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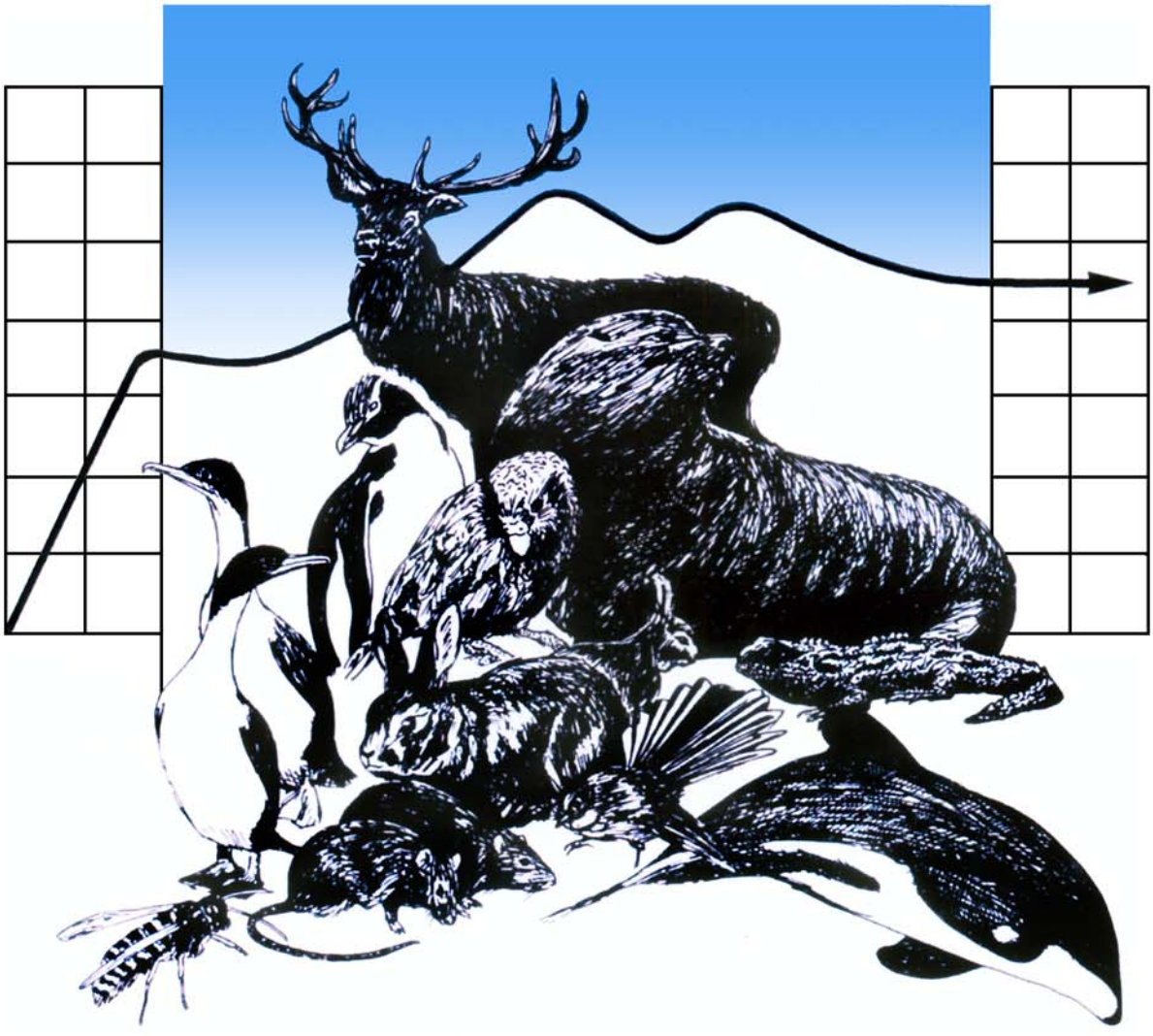

WILDLIFE MANAGEMENT

Enhancing the Conservation Value of the Birchwood Wetland

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EXECUTIVE SUMMARY

The Birchwood wetland area has recently been included within the Ahuriri Conservation Park in the MacKenzie Basin, South Island, New Zealand. The wetland area is ranked as an 'outstanding' site of wildlife interest, providing breeding grounds for black stilt, black-fronted tern, large wrybill and Australian bittern populations, in addition to providing essential habitat for other waterfowl. However, past anthropogenic activities, such as drainage, recreation and introduced species, have degraded the Birchwood wetland. The aims of this research and management proposal attempt to increase the productivity of the wetland system, which serves to expand and improve the suitability of habitat for target birds and to enhance the awareness of the public through conservation education. Our research and management plan draws on past wetland enhancement strategies, in addition to incorporating site specific data and original thought.

Recommendations

A combined ecological and social approach to the management of the Birchwood wetland was proposed.

ECOLOGICAL

- Due to the complete lack of information about the ecological processes within the wetland, intensive research of the hydrology, geology, invertebrate and vegetation composition was recommended.
- Research is critical as modification to the landscape and system may have serious long-term consequences to the Birchwood wetland and neighboring ecological systems.
- A bottom up approach was recommended, whereby hydrology is seen as the primary forcing factor influencing the ecological value of the wetland.

