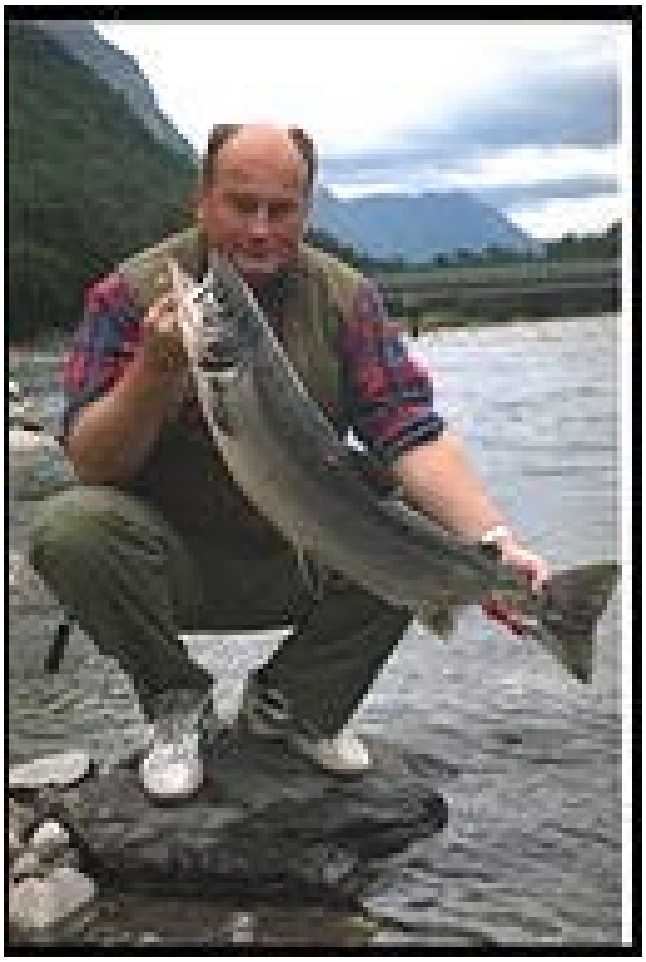

FARMERS, ECO-TOURISM AND A NORWEGIAN DILEMMA

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Introduction

In Norway river owners, who are typically smallholding farmers, have turned to salmon tourism as an important source of supplementary income to their farm operations. Tourism is the world's fastest growing business at the turn of the century, and eco-tourism is a new and increasingly important niche within the business. Salmon tourism has grown into a business whose annual revenues were estimated in 1980 to be in the order of 100 million dollars in Norway (Krokan & Mørkved, 1994). These revenues mostly benefit farmers with few other opportunities for off-farm employment, and who depend on supplementary employment to be able to continue living on their land.

As the river owners discovered the value of their rivers, they started organizing sales of fishing permits, and investing in fish cultivation programs. Some rivers owners' associations own their own hatcheries, while others are carrying out fish cultivation programs in cooperation with others, including government owned research facilities, engaged in fish breeding programs for the fish farming industries.

Now salmon tourism is in peril because of declining salmon populations due to a number of threats to salmon survival. One of these is a deadly parasite which was accidentally introduced to Norwegian rivers around 25 years ago, *Gyrodactylus salaris* ("gyro"). Since then, the parasite has spread to around 40 rivers, and in at least 5 of these salmon is extinct as a result (DN & LR, 1999). Unfortunately, the probability of getting a river infested with gyro is higher the more human activity there is there, i.e. the more economically interesting the local stock of salmon is. Among the affected rivers are some of the most famous salmon rivers in Europe, which have attracted tourists for over a century.

The Problem

Salmon is a migrating fish, which is being exploited by different groups at different stages of life. While in the rivers, it is subject to angling and other primitive fishing methods, which allow one fish to be caught at a time. While in the ocean, salmon form schools of fish, which have been subject to extensive commercial fisheries in the past. This makes salmon a typical public good; it is difficult to connect costs and benefits incurred by the management of the resource, and make the beneficiaries pay the bill. So the government has assumed a vital role in managing the wild stocks of salmon.

