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MONITORING IMPACTS OF WATER ABSTRACTION FROM THE TAKAHUE RIVER

(Short Answers in Conservation Science)

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INTRODUCTION

The demand for water for pasture irrigation in Northland has increased enormously within a short time. Projections of greatly increased dairy production from using pasture irrigation over the dry summer period has triggered this demand. There has since been a rush of applications for water use consents to abstract major quantities of water from streams and rivers flowing through dairying areas. Agencies responsible for managing aquatic resources in Northland must carefully consider the long term and cumulative effects on stream ecosystems of high rates of water abstraction over summer.

The Department of Conservation has legal responsibilities toward the plants and animals (particularly native species) of the streams of Northland. However the biology of these streams is not well understood, it is likely that even undescribed species are present. In the face of the amount of abstraction proposed, DoC has neither the time, manpower, resources or access to any knowledge base to quickly develop management guidelines which guarantee sustainability of aquatic habitats and the biological community dependent on those habitats.

Even should the finance needed to develop a knowledge base become available, the lag time needed to develop management recommendations would be in the order of years. In addition, every stream is subtly different, guidelines adequate to protect one length of a stream may not be suitable for another stream or even another reach of the same stream.

A WATER USE CONSENT APPLICATION

Granted that the Officers of the Department of Conservation are obliged by the law to advocate for protection of streams and stream wildlife, how should they respond to an application such as the following ?:

Mr D. I. Gray of Takahue proposes to abstract water down to 75% of the 1 in 5 year low flow from the Takahue river, to irrigate pasture. The Takahue river is a major tributary of the Awanui River which is the main flow into Rangaunui Harbour. The Takahue has a catchment of 7500 ha and rises in the Raetea State Forest and from hilly country to the Southeast of Kaitaia.   Much of the headwaters are in native bush.

The Takahue is a predominantly hard bed river and other than in flood conditions is relatively clean. In the vicinity of the take point the stream meanders through dairy farmland but is still of reasonable gradient. There are numerous gravel banks and although the riparian zone is largely grasses, there is still a significant amount of overhanging vegetation and a mixture of larger native and exotic trees. The general ecological values of the Takahue River should be considered to be relatively high.

A study (Poynter 1988) reported 13 fish species in the Awanui River catchment. Nine species of diadromous fish (fish that migrate between the sea and the river to complete their life-cycles) are known to occur in the Takahue and tributaries:

Longfinned eel
Shortfinned eel
Torrentfish
Common smelt
Inanga
Banded kokopu
Common bully
Redfinned bully
Gray mullet

In addition there are likely to be two further, rarer native fish species present:

Shortjawed kokopu
Koaro

All these species must migrate upstream and downstream past the proposed water abstraction. Fish larvae, juveniles and adults are all likely to encounter the water intake.

ALLOCATION REGIMES

It is a new policy of the Northland Regional Council to permit the abstraction of water down to 75% of the 1 in 5 year low flow. Certainly this policy will allow for the utilisation of a significant proportion of the water resource. However the eventual impacts on stream ecology and aquatic values are unknown.

Over a 20 to 50 year interval, flows below the 1 in 5 year minimum daily flow can reasonably be expected. At these times there is obviously potential for streams to become over allocated. In addition it is in the summer when water is required for irrigation. Temperatures are at their highest, oxygen levels are low and the diluting effect on polluting inflows such as dairyshed discharges least.

Until recently the Auckland Regional Council had a similar policy, allowing allocation of 70% of the 1 in 5 year daily low flow. However this allocation technique has since been reconsidered. Not only did it not readily comply with the provisions of the Resource Management Act, but Biologists and staff at ARC now consider it was simplistic to have a blanket policy, in the face of widely differing stream types, biological diversity and natural values. Certainly studies had shown that for relatively incised small streams of a simple pool and run structure, abstraction limits of 70% of the 1 in 5 year low flow did not appear to have a major impact on stream ecology. However streams with significant riffle sections or braiding will respond very differently to water abstraction. Other impacts such as pump intake design and the timing of abstraction have also to be considered.

The problem of equitable water allocation is still very contentious in the water-short Auckland Region. Cases are now considered individually on a reach by reach and site basis. In the extreme case of an open concrete lined drain with no natural values, considerably more than 70% of the flow has been allocated. For the relatively few high quality habitats remaining in the region the approach has been more conservative. Granting less water initially, monitoring the effects and then gradually allowing more abstraction if no adverse impacts are identified, has been one method for protecting natural values.