SOCIAL

- Previous conservation studies indicate that there is a lack of communication between DoC and local communities on conservation issues. The social approach aims to liaison between the public and DoC, to initiate dialogue within the community and to ensure public participation in management planning and implementation.
- Communication may reduce opposition and increase efficiency of conservation measures.

This research and management proposal utilizes adaptive management and monitoring as tools to implement the long-term goals of enhancing the conservation values in the Birchwood wetland.

1. INTRODUCTION

The failure to recognize the importance of wetland functions and values has been a leading reason for the degradation of such ecosystems. Water control in the form of abstraction and damming for hydro generation and agricultural development is responsible for much of the loss New Zealand's wetland habitat. Much of the remaining wetland habitat is of poor quality due to combined effects of weed invasions, mammalian predators, continued grazing of sheep, cattle, and horses, and falling water tables (Sanders and Maloney 1994).

Wetlands are transient habitats unless they are pulse stabilized by tidal flooding, seasonal inundation, the wandering of an erosive river or repeated fires (Etherington 1983). Seasonal flooding also serves to perpetuate the existence of a wetland by causing changes in water levels, which reset invertebrate communities, expose new, wet substrata and provide shallow foraging areas for wildlife (Sanders 2000). Construction of impoundments eliminates seasonal flooding and removes pulse stabilization, which may have previously prevented successional infilling. These hydrological constructions may also prevent the transfer of nutrient-containing silt (Etherington 1983). Agricultural practices have been shown to contribute to the degradation of wetland habitat values by causing eutrophication. Major input of nutrients entering the system as run-off from farmland further upstream has been observed to cause fish and bird deaths in other wetland ecosystems through microbiological production of toxins. This production of toxins is caused by a loss of bottom macrophytes due to major nutrient input, resulting in unstabilized and anaerobic sediments (Etherington 1984). Decline of keystone macrophytes detracts from the habitat value of the wetland and alters the composition of substrate and quality and quantity of particulate organic matter (POM) within the system. Therefore, agricultural and hydro-electric practices are indirectly responsible for the degradation of suitable habitat and food resources within wetland ecosystems.

One of the major concerns regarding this degradation of wetland habitat is the loss of suitable nesting and feeding habitat for wader bird species. This is especially the case in the Mackenzie Basin, South Island. Forty percent of the area's wetlands have been drained for farming since 1850. Hydro-electric power development has flooded 16% of braided river habitat, dewatered 9% and flooded a further 20% of swamp (Project River Recovery's Wetland Construction 2000). Most of the remaining older wetlands within the Mackenzie Basin are of poor habitat quality for breeding bird species; many are deep (up to 1 meter), steep-sided, and surrounded by tall vegetation (Sanders and Maloney 1994). Target species such as black stilts require low gradients and sparse, low vegetation to ensure an unobstructed view of their surroundings at all times for protection from predators (Project River Recovery's Wetland Construction 2000).

The intensive habitat alteration in the Mackenzie basin has been acknowledged and

some management measures have been proposed by Project River Recovery (PRR). PRR is a braided river and wetland habitat restoration programme in the upper Waitaki River. It is run by the Department of Conservation (DoC) and fully funded by Meridian Energy. The project aims to lessen the adverse environmental effects of hydroelectric development on wildlife and enhance the habitat of the rivers and wetlands in the upper Waitaki Basin (Project River Recovery).

As well as indirectly altering wetland habitat, direct usage via recreation and tourism by humans can have significant negative impacts on the flora and fauna of wetland areas. Past studies on recreational uses within swamps have suggested that recreational users do not fully comprehend the impacts of their activities on wetland habitat, particularly in regards to nesting sites and survival rates of sensitive bird species such as the black stilt (Smith *et al*. 1997). The Smith *et al*. study sought to determine the relationship between recreational users and the wildlife within the Tekapo and Ohau riverbeds of the Mackenzie Basin in order to improve conservation management. The results of the study reflect a lack of communication between DoC staff and recreational users regarding management objectives and rationale. In addition, the study highlights that despite signage within the riverbed areas, a lack of knowledge may be responsible for unintended disturbance to sensitive birds.

The Ahuriri River Valley in the upper Waitaki basin is the most unaltered of the river catchments in the Mackenzie basin, and has a significant area of wetland ecosystems including the Birchwood area. This wetland is ranked as an 'outstanding' site of wildlife interest (Jarman 1987), providing breeding grounds for black stilt kaki, black-fronted tern, large wrybill and Australian bittern populations in addition to providing essential habitat for other waterfowl and waders (Keller and Pfluger 2005). Drainage within the Birchwood swamp has resulted in decreased water tables, and subsequent grazing of sheep, cattle, and horses, and weed invasions of robust tall species, such as cracked willow, has decreased the size, timing and frequency of normal braided river and wetland transient flow regimes. The Ahuriri Valley is also a heavily used recreational area, in which fishing, mountain biking and tramping activities occur (Ahuriri Conservation Park). The constant human activity in the area undoubtedly negatively impacts the flora and fauna. All of these consequences to past anthropogenic activities have added to the degradation of the Birchwood wetland.

Thus, the enhancement of conservation value within the Birchwood wetland will involve both an ecological and sociological approach. The proposed research and management plan will attempt to increase the productivity of the system, which serves to expand and improve the suitability of habitat for sensitive target birds, and to enhance the awareness of the public through conservation education. Conservation plans that do not take account of local needs can impose costs on surrounding communities. Failing to communicate the benefits of conservation initiatives to local communities may result in the opposition to or lack of support of

such conservation efforts. Such opposition can increase the cost of management implementation and reduce the effectiveness of conservation measures (Cosslett *et al*. 2004). Therefore, an effective conservation enhancement plan relies on public support, which is essential to generate political and legislative action, to obtain financial resources, and to support successful implementation of legislation and management (Parikh *et al*. 2003).