The government has chosen sanitation of rivers with the fish poison rotenone as its core strategy to exterminate gyro, deemed essential to save the indigenous salmon populations of Norwegian rivers. Since 1982 25 rivers have been treated with rotenone against gyro, with successful result in more than 80% of the cases (DN & SDH, 1997).

The problem is that the rotenone program is highly controversial, with environmentalists, anglers, the general public, and government agencies disagreeing if it should be continued. Rotenone treatments cause mass death among fish in the rivers, which understandably stirs strong feelings.

This means that the river owners face a multitude of competing interests in the battle to save the wild salmon from extinction. Now the government needs to decide whether it will allocate the necessary means to continue the rotenone program in spite of these controversies, or abandon the program and let nature take its course. But it can’t turn to the river owners for advice; they are as divided on the issue as any other involved interest group.

Objective

The objective of this paper is to determine the importance of the rotenone program for the interests of river owners. There exists a six-year old cost-benefit analysis of the rotenone program, as seen from the government's point of view (Krokan & Mørkved, 1994). This paper follows up that research by focusing on the economic implications for river owners.

Procedure

Two rivers with a history of salmon tourism are chosen as examples of rivers with different stories related to this issue: the river Driva (pron. 'dree-va') in the Sunndal valley, and the river Lærdalselven (pron. 'lare-dals-elven') in the Lærdal valley. See **figure 1**, page 13. In Driva the parasite was first detected in 1980 (DN, 1995), but twenty years later, nothing has been done to exterminate it from the river. In contrast, Lærdalselven had never been infested before 1996 (DN & SDH, 1997), but when it happened, river owners and government authorities cooperated to ensure a swift rotenone treatment, implemented within months of the first detection (FMSF, 1996/97). An explanation of this difference in behavior is offered below, which emphasizes the role of the river owners in implementing rotenone treatments.

The question of whether or not the river should be treated with rotenone is analyzed by assigning weights to the pros and cons of rotenone treatments of rivers, and make a decision table. This table presents the effectiveness of the two available options to protect the interests of the Government and the river owners in both rivers.

Parasite biology and the strategy chosen to combat it

Gyro is a freshwater disease of salmon, which is mortal to the young fish, not yet old enough to leave the river for ocean pastures. It is a small worm, about 0.4 mm long, that kills the fish by eating holes in its skin, which become entry points for secondary infections, and which also impair the skin's osmotic processes. But when the host leaves freshwater, and enters salt water, the parasite quickly dies (DN, 1996).

Gyro is a hermaphrodite, giving birth to living offspring. The newborn is already pregnant, and so is the fetus, so several generations live inside each other like Chinese boxes. See **figure 2**, page 14. This gives gyro an enormous capacity to multiply, but it also means it doesn't have a life stage (like eggs) which can survive without the host. When the host dies, so does the parasite (Mo, T.A., 1991).

In infested rivers, the mortality of young salmon increases drastically, and within 3-4 years after the parasite has been introduced to the river, all young salmon are gone. Some years later, the number of adult fish migrating up the river starts to decline. Eventually, all salmon found in the river are escaped farm fish, and not members of the river's indigenous stock.

But when all fish in a river are killed with rotenone, provided that the infestation has not had enough time to deplete the ocean stocks, there is still a population reserve of adult salmon in the ocean, which will migrate up the river to spawn later, and thus contribute to a restocking of the river. In addition fish breeding programs produce fish to be released after a rotenone treatment. After a treatment, there will be a period when there are no hosts available for the parasite population, which will then die out, so the river is clean when it is restocked. After a rotenone treatment, all fishing is banned in the river for three years, to allow the stock to rebuild. The losses and gains in catch quantities when a river is infested, and when it is treated with

rotenone, are illustrated in **figure 3**, page 15 (Krokan & Mørkved, 1994). Rotenone treatment is the only known method that can efficiently keep the gyro epidemic under control (NOU 1999:9). But the dramatic impact of mass death of fish in a river provokes controversy. It takes a very good argument to convince people that this is beneficial to the river's eco-system.

A rotenone treatment is a very complicated operation, which cannot be conducted by amateurs, and only the Ministry of Environment and its subsidiaries, including the Departments of Environment of the County Governors, have the necessary expertise to carry out such operations. But while these experts plan and organize the operation, they are dependent on the river owners and other local volunteers (members of the Angers' Association and others) to do the practical work involved, such as spraying out the chemical at assigned locations at assigned moments in time, and afterwards collecting dead fish. Without the active participation of these groups, government experts are unable to implement rotenone treatments.