Wherever possible, the Auckland Regional Council has encouraged storage during winter, outside the stream system, for use over the summer low flow period.

MONITORING OF IMPACTS

Stream ecosystems are very difficult habitats in which to predict and monitor effects such as a partial withdrawal of water. Our knowledge of New Zealand streams is incomplete. The animals are cryptic and prone to seasonal cycles in abundance, mass dispersal and emergence. Plants and bacteria respond to dissolved chemicals and nutrients that may enter the system in the ground water or from considerable distance away. Periodic flood events are capable of making gross adjustments to the numbers, abundance and size classes of the plants and animals. Riparian vegetation and stream shading also have considerable effects on stream ecosystems.

Monitoring of every facet of the ecosystem of every impacted stream is not possible. Instead biologists turn to key species or species groups to look for evidence of adverse impacts. The presence or absence of sensitive species is the first step. The next is to look at ratios between sensitive and insensitive species. Ratios such as Ephemerids:oligochaetes have been around in the biological literature for a long time. Dr. John Stark of the Cawthorne Institute in Nelson has developed community indices for New Zealand invertebrates which are sensitive indicators of change in stream ecosystems.

Stream insect populations respond quickly to changed conditions. Key species are usually very abundant, and large samples can be collected from small areas with simple equipment. However accurate identification of the many species is a complex task. Sorting of samples is time consuming and specialist skills are required. Interpretation of the results is also a task for the expert, and it is difficult to immediately and intuitively grasp the significance of changes.

Attached algae can be obvious components of small stream communities over the summer. Steven Moore of the Taranaki Regional Council has developed an understanding of the types of algal community to be expected at various levels of stream stress. Shifts from solitary diatoms to sheet species, attached green algae and then cyanobacteria can be used to plot the decline of a stream. Dr. Barry Biggs of NIWA, Christchurch, is also an exponent of periphyton and invertebrate communities.

However it has been shown that changes in the riparian vegetation and hence the degree of stream shading can also have major effects upon plant communities. The beneficial effects of intensified shading can readily outweigh plant growth problems brought on by water abstraction and consequent low stream flows.

Fish are large, obvious inhabitants of streams. It is easy for both development and conservation interests to comprehend the impact of changes when it translated into impacts upon fish. Interest in fish and the impact of water abstraction upon fish has been translated in to the development of models which can be used to predict the change in fish habitat and fish food producing habitat with alterations in the stream flow. This is of course the IFIM method (Instream Flow Incremental Method). Models have been developed by Dr. Ian Jowett of NIWA for trout and some invertebrates in New Zealand.
However it must be recognised that there is no evidence from angling activity or angling records that a naturally self-sustaining trout population exists in the Takahue River. Models have not yet been developed for native fish as this depends upon collection of a very large amount of data in order to generate probability of use curves. The collection of this data is recognised as a priority area. When this information becomes available it will be very relevant for situations such as the Takahue River proposal.

AN APPROACH COMPATIBLE WITH THE PRINCIPLES OF THE RESOURCE MANAGEMENT ACT

The Department of Conservation is correct in recommending a more conservative allocation, in the face of uncertainty about the impacts of fully allocating the water resource of a stream. In fact, this approach is also compatible with the interests of both the Regional Council and the Farmer.

It is far easier to allow the abstraction of more water in the future than it would be to reduce abstraction. The Regional Council would face bad publicity from farming groups for taking away access to water. In addition the environmentally aware public would lambaste the Council for allowing aquatic resources to be degraded in an apparently reckless fashion. The farmer would have overinvested in plant which will be useless without the water resource.

The DoC stance, to retain 100% of the 1 in 5 year daily minimum low flow and to reduce abstraction when flows have reached this level for 7 days appears quite reasonable. Before further allocations of water are made the impacts of abstraction to natural low flows upon the biological community should be examined and understood.

What sort of information should be collected ?. What sort of survey or monitoring is required; when, where and why ?.