1.1 Site Description

The Ahuriri River is a major braided river in the upper catchment of the Waitaki Basin, South Island, New Zealand, and is one of the four main tributaries of the upper Waitaki River. The upper section of the Ahuriri river valley is characterised by typical glacial landforms, and the lower section is dominated by extensive alluvial flats (Robertson *et al.* 1983). The river valley consists of a mosaic of braided river, gorge, wetland, swamp, and tussock grassland habitat (appendix 1). The area has on average a rainfall and temperature of 500mm and 9°C respectively, however this is highly variable depending on the season and position in the catchment (Robertson *et al.* 1983).

The majority of the Ahuriri River Valley and part of its surrounding catchment is within the Ahuriri Conservation Park. The Natural Heritage Fund recently purchased the Birchwood Station pastoral lease (23,783 hectares) in the upper Ahuriri Valley for $10 million, making the total Conservation park area 49,000 hectares (Haven for Black Stilt). Birchwood station was farmed by the same family for 62 years, and their intelligent land use has left some of the least modified valley floors in the Eastern South Island. The Ahuriri Conservation Park also adjoins public conservation land to the east, and a mixture of conservation and pastoral land to the west and south (Ahuriri Conservation Park).

Birchwood wetland is classified as a Palustrine wetland swamp that has small open-water bodies, vegetated wet ground and is non-tidal (Buxton 1991). Initial site assessment carried out by Joy Comrie from the DoC in Twizel has reported that the wetland is approximately 180 – 200 hectares in size, is positioned on a river flood plain, and is shaped by river meanders and over bank flow of the Ahuriri River. There are a number of fluctuating ponds, springs, small streams, several small and large oxbow lagoons, and river-braids found within the wetland area (appendix 1).

Birchwood is predominately a fertile area dominated by sedges and grasses. The vegetation composition consists of sedges *Carex* (30%) and *Juncus* (10%), a rush species *Schoenus* (30%) and exotic grasses (10%). The main weeds found in the area include crack willows, Russell lupins, and introduced grasses which make up the greatest exotic cover. Large sections of the wetland have been left unmodified, but two kilometres of drains, including two main drains, and other smaller cuts to redirect water has caused changes in vegetation and water levels in certain areas. This has resulted in a lot of gradation from wet to dry

throughout the wetland (pers.comm. Joy Comrie 2006). A long history of intensive grazing by cows and sheep in the area has created reasonable modification of the environment. Presently, sheep continue to graze the site. Within the surrounding catchment, one third of the original forest vegetation has been burnt off. Three quarters of the existing vegetation consists of forest and shrub-land vegetation (pers. comm. Joy Comrie 2006). There is also a history of over-sowing and topdressing in the catchment which is typical of high country areas. Despite habitat alteration, the Birchwood wetland is still seen as a retrievable in terms of restoration due to its large areas of relatively intact wetland vegetation and total size (pers. comm. Joy Comrie 2006).

The following structure for presenting the objectives of our conservation enhancement plan and key actions to fulfill these objectives was modeled after the Keolada National Park, India, National Wetland Strategy (Parikh *et al*. 2003) and community-participation conservation approaches (Fitzgerald 1999; Cosslett *et al.* 2004).

1.2 Objectives:

1) To prevent any further degradation, conserve and collaboratively manage a multi-use, multi-function wetland ecosystem.
2) To increase the ecological value of the wetland by increasing the habitat value for target species.
    a) The ecological focus of the conservation enhancement plan is on managing bird species that are known to be threatened, endangered or decreasing in range and abundance. Maintenance of habitat for such target species, will also serve to maintain and enhance habitat for many other wader bird species.
3) To promote sustainable and ecologically sound use of wetlands and their resources by giving importance to the traditional practices and interest of local users.
    a) To increase the awareness of users and locals to the ecological importance of wetlands and how wetland ecosystems perform many functions for humankind.
    b) To explain the importance of certain management protocol, such as vegetation removal and water management.
    c) To explain how agricultural and recreational practices may affect wetland ecosystem function and impede the goal of future management, e.g. nest disturbance, water/nutrient sources and eutrophication.

1.3 **Key Actions to Fulfill the Objectives**:

Short-term Actions:

1) To establish adaptive management practices of planning and monitoring at various trophic levels and to build a feedback loop, identifying costs and benefits to the community and ecosystem, into management decisions.

KEY ACTION- PLANNING & MONITORING

- A fundamental aim of the management plan is "to maintain the ecological character" and increase the habitat value of the wetland. "Maintaining the ecological character does not preclude human usage, but aims to avoid fundamental change to components, functions or values of its ecosystem" (Parikh *et al.* 2003).
- The creation and implementation of the management plan must emphasize education and the involvement of the local communities and other stakeholders.
- Review of PRR and other national wetland management planning guides.
- Literature review of wetland valuation, restoration and management strategies.