The infestation history of Driva

Driva was among the first rivers in Norway to be infested by gyro, at a time when knowledge about the epidemic was limited, and even less was known about possible treatments against it. The river is very large – salmon runs around 100 kilometers (60 miles) of it. The government experts were therefore reluctant to treat Driva before they had acquired the necessary experience with rotenone treatment from other rivers. The first time rotenone was ever used in Norway to sanitize a river against gyro, was in 1981. (FMSF, 1996/97). Before infestation, Driva was the river with the highest catch statistics for salmon of all rivers in its county, Møre and Romsdal, and it had a long history of attracting tourists - from the British aristocracy in the nineteenth century, and later from a broader population base domestically and abroad.

After infestation, salmon catches declined, and salmon fishing was banned there in 1989. But when salmon disappeared from the river, the previously suppressed population of trout started to increase, and by the mid 1990's, the catch statistics for trout in Driva became the highest of any river in Norway. The total quantity (in terms of weight) of fish caught remains much lower than when there were salmon in the river, but the number of fish caught is higher (trout are on average smaller than salmon), so a greater number of tourists experience successful fishing trips now than earlier. So the river owners feel that the disappearance of salmon has not hurt their business. Tourists still find Driva attractive as a travel goal. Catch statistics for salmon and trout caught in Driva are shown in **figure 4**, page 16 (SunNJFF).

As a result of this unexpected turn of events, resistance against a rotenone treatment of Driva has grown among the river owners there. A rotenone treatment now, more than twenty years after the infestation of the river, will decimate a healthy trout population, which will have to be restocked artificially, while there is no guarantee that the indigenous stock of salmon, which is extinct outside of the hatcheries, will ever return to the river.

A tributary to Driva is developed for hydroelectric power production, supplying power to a metallurgic factory in the valley. The power plant is required by the Government to release salmon produced in hatheries as compensation for their disturbance of the river habitat (DN, 1995). Since 1993, over 35,000 smolt (young salmon ready to leave the river for ocean pastures) have been released annually from the local hatchery. This has resulted in small quantities of salmon showing up in catch statistics the last few years, but the number of released smolt returning to spawn later has been disappointing (Aftenposten, June 15, 1999).

Since the mid 1990's, the government experts have felt ready to implement a rotenone treatment of Driva, and a treatment has been officially scheduled for the river at least since 1996.

But so far these plans have been abandoned due to local resistance, both among river owners and the local population in general (FMMR, pers. comm.).

But in 1999 newspapers reported about a new disease problem, which may turn the picture around again. A saltwater disease of salmon, which has increased substantially as a result of fish farming in the fiords, is spreading to trout, and this disease has apparently caused a 70% reduction of the trout population in Driva since 1995 (Aftenposten, June 15, 1999). If this is correct, one important reason for the river owners' resistance against rotenone treatment will possibly be eliminated.

The infestation history of Lærdalselven

Just like Driva, Lærdalselven has attracted international tourists for well over a century. Unlike the Sunndal community, Lærdal is a remote village, with very few opportunities for off-farm employment for farmers. So here eco-tourism is of greater economic importance than it is for river owners in Sunndal. In 1996, the Norwegian King officially opened a new Salmon Center in this village, where tourists can experience salmon both as wildlife, food, and ancient culture. This was a major investment by the village, supported economically by the government's District Development Fund, and whose sole purpose was to attract more tourists. The center had around 85,000 visitors during its first two years of business. The revenues generated by salmon tourism in Lærdal alone since 1996 are estimated to total around 1.4 million US dollars per year (NOU 1999:9).

When gyro was detected in Lærdalselven in October of 1996 (DN & SDH, 1997), the news was taken as a disaster by the interest groups behind the tourist investments in the village. The salmon experts of the County Governor, backed up by the river owners, immediately started

planning a rotenone action, and hurried through the red tape of environmental bureaucracy, to be ready for a rotenone action already the next year. Because of the risk that the infestation might spread to adjacent rivers which migrating fish can reach without entering salt water (passing through brackish water only), it was decided that a local treatment of the lower parts of Lærdalselven had to be done already in the spring of 1997. Here most of the smolt were expected to be concentrated. A second, full treatment of the whole river was then carried out in August of 1997 (FMSF, 1996/97).