Fish are obvious components of stream ecosystems. They can be readily identified (in contrast to aquatic insects), found throughout New Zealand and the presence or absence of different species makes statements possible on environmental impacts throughout the catchment. They are relatively long-lived animals and in contrast to aquatic insects, cannot quickly recolonise after adverse events. Fish can be considered as relatively long-term, instream monitoring instruments. In the absence of IFIM models it is suggested that the fish community of the Takahue River be monitored over a 5 year period to look for changes which may be attributable to the abstraction of water.

An exhaustive survey at regular intervals is not a fair expectation to impose on the farmer. However there are a number of key fish species which will make good indicators of undesirable changes to stream biology.

WHAT IMPACTS CAN ABSTRACTION HAVE ON FISHES ?

Obviously a fish without water is not a happy fish. However there are a series of less direct impacts which abstraction can have upon fish:

1. Loss of habitat - a smaller stream will support fewer fish, particularly territorial species.
2. Blockage of migration pathways.
3. Changes to habitat quality from heating, reduced oxygenation and reduced dilution of effluents and pollution.
4. Drying out of riffles (the major food production areas of stream systems).
5. Entrainment of juvenile and larval fishes in pump intakes, particularly on the upstream migration.

There are a number of changes which can be measured in fish and fish populations to monitor the impacts of abstraction:

1. What species of fish are present ?. Are they warm-water tolerant or are they cold-water fish ?. Are they tolerant of poor land use practices and water quality or are they sensitive species ?.
2. How many fish are there ?. Is this good fish habitat or not ?.
3. What is the growth rate of these fish ?. Is this good fish habitat or not ?.
4. What is the diet of the fish ?. Are the fish dependent on food from the surrounding land or is the diet rich in aquatic foods ?.
5. What is the health of the fish ?. Has the cycling and reinfection rate of common diseases increased with reduced flows and crowding of fish into limited habitats ?.
6. What is the fecundity of the fish ?. Are they gaining sufficient food in order to reproduce or are non breeding individuals common ?.
7. How much recruitment is there ?. Does the population have a normal age structure or are there few juveniles younger than the time the abstraction began ?.

The abundance and diversity of the fish population is a good guide to the health of the stream ecosystems. At present the Takahue River is of good quality, the abstraction site is quite close to the sea and consequently a diverse fish community with many migratory species is present.

WHAT PARAMETERS SHOULD BE MONITORED IN THE TAKAHUE RIVER ?

It is suggested that repeat survey be made of the Takahue River to add to the data collected in 1988. A minimum of 10 sites should be fished upstream of the abstraction point and the same number below. The survey should concentrate on electric fishing as this technique is especially effective in shallow riffle zones, the area of stream habitat disproportionally affected by water abstraction.

Sampling for fish should then be repeated on an annual basis. The monitoring should be done in late summer, when native fish abundance is at a peak and when the impact of summer water abstraction is most marked. Sampling should concentrate on three species of native fish present in the Takahue River (although all species of fish caught should be recorded).

Torrent fish *(Chiemarrichthys fosteri)* spend the daylight hours hiding beneath cover in rapids and fast riffle sections. The numbers of these fishes caught in standardised electric fishing sweeps of known lengths of habitat should be recorded. All torrentfish from each sampling site should be retained, anaesthetised and measured and weighed immediately after sampling, before being returned to the collection site. An initial sample of 100 fish below and 100 fish above the intake site is a target. Over the following years, data will be examined for large changes in fish numbers and changes in population size structure. Loss of habitat below the intake should be reflected by crowding, poor condition and reduced recruitment success for juveniles. Owing to the 3 -5 year lifespan of torrent fish, impacts of water abstraction will be measurable within a 5 year monitoring programme.

Redfinned bullies *(Gobiomorphus huttoni)* also are found beneath cover in fast flowing water. Electric fishing for torrent fish can also be expected to sample this fish. Redfinned bullies are probably less sensitive to water abstraction than torrent fish. However, a major advantage of this species for biological monitoring is the short larval and juvenile turnover time and the fact that some knowledge of the breeding biology of this fish is available. Larval redfinned bullies drift downstream over late spring and early summer. These minute fish are vulnerable to entrainment in irrigation pump intakes. Within two months (over mid to late summer), juvenile bullies, 25 - 30 mm in length, begin a return migration back upstream. These small fish then have to move back upstream past the pump intakes. Observations should be made at the pump intake for evidence of significant entrainment of juvenile fish.

A decline in redfinned bully recruitment above the intake zone would be reflected in a gradual drop in numbers, with this effect most pronounced at the sites of furthermost upstream penetration of this fish.