Long-term Actions:

1) To promote research and development to enhance scientific knowledge and understanding of the functioning of wetland ecosystems, and to develop methods to restore Birchwood swamp to a wetland condition suitable for wader habitat and successful nesting.
2) To prioritize creation of infrastructure for planning, monitoring, networking, assessment of human resource needs, and training for wetlands management under capacity building.
3) To promote public and corporate awareness on importance and values of wetlands through environmental education, extension activities and dissemination of scientific knowledge on wetland ecosystems.
4) To initiate participatory processes involving local people and other stakeholders, and the use of traditional knowledge and agricultural techniques in planning and management of wetlands.

KEY ACTION 1- RESEARCH & DEVELOPMENT

- Identification of knowledge gaps and prioritization of research needs.
- Long-term monitoring of changes for adaptive management.
- Develop methodologies for wetland restoration, rehabilitation, and habitat enhancement.

- Develop strategies for long-term management and monitoring using integrated environmental management.

KEY ACTION 2- CAPACITY BUILDING: Skill Development and Training

- Identification of training needs and opportunities in the field of wetlands.
- Training of site managers in interpretation, education, and communication within the local and tourist community.
    - Site managers and management liaisons may include, but not be limited to, DoC employees, community volunteers, committee members.
    - To enable local people to plan, implement, and manage their own projects through training workshops in participatory processes in order to facilitate community discussion and development.

KEY ACTION 3- PUBLIC AND CORPORATE AWARENESS

- Implementation of an education and public awareness program on wetlands.
- Distribution of informative material on wetland ecology, factors influencing conditions of wetlands, proposed management steps to enhance the habitat for waders (highlighting the importance of invertebrates, within and surrounding vegetation, and hydrology), how wetlands can impact and benefit humankind, and anthropogenic activities that may disrupt and enhance wetland ecological function.
    - Dissemination via group meetings, film shows, poster exhibitions, fliers, demonstrations, radio, local newspapers/magazines, local television, house visits and interviews.
- Education and public awareness exhibitions at visitor centers, museums, libraries and other public institutions.
- Education and public awareness exhibitions in conjunction with educational curricula and organizations, i.e. school field trips, adult and youth extra-curricular organizations.

KEY ACTION 4- PARTICIPATORY PROCESSES

- Utilize a participatory approach and use of traditional land and agricultural knowledge in the management of the Birchwood swamp.
- Promote and facilitate participation of local communities in monitoring wetlands.
- Inclusion of the interests and opinions of local communities and stakeholders in the process of planning the conservation and restoration management and future recreational use of the Birchwood wetland.

- Involvement of the corporate sector in the management of wetlands and in education and public awareness programs.

2. ADAPTIVE MANAGEMENT: A Synthesis of Research and Management

Our research and management plan intends to utilize adaptive management protocol in which information coming in from on-site monitoring is combined with data from research in order to inform and revise site-specific management plans (Noss *et al*. 1997). We then propose long-term adaptive monitoring in which data collected is used to define the next monitoring intensity level or action. Such a process adaptively incorporates changing monitoring priorities as needed, depending on data obtained from clearly defined indicators of change (Smit 2003).

2.1 Phase 1: Research and Management

2.1.1 Ecological Enhancement

Ecological enhancement of the Birchwood wetland must start at the research level for there is a lack of data describing the hydrology, geology, soil, invertebrate and vegetation composition, and predator density. Intensive research is needed in order to assess these ecological factors before any management plan can be implemented. It is also acknowledged that DoC staff will not be trained in such specific areas of hydrology and geology, therefore, specialists in these areas may need to be brought in to assess the situation and give expert opinions.

Past wetland restoration and improvement projects have gone about increasing the ecological value of the wetland by enhancing the habitat value in terms of increasing biodiversity of invertebrates and providing a suitable habitat for specific native wader birds. Abundance of wetland birds has been correlated with the availability of aquatic invertebrate prey. Therefore, augmenting the production and accessibility of aquatic invertebrates to wildlife can increase the wetland habitat value. The accessibility of invertebrates can be enhanced by manipulating water levels to provide shallow foraging habitat. The production of invertebrates and maintenance of a high biomass typical of many aquatic invertebrate communities in early successional stages is influenced by water levels and other factors of hydrology, quantity of POM in the substratum, and particle size composition of inorganic substratum. POM is a reflection of vegetation within and surrounding the wetland, while inorganic material and nutrient load may be a factor of runoff from neighbouring agricultural activities (Sanders 2000). Vegetation patterns are affected by abiotic factors such as nutrient sources, rates at which materials exit the system, and sediment properties such as nutrient availability, pH, sediment porosity, and anoxia. All of these factors are determined by water regime, such as water flow rates through wetlands and water retention times. Therefore our management plan

considers hydrology as the primary forcing factor by which to increase ecological value, and thus enhance the habitat quality of the Birchwood swamp. See appendix 2 for a flow diagram of the proposed "bottom-up approach" to habitat and conservation value enhancement.

The ecological enhancement management proposal outlined below draws upon several sources (Sorrell and Partridge 1999; Parikh and Datye 2003a) as well as original thought.

MANAGEMENT PROPOSAL: RESEARCH AND DATA COLLECTION

I. Assess waterbody dynamics over time using Remote Sensing (RS), Geographic Information System (GIS), historical maps, site visits and consultation with past landowner.