Since then, there has been a fishing ban in the river, which will not be lifted until the summer of 2001. In this period, the Lærdal community loses some revenues from absent sales of fishing permits, but thanks to the Salmon Center, there is still some tourist activity. After the fishing ban is lifted, tourists are expected to arrive in at least the numbers experienced before the rotenone treatment of the river. Since the treatment came so early after infestation, the salmon stock in the river has only lost one cohort of fish, and is expected to recover quickly, at least compared to rivers where gyro has been allowed to damage stocks over longer periods of time (Olsen, A., 1998).

A conflict of interests between the Government and the river owners

The Government's interests in this matter are not limited to protecting the economic interests of river owners, but also to protect salmon stocks as a resource to be fished commercially in the ocean, as well as a member of the general biological diversity of the country, which it is obligated to protect through international treaties such as the Rio Convention of 1992, and the Convention for the Protection of North Atlantic Salmon of 1982, both of which Norway has signed (NOU 1999:9).

Both Driva and Lærdalselven are large rivers, whose salmon stocks have historically made contributions to the ocean stocks of salmon that were large enough to matter. The extinction of the Driva salmon has thus added to the general depletion of the population of salmon in the North Sea and the North Atlantic. If many large rivers the size of Driva lose their salmon stocks, this could become a major threat to the future of the species. Furthermore, gyro has the capacity to spread from infested rivers to other rivers in the same fiord system, if there are periods when the water in the fiord gets brackish, which it typically does in springtime. Gyro can tolerate salinity levels up to 2.0 % (DN, 1996). If gyro is allowed to spread like this, of course the problem only grows. So for the Government it is important to get started on a treatment of Driva that may bring salmon back to the river. The Government sees the uncooperative attitude of the river owners of Driva as an unfortunate obstacle.

A decision table for all three participants

There are three major decision-makers involved in the process of deciding how to handle the gyro infestation in these two rivers; the river owners of Driva, the river owners of Lærdalselven, and the Government. All three have different interests at stake. But the fate of these rivers depends on the ability of the agents to make joint decisions, and to cooperate about their implementation.

The author has created a decision table, which is represented by **table 1** (below) and the chart in **figure 5**, page 17. Here arguments in favor of and against rotenone treatments have been weighted, and given points according to the assumed value of these factors to the respective groups. This weighting and value assessment is based entirely on the author's own judgement, but it illustrates how the behavior of these agents can be explained. The more directly an agent is

assumed to be affected by the effect of the factor, the higher value is assigned to it by the agent. But all agents are assumed to range them equally according to importance, as they are believed to relate to the same perception of the world. All factors are considered "important", except the effects of rotenone treatments on protest groups and on the environment, because these effects are assumed to be short lasting, based on previous experience. But river owners are believed to be uninterested in the positive effect on incumbent political bodies of serving the interests of other constituencies than themselves. And, finally, the river owners in Driva see a greater value in commercial exploitation of trout than do the river owners of Lærdalselven, because they have experienced how this species has replaced the extinct salmon population, and enabled them to continue making a profit on selling fishing permits, as before.

Pros	Driva	Lærdals-elven	Govern-ment	Weight
Increased income from selling fishing permits (salmon)	3	4	2	*2
Increased attraction of tourists	3	5	2	*2
Serves interests of multiple constituencies	0	0	5	*2
Improves fulfillment of obligation by international treaties	0	0	4	*2
Cons				
Lost income from selling fishing permits (trout)	3	2	2	*2
Lose three seasons of selling fishing permits due to fishing ban	4	4	2	*2
Provokes embarrassing protests from environmentalists	2	2	5	*1
Uncertainties about detrimental side-effects on environment	2	2	4	*1

Table 1. Decision table. The points represent value of factors pro and con rotenone treatment, as perceived by the respective interest groups. Values are then multiplied by the weights, which is 2 for "important" factors, and 1 for "less important" factors.

