied at different stages of the analysis, the Net Present Values must be computed for each stage and then totaled.

The Net Present Value for barriers is compared with that for chemical treatments. The smaller number indicates that the cost in present value terms is lower and is therefore preferable. However, the estimate is subject to variations in the assumptions. The estimates should be redone with discount rates that are substantially higher and lower to determine how much of a change is needed to reverse the results. Consideration can then be given to the probability of such a change in discount rates actually happening.

Similarly in testing the result, all cost factors that contribute to the total costs for the option, an amount that is in percentage terms more than half of the percentage difference between the two NPV's for the options should be re-estimated. Thus if the one NPV is 12% greater than the other, any cost factor that contributes more than 6% to total costs for the option should be re-examined. It should be determined for each cost, how much it would have to change, to reverse the result and thought should be given to how likely such a change actually is.

This testing will clarify the difference between NPV's. It is preferred if the difference rests on costs incurred in the near term, as these are less subject to errors in estimating inflation or the discount rate.

J Going From Project to Program

The point of choosing between barriers and chemicals is to save money and use the savings to improve overall program effectiveness. The above analysis allows this decision to be made on a stream by stream basis.

Each year there are 70 chemical treatments. And there are 35 barriers. If a barrier replaces a treatment every four years, there are the equivalent of 79 treatments ongoing now. If there were 70 barriers, there would be the equivalent of 88 treatments a year. There could be 70 to 80 barriers in ten years. This would place barriers on half the candidate streams. Which streams should be chosen? Those where technical feasibility is established; but what if each is economic and technically feasible?

Barriers should be placed so that when combined with the 70 TFM treatments each year, the combination does the most good. This question of 'most good' requires analysis of how lamprey and fish populations would respond to sequential whole lake treatments. If whole lake treatments (that is barriers on many streams and treating all other streams on a lake at lest two years running) would greatly reduce lamprey populations, then there is potential for great benefits to fisheries. The intent should be to select streams so the 70 chemical treatments can be concentrated on one lake. That is, no lake would have more than 70 streams that needed treatment. Whole lake treatment would then be possible on a repeated basis. This could allow the control program to approach extermination without adding to costs.

The analysis looked at in this note assumes benefits are similar and seeks the lowest cost method of control. (Net Present Costs) The analysis contemplated for whole lake treatments assumes identical costs, but different benefits. Hence it would require a biological and then an economic assessment of the different probable benefits

With this perspective in mind, it may be desirable to build some barriers, which on a stream only comparison would be uneconomic. However, if by building them, it is possible to achieve whole lake control it is highly probable that they should be built.

Part of the analysis and objective should be to target streams for barriers with the aim of reducing the number of streams needing chemical treatment on a lake to less than 70. This will make sequential whole lake treatment possible. And, that can make a further major reduction in lamprey possible with resulting improvements to fish populations.