1) Spatial and temporal distribution;
2) perennial and ephemeral nature of neighboring streams;
3) seasonal water excesses and water blanks;
4) estimate runoff potential in streams;
5) land degradation in the vicinity of the wetland and within the watershed;
6) determine historical hydrology of the area before drainage (if possible);
7) determine water table level at multiple positions in the wetland;
8) investigate surface and underground water flow within the system;
9) assess soil and geology of the area in terms of water storage and seepage.

II. Catchment and Sedimentation Issues

1) Evaluate sediment and POM properties in order to consider possible substratum modification.

III. Assess current vegetation and its relationship to land management practices using RS, GIS, site visits, historical and DoC maps, and consultation with past landowner.

1) Produce a vegetation map of the wetland.
2) Site visits to look for evidence of siltation, habitat changes and to verify vegetation map with ground-truth correlation along transects.

IV. Devise Conservation Values of Vegetation

1) Determine levels of eradication or management depending on value.
2) Weed invasions/eradication implementation.

V. Assess Invertebrate and Fish Community Composition and Biomass

VI. Anthropogenic Disturbance

1) Recreational uses: levels of impact of different users.
2) Farming practices: direct effects of animals in or nearby wetlands.

VII. Collection of water quality data

1) Determine values for nitrate, nitrogen, dissolved reactive phosphorous, total phosphorous, oxygen demand, faecal coliform, ammonium concentration, which can be a result of run-off from farmland groundwater from acidic soils further upstream.

POTENTIAL MANAGEMENT ACTIONS

Hydrology

A natural seasonal change in water levels occurs within the Birchwood wetland, indicating that water flows in and out of the system. Peak flows occur in spring when snow remaining from winter melts further up the catchment. The area is subject to harsh winter conditions in which many of the ponds become partially or fully frozen (Robertson *et al.* 1983). Previous wetland restoration or improvement projects have used a variety of structures and processes in order to manipulate the water levels in wetland areas. The lack of information on Birchwood wetland precludes any definite decision about water level manipulation, but there are several options that seem to be the most relevant to this particular area:

a) Blocking/infilling the two main drainage channels so that water levels increase in the wetland area behind the outflow point.
b) Constructing a weir in the main drainage channel in order to block the runoff from the wetland. Weirs can also be manipulated to allow different rates of flow through the system during flooding events or drought.

The ideal outcome for any management strategy is that initial management and modifications will lead to a fully independent self-sustaining system, i.e. no human intervention. However, past landscape modifications and uses may have permanently altered the hydrology of the system, such that it can never be returned to its natural state. Therefore, several methods of hydrological management and their possible negative effects must be assessed before implementation can occur. Remote sensing and GIS have the potential to analyse the cumulative effects of management impacts and quantify wetland alteration by comparing maps representing two different points in time and measuring the rate of wetland change. Transition probabilities derived from such analyses can be used to develop predictive models for future wetland trends (Roy and Behera 2003).

Vegetation

Manipulations in water levels may actually be able to control and reduce invasive weeds without active removal. Therefore, certain weeds may not need to be actively managed until hydrological research and implementation has been initiated. However, weed eradication is necessary for certain robust species that have a high potential of

spreading. Although some weeds can affect survival of native plant species and impede waterflow if present in large amounts, moderate amounts of certain weeds can provide valuable habitat for invertebrates and fish. Therefore, weed eradication can also not be implemented until vegetation composition and value is determined.

2.1.2 Social Enhancement

This social enhancement section of our proposed research and management plan aims to liaison between the public and DoC, to identify and rank aspects of wetland ecosystems that stakeholders value, to initiate dialogue between groups and to bring together different stakeholders in an institution such as a "committee of stakeholders" at the local level. Multi-organizational involvement in research and management planning activities is an effective approach to ensure people's participation and a means by which to initiate short-term and long-term behavioural change through conservation education and public awareness (Mahajan 2003).

By interviewing stakeholders of different status (user, non-user, local, neighbouring local, tourist, native, education, age, career), the values of varying aspects of the Birchwood swamp, motivations for use, and attitudes towards conservation may be revealed for each group. Similarities and differences in such findings may aid in coalition formation and policy making. Similarities in values, goals, or motives of certain groups may serve as grounds on which to initiate dialogue between groups, assist in the formation of coalitions, and unite groups on a common ground. Such coalition forming may facilitate policy decisions and could potentially lead to financial assistance and/or delegation of management implementation.

In addition, questionnaires administered to various social groups may reveal knowledge gaps and differences in perceived aspects of importance, which could be used to direct future interpretation and education measures. Questionnaires may also indicate through which media audiences are most likely to be affected by education and interpretation measures. Such initial questionnaires could reduce insignificant efforts and wasted funding by pinpointing knowledge gaps and misconceptions that need to be addressed, to which groups to address such issues, and identify the most efficient means by which to disseminate such information.

In order to encourage active and informed participation of local communities and private and corporate sectors in the conservation and wise use of wetlands, the benefits of enhancement measures to community members must be identified and publicized (Fitzgerald 1999). Aspects of wetlands observed to benefit humans directly are recreation, tourism, aesthetic and cultural values, detoxification and decomposition of wastes, improvement of water quality, mitigation of floods by providing water storage and

flow regulation, maintenance of stream flows and groundwater levels during drought (Buxton 1991; Daily et al. 1997). These properties are vital for communities (human and nonhuman) downstream of wetlands.