Conclusion

The analysis shows that as seen from society's point of view, the benefits of continuing the rotenone program outweigh the costs, but that for river owners rotenone treatments only make sense if they are implemented quickly after gyro infestation is detected where trout tends to replace falling salmon stocks. Trout generates revenues from selling fishing permits that can compete with revenues from salmon. This is the situation in Driva. But if the revenues from eco-tourism are not so much dependent on tourists' access to fishing possibilities, but rather on the mere existence of salmon at the place, as is the case in Lærdal, rotenone treatment against gyro acquires vital importance for the river owners.

The situation in Driva is basically a result of its getting infested by gyro at a time when government experts had not yet learned how to implement rotenone treatments in such large watersheds. In the future it is less likely that the salmon stocks of rivers the size of Driva will be allowed to go extinct because of gyro infestation. Thus, the situation where the eco-system of a river adapts to the disappearance of salmon will probably not be repeated elsewhere.

However, there are around half a dozen rivers in the same situation as Driva (DN & LR, 1999). Many of these are large watersheds, which historically hosted large salmon populations. To the Government, reviving these rivers as salmon habitat is important. To the local river owners, it is not. The Government may have to consider compensating river owners in these watersheds to make them support rotenone treatment of their rivers. To assess the kind of compensation needed to achieve this, it is desirable to establish a better understanding of the rivers owners' interests. This can be done by polling them, or by collecting survey data. To the knowledge of the author, this has not been done.

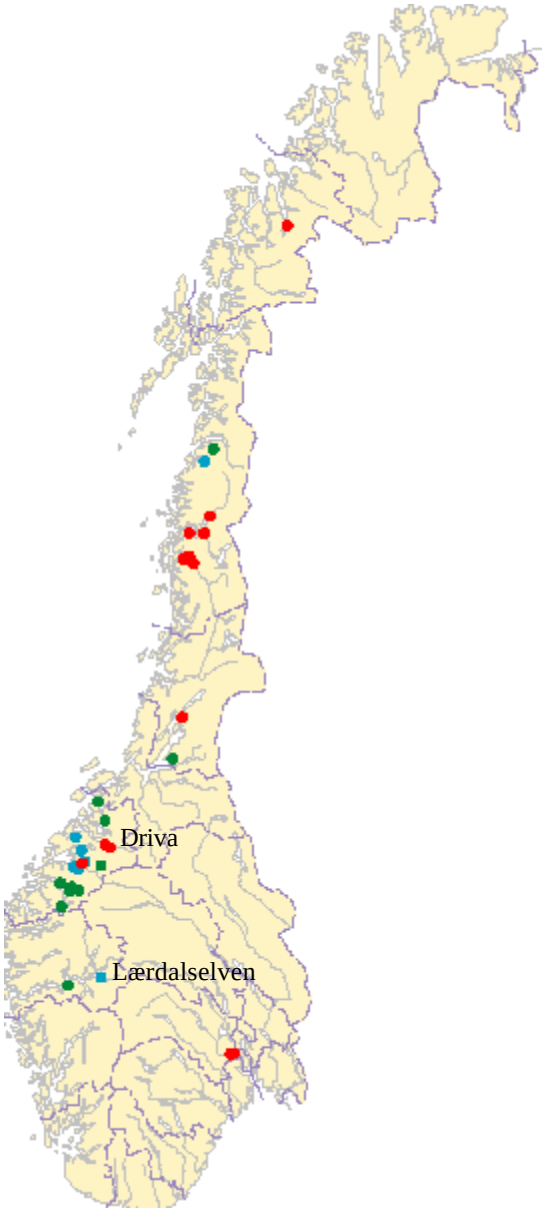

Figure 1. Map of Norway with the rivers Driva and Lærdalselven marked. The spots represent infested rivers, and the colors indicate treatment status on Jan. 1, 1998.

Red: Untreated infested rivers
Blue: Rotenone treated rivers
Green: Rotenone treated rivers with a Clean Bill of Health

Source: The Directorate for Nature Management, web site.