Therefore a preliminary biological survey should attempt to define the distribution pattern of this fish within the river system and locate several sampling stations which are close to the limits of upstream penetration, before the start of abstraction. Electric fishing using a 2 mm mesh stop net should be used in both adult habitat and within slower flowing weeded backwaters, where juveniles initially congregate. In these areas the electric fishing should be supported by kicknetting. All bullies caught will be separated into species, anaesthetised and measured. Bullies over 0.5g weight can also be weighed before all fish are returned to the water at the capture site. Initial samples of at least 100 fish will be necessary. A similar intensity of effort should be applied in succeeding years. Sampling localities and dates need to accurately replicated owing to the growth of the young fish and rapid changes in population numbers with time.

Histograms showing the size frequency of redfinned and common bullies *(Gobiomorphus cotidianus)* will be prepared and the results examined to look for major changes in population size structure over the 5 year period. The 2 to 3 year lifespan of these fish implies that significant changes to the recruitment pattern will become obvious within this period.

In complete contrast to the preceding two species, the longfinned eel *(Anguilla dieffenbachi)* is extremely slow growing. Eels are territorial and tend to remain resident in relatively short sections of rivers for protracted periods of time. These fishes have a value for examining the impacts of abstraction upon stream ecology by allowing the past to be compared with the present. Longfinned eels are the top predator in New Zealand freshwaters. If the productivity of a stream system is reduced by abstraction, these effects can be expected to flow on to the top predator. Likewise, a lowering of environmental quality will be accompanied in the top predator. like all the fish present, with a reduction in growth rates.

It is suggested that a sample of 10 medium sized longfinned eels be removed from the stream in the immediate reach below the intake structure. In addition to the measurement of lengths and weights these fish will be killed, gut contents examined and the otoliths removed. The eels will be aged by counting annual bands on the otoliths and then photographs will be taken of the otoliths. Working from these photographs the annual band widths will be measured and a series of plots of annual growth rates of the individual and combined eels prepared. It is a primary assumption of this technique (supported by research data), that growth rate is reflected in otolith band width. It is expected that these samples will allow estimates of annual eel growth rates in the stream over the preceding 20 years.

At the end of the 5 year monitoring period a second sample of 10 medium sized eels will be collected from the same area. All the same parameters will be measured for these fish. Particular attention will be paid to the width of the summer growth rings at the outer perimeter of the otoliths. This data will be compared with the growth rings measured prior to water abstraction. A quantitative statement can then be made on the apparent impact of water abstraction on growth of the top predator.

TIME AND COSTS OF MONITORING

Over a 5 year period it is anticipated that the following time and costs would be involved with environmental monitoring:

Initial survey- 3 days preparation and field work for 2 staff.	= 6 days
Annual surveys - 2 days preparation and field work for 2 staff	= 8 days
Laboratory work/eel aging - 4 days for 1 staff	= 4 days
Data analysis - 10 days for I staff	= 10 days
Preparation of annual reports & final report - 7 days for 1 staff	= 7 days

Maintenance of electric fishing machine
Mileage
Travel and Accommodation costs
Tolls
Stationary/photography/photocopying costs

Overall cost estimated to be $25000 over a 5 year period or $5000 per year

MITIGATION

The water use consents process allows for tradeoffs and compensation, in addition to direct confrontation over the allocation of a resource. One of the most obvious impacts of pastoral farming in New Zealand is the degradation of riparian zones by grazing and trampling of livestock. Studies funded by the ARC have already shown that shading by riparian trees has an overriding effect on the growth of algal slimes and the occurrence of extreme water temperatures over summer. Native fish are adapted to living in streams flowing through forest. Some species are closely associated with instream woody debris and a significant proportion of food is derived from forest insects.

In compensation for the losses of habitat which will occur from any significant abstraction of water it is suggested the DoC advocate for compensatory fencing and planting of trees along the riparian margins. The Takahue River already has significant numbers of remnant native trees along the riparian zone. Fencing would allow regeneration to occur. In addition, exclusion of stock will greatly reduce sediment inputs from bank collapse, and will stop fouling and roiling of the water over summer. Providing piped drinking water for stock also reduces the risk of transmission of water borne diseases such as *Leptospirosis* and *Brucellosis* from neighboring herds.

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