Methods proposed below reflect the aim of the conservation education and public awareness plan to target different social groups in order to enhance conservation value through a community-participation approach. The social enhancement management proposal outlined below was influenced by site specific data, other sources of social impact assessment and community-participation based protocol, in addition to original thought (Fitzgerald 1999; Cosslett 2004; Mahajon 2003; Chopra 2003)

MANAGEMENT PROPOSAL: RESEARCH AND DATA COLLECTION

I. Baseline Survey

1) Profile community using participatory mapping exercises, available statistical data, and consultations.
2) Determine social target groups;
    a. locals, native New Zealand citizens, non-native New Zealand citizens, tourists (visitors);
    b. user and non-user;
    c. type of use (fishing, walking, cycling, other).
3) Awareness Survey- questions pertaining to stakeholder's awareness of:
    a. Importance and role of wetlands and the Birchwood area.
    b. Impacts of agriculture, hydroelectricity, and recreational activities on wetland system function.
    c. Role of vegetation, such as willows, in changing wetland and riverbed morphology, nutrient sources, substrate, pH, temperature, habitat for invertebrates, fish, and waders.
    d. Health and survival of wetlands may depend on human intervention and community involvement.
4) Attitude Survey- questions pertaining to stakeholder's attitudes towards:
    a. Rights on resources (wildlife vs. humans, community vs. government).
    b. Perceived role of DoC staff.
    c. Whether or not DoC staff are properly fulfilling the expectations of local communities and doing their best to help the local communities.
    d. Perceived benefits of research and management implementation.
5) Valued Aspects Survey- questions pertaining to uses of the area perceived to be important by stakeholders:

a. Respondents from each group will be asked to rank aspects of the Upper Ahuriri Catchment and the Birchwood wetland perceived to benefit them the most.
b. Define functional uses that may be valued by stakeholders: ecological, consumption, livelihood, rarity, aesthetic, future, existence, services, ritual and cultural.
c. Determine values and rank given to aspects within each social target group.
d. Compare areas of agreement/similarity in rank of wetland aspects.

6) Identify and evaluate effectiveness of current education facilities and efforts within the Upper Ahuriri Catchment area.
    a. Identify quantity and placement of existing signage.
        i. Compare placement of existing signage with major routes of entrance and use within riverbed and wetland areas.
        ii. Evaluate quality, attractiveness, and recency of information on signage.
    b. Identify other means of scientific communication present.
    c. Conduct surveys and interviews with questions pertaining to use and informative quality of any signage along neighboring riverbeds, average interaction with DoC staff (distinguishing between interpretation, management, and research staff), frequency of visits to museums, libraries, town meetings, visitor centers and other public institutions.

2.2 Phase 2: Adaptive Monitoring

2.2.1 Ecological Monitoring:

Our research and management plan follows an adaptive approach to conservation enhancement. Such an approach is dependent on long-term monitoring of attributes, or indicators, which provide feedback as to whether management protocol needs to be modified in order to better achieve the objectives. The indicators chosen for monitoring may include physiochemical factors (temperature, oxygen concentration, pH, conductivity, nitrate, nitrogen, dissolved reactive phosphorous, total phosphorous, and ammonium concentration), invertebrate biomass and eveness, water depth, wetland perimeter, density and horizontal diversity of vegetation, invasion rates and density of weedy or opportunistic species, and predator density and composition**.** Through advancements in social enhancement of the conservation value of the Birchwood wetland, our proposed education and public awareness plan aims to ignite interests in the Birchwood area in order to delegate some tasks and authority for the planning and

data collection processes to local jurisdictions, and to call upon outside sources for assistance in ecological monitoring and funding through volunteer work and donations.

2.2.2 Sociological Monitoring:

Monitoring peak recreational use and whether it coincides with critical periods of target species breeding season may provide data on factors influencing mating and nestling and fledgling success. Solutions such as altering recreational use during times of peak breeding may serve to decrease human-bird conflicts. Recording the volume of volunteer work (total hours of work or percentage of projects completed by volunteers) and number and frequency of volunteers in relation to social group, and re-administering initial baseline surveys may indicate whether certain social target groups have been impacted more than others by the conservation education and public awareness program. By use of adaptive management, periodic analysis of this data may reflect flaws within the education and awareness program and modes of communication. These findings may serve to guide future modifications of the program to more efficiently and successfully target specific groups based on methods and substance of communication.

3. POTENTIAL IMPACTS OF PROPOSED MANAGEMENT

It is unknown how much water inundation different plants and animals inhabiting wetlands require or can tolerate. Water flow in wetland areas is a major determinant of physical habitat, which in turn is the major determinant of the biotic composition (Burn and Arthington 2002). Therefore, changes in water levels upstream and downstream as a result of water manipulations could negatively affect animal and plant communities by altering species composition, competition and predation, disrupting evolved life histories and responses to existing flow regimes (Burn and Arthington 2002), and facilitating invasion and success of exotic vegetation. Changes in water regime can also alter the nutrient sources and sediment properties of the system, which may modify the vegetation characteristics of the wetland. Therefore, interrupting the processes within wetlands via hydrological manipulation may potentially be very risky, as it is widely acknowledged that wetland ecosystems are poorly understood and researched. Landscape alteration may impact flow regime in ways that are unanticipated and irreversible. Therefore, it is critical for aspects of hydrology and landscape to be defined in order to best advise management planning. Remote sensing and GIS could provide a means by which different hydrolic schemes may be modelled before any management decisions are made (Roy and Behera 2003). It is also advised to perform site-specific pilot studies within the Birchwood wetland before any wide-spread management plan is decided upon.