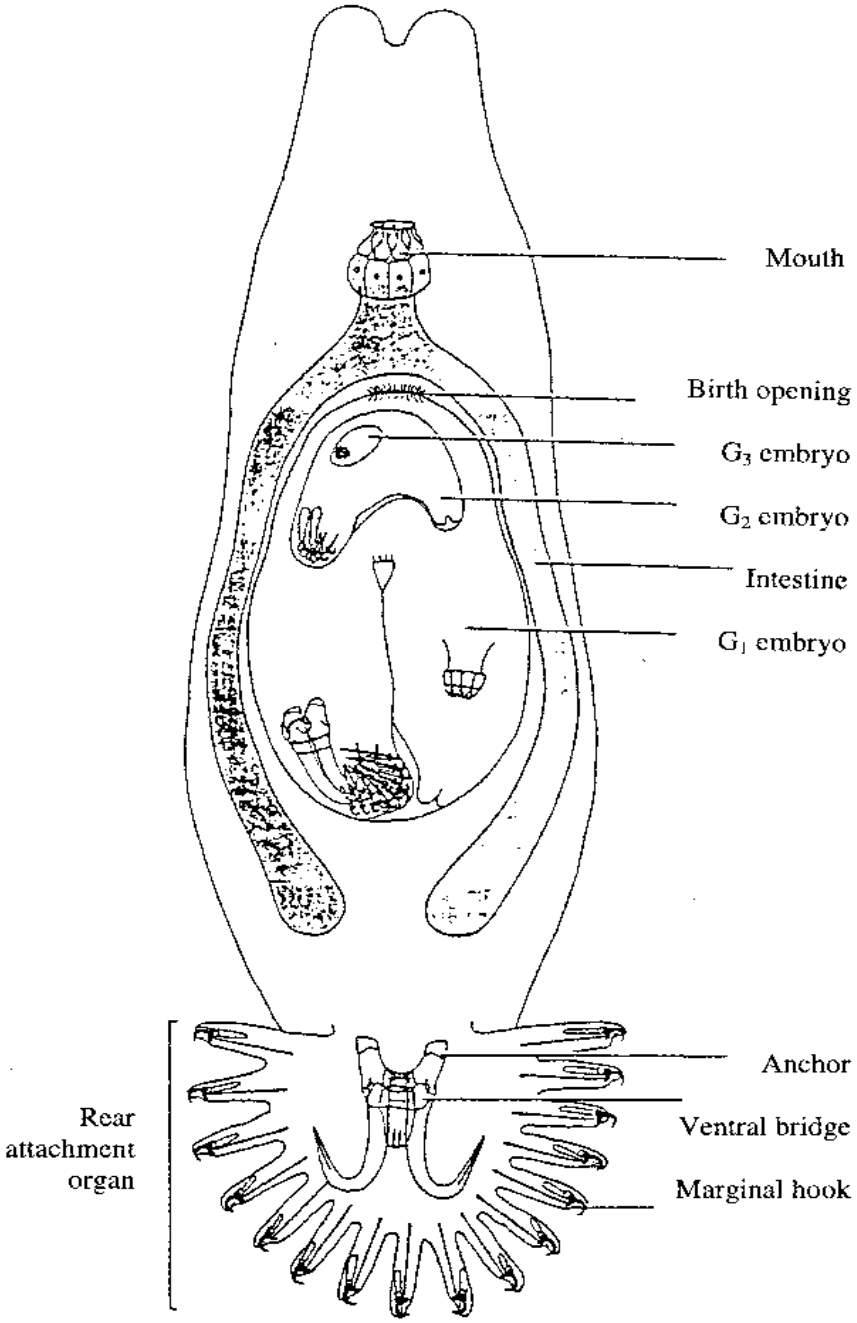

Figure 2. A newborn gyro pregnant with its first child, grandchild, and great-grandchild.