4. FINANCIAL RESOURCE ALLOCATION

Extensive financial assistance will be necessary, from both governmental and non-governmental sources. Non-governmental sources include funding from local community and national organizations and volunteer efforts from local community and national organizations in the implementation of certain physical monitoring and management protocol. A participatory approach provides the opportunity to call upon members from such organizations to assist in ecological monitoring through volunteer work. Such volunteer work would not only serve to enhance the social conservation value of the Birchwood wetland by involving the local community in management implementation and in observations of direct effects of management, but also would decrease costs of research and monitoring. This would further the ability to fund research and expand upon management in order to enhance ecological values in addition to providing feedback from a diverse suite of benefits or costs perceived by people from outside of the research realm.

5. CONCLUSION

5.1 Prioritisation of Efforts: Research Matters

Knowledge of the Birchwood area must first be obtained before any management plan can be proposed. Research is critical as modification to the landscape and system may have serious long-term consequences to the Birchwood wetland and neighboring ecological systems. In order to ensure a self-sustaining independent system, management plans must only be implemented when adequate knowledge of the system and foresight of predicted outcomes have been obtained. Accurate inventory and mapping and site-specific pilot studies within the Birchwood wetland are advised before any widespread management plan is decided upon.

Ecological research may cut costs by providing a focus and direction of a management plan. Research may also reveal that certain aspects of the outlined management proposal may not be necessary or will not have a large affect on enhancing the habitat for target species. Our proposed bottom up ecological approach reflects how research at one trophic level influences management decisions regarding another.

Sociological research is necessary in order to communicate the benefits of conservation efforts to the local communities and to gain public support. This may reduce opposition and increase the efficiency of conservation measures by generating political and legislative action, providing financial resources, and delegating management implementation. Sociological research may also decrease insignificant efforts and wasted funding by pinpointing knowledge gaps and misconceptions held by certain social groups that may impede or slow conservation efforts. Research may also serve to identify the most efficient means of

communication and education through which to initiate short-term and long-term behavioural change.

5.2 Adaptive Management and Monitoring

Adaptive management and monitoring is dependent on long-term monitoring of indicators, which provides feedback as to whether management protocol needs to be modified in order to better achieve conservation objectives. Monitoring of social enhancement methods may reveal flaws within the proposed public education and awareness program and in methods of communication. Feedback from the community may serve to guide future modifications of the program. Enhancing public interests and awareness of the Birchwood wetland may further the potential of ecological enhancement management by providing opportunities for volunteer work and funding.