Source: Mo, T.A., 1991

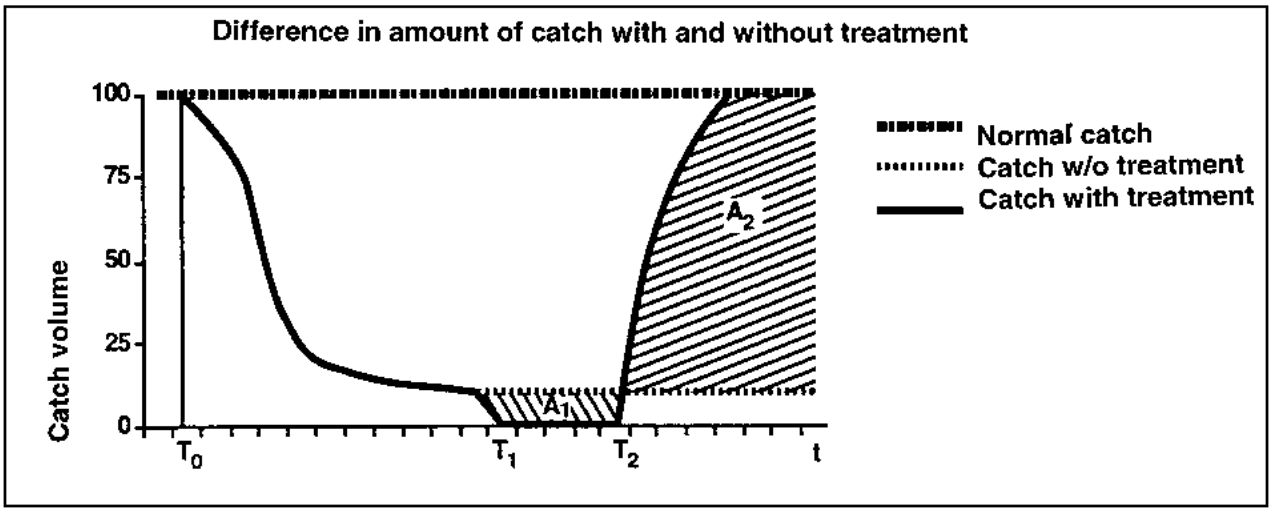

Figure 3. The impact of gyro infestation and a rotenone treatment on the salmon population. T_0 is the point in time when gyro is introduced in the river. The whole line represents catch in percent of normal catch for the river, after gyro infestation. The horizontal, broken line represents normal catch, without the effect of the gyro infestation. In the graph this line is horizontal, but in reality catches are declining because of other factors that reduce the salmon population, such as acid rain, over-fishing, etc.

A_1 is lost catch during fishing ban after rotenone treatment. A_2 is gained catch after a successful rotenone treatment.

Source: Krokan & Mørkved, 1994

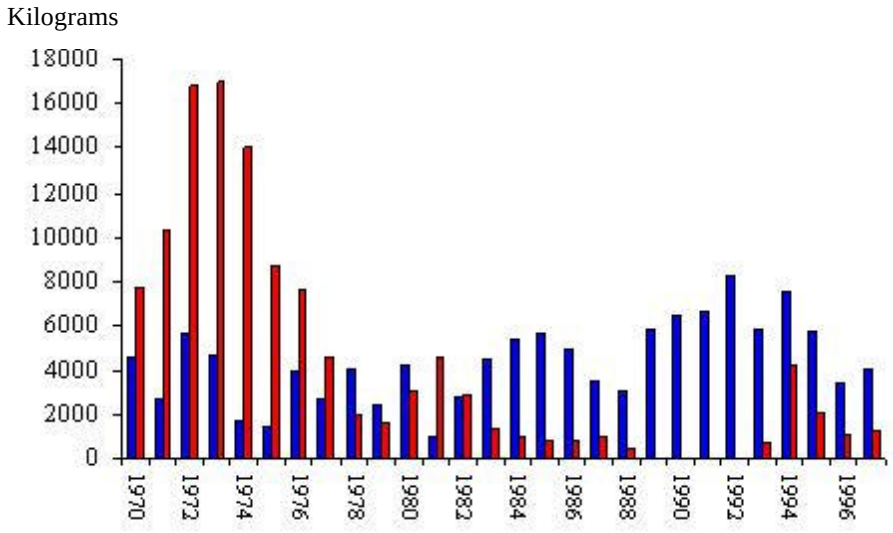

Figure 4. Catch statistics for salmon and sea trout in Driva, 1970-1997.

Red: Salmon
Blue: Sea trout

Source: SunNJFF

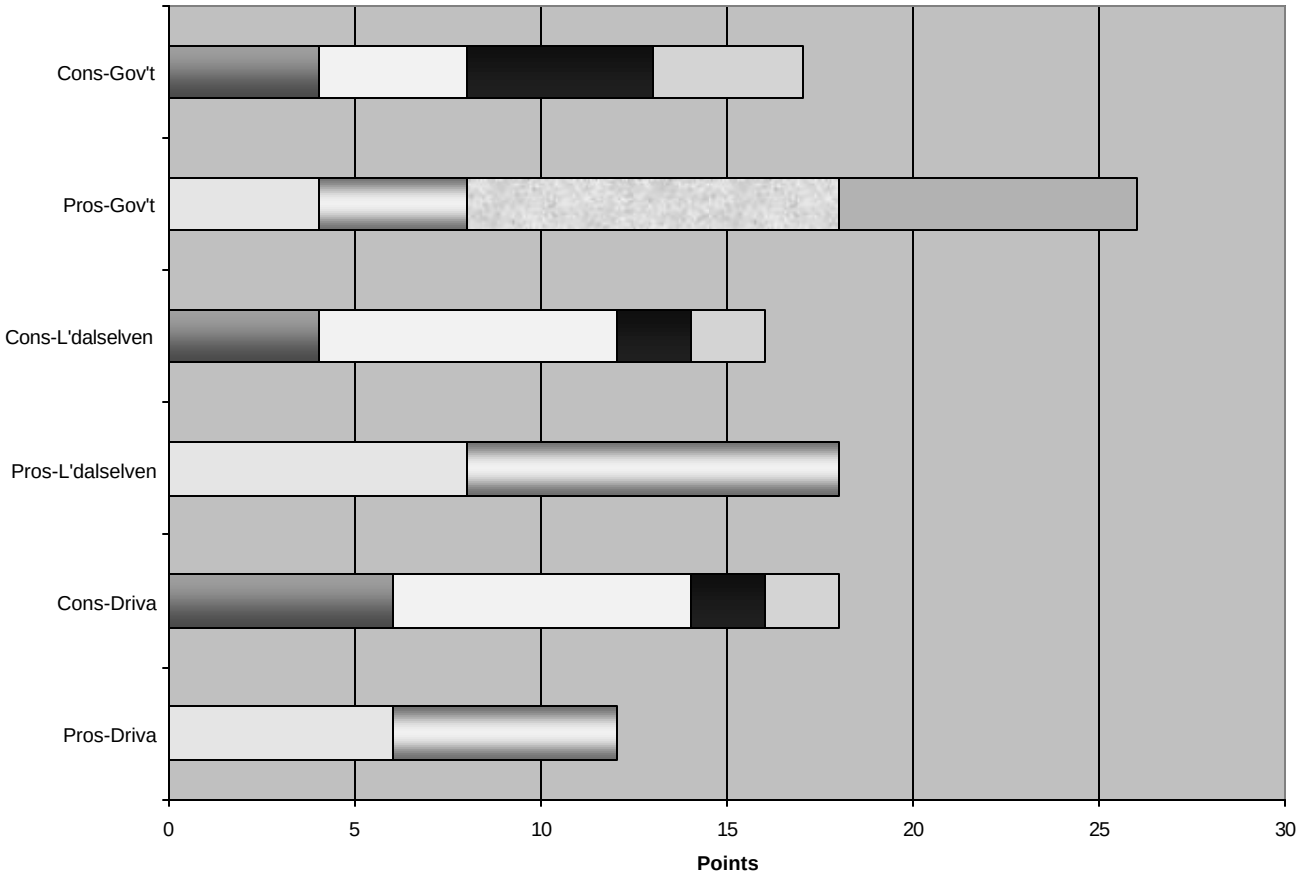

Figure 5. Decision table. The bars represent the points given to these arguments pro and con rotenone treatment of the respective rivers, arranged from left to right:

Pros	Weight
Increased income from selling fishing permits (salmon)	Important
Increased attraction of tourists	Important
Serves interests of multiple constituencies	Important
Improves fulfillment of obligation by int'l treaties	Important
Cons	
Lost income from selling fishing permits (trout)	Important
Lose three seasons of selling fishing permits	Important
Provokes embarrassing protests from environmentalists	Less important
Uncertainties about negative side effects on environment	Less important

Created by the author, based on personal judgement

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