6. ACKNOWLEDGEMENTS

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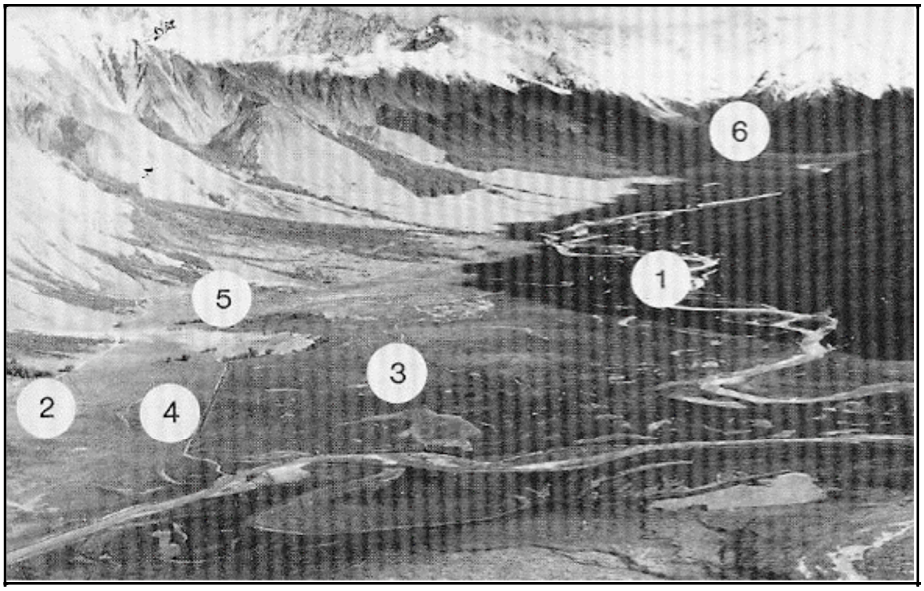
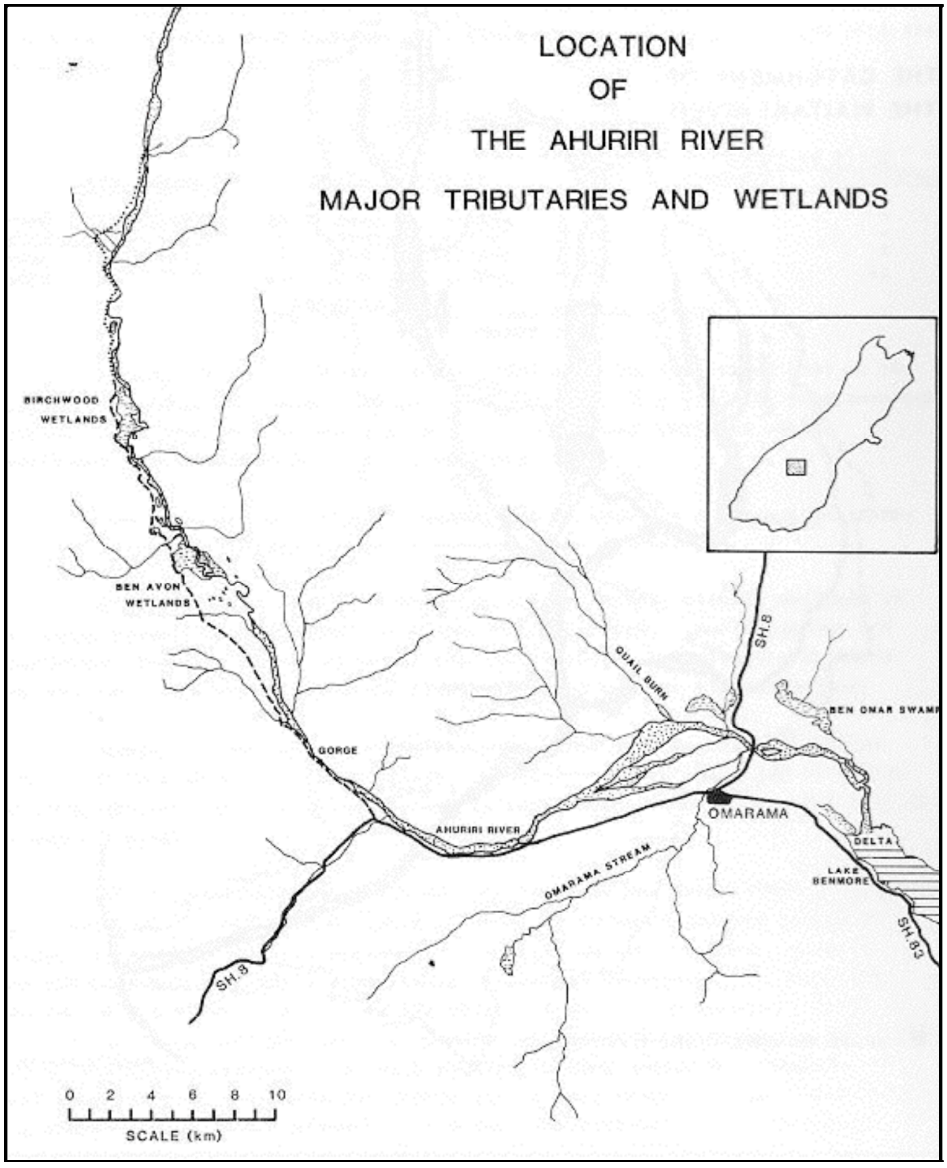
Appendix 1



Aerial photo of the Birchwood wetland area looking north upstream. 1) Ahuriri River 2) Birchwood Station 3) Birchwood wetlands 4) drainage channel 5) large pond 6) Canyon Creek confluence. (Robertson *et al.*, 1983)



Location of the Ahuriri River within the South Island New Zealand, and its main tributaries and wetlands (including Birchwood Wetland). (Robertson *et al.*, 1983)

Appendix 2

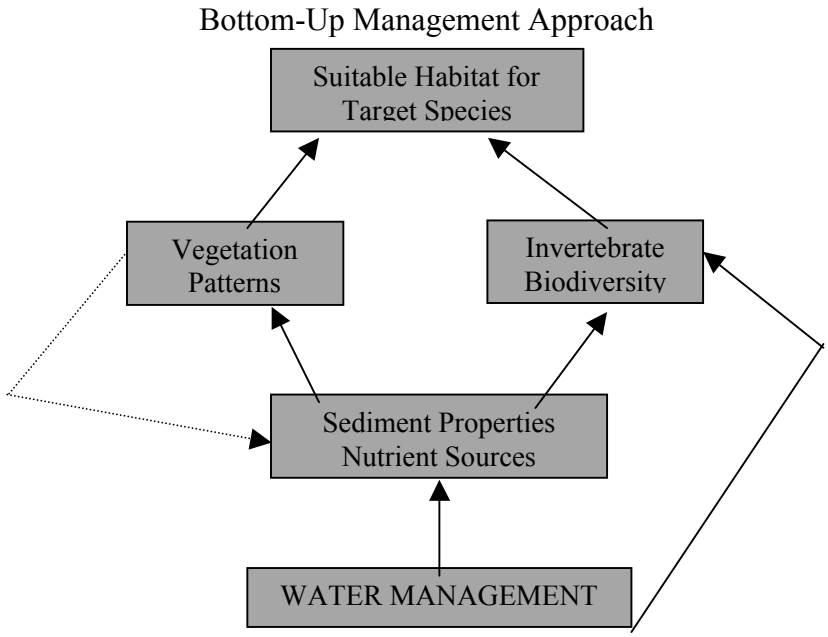


Figure 1.1 A flow diagram of the proposed bottom up approach to habitat and conservation value enhancement within the Birchwood wetland. Hydrology dictates sediment properties and nutrient sources such as particulate organic matter, pH, nutrient availability, sediment porosity. Aspects of hydrology, such as water levels, may also directly influence invertebrate biodiversity by maintaining a high biomass. In addition, hydrological aspects may increase the accessibility of invertebrates to target species. Sediment in turn dictates vegetation and invertebrate composition.