SCIENCE & RESEARCH SERIES NO.58

TOWARDS A PROTOCOL FOR ASSESSING THE NATURAL VALUE OF NEW ZEALAND RIVERS

by

Kevin Collier

SCIENCE & RESEARCH SERIES NO.58

TOWARDS A PROTOCOL FOR ASSESSING THE NATURAL VALUE OF NEW ZEALAND RIVERS

by

Kevin Collier

Published by
Head Office,
Department of Conservation,
PO Box 10-420,
Wellington,
New Zealand

ISSN 0113-3713 ISBN 0-478-01490-2

National Library of New Zealand
Cataloguing-in-Publication data

Collier, Kevin J. (Kevin John), 1959-
Towards a protocol for assessing the natural value of New Zealand
rivers / by Kevin Collier.
1 v. (Science & research series, 0113-3713 ; no. 58) ISBN 0-478-01490-2 (pbk.)

1. Stream ecology--Research--New Zealand--Methodology. 2. Rivers--New Zealand--Management.
3. Conservation of natural resources--New Zealand. 4. Tongariro River (N.Z.) I. New Zealand.
Dept. of Conservation. II. Series: science & research
series; no. 58.

574.52632301 zbn93-055918

Keywords: rivers, natural value, aquatic reserves, evaluation, New Zealand

CONTENTS

TOWARDS A PROTOCOL FOR ASSESSING THE NATURAL VALUE OF NEW ZEALAND RIVERS

by Kevin Collier
Science & Research Division, Department of Conservation, Wellington

ABSTRACT

Steps taken to date to develop a method for assessing the natural value of New Zealand rivers are described. Five criteria (ECOLOGICAL REPRESENTATIVENESS OR RARE TYPE OF ECOSYSTEM, DEGREE OF MODIFICATION, DIVERSITY AND PATIERN, RARITY AND UNIQUE FEATURES OR SPECIES, and LONG-TERM VIABILITY) for assessing aquatic reserve value were determined at a workshop at the 1987 Limnological Society conference, and possible quantitative descriptors for these criteria were later developed. Weightings for the suggested descriptors were obtained through a questionnaire sent to limnologists. A trial assessment was carried out on seven different sections of the Tongariro River to determine the utility of this method in defining natural value in terms of DEGREE OF MODIFICATION, DIVERSITY AND PATTERN, and RARITY AND UNIQUE FEATURES OR SPECIES. The method appeared to provide sensible scores for these criteria, but further refinement of the descriptors and weightings is necessary before the method should be generally applied.

1. INTRODUCTION

In New Zealand, the assessment of conservation value has focused largely on terrestrial environments and wetlands (Park *et al.* 1986, Simpson 1985). PNAP (Protected Natural Areas Programme) and WERI (Wetlands of Ecological and Representative Importance) both use subjective criteria to make these assessments. A widely accepted method for evaluating river systems has not yet been developed in New Zealand, and partly as a result of this, rivers are under-represented in the protected areas network compared with terrestrial environments and wetlands (see Collier 1992).

Historically, the justification behind river protection in New Zealand has mainly been to preserve the fishery value, and secondary importance has been placed on "natural value", the definition of which is embodied in the goal of natural area protection (Park *et al.* 1986): to ensure "…as far as possible, the survival of all indigenous species of flora and fauna, both rare and commonplace, in their natural communities and habitats, and the preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave New Zealand its own recognisable character."

In this report, I outline a system that, once refined, could be used to assess the "natural value" of rivers, and thereby help identify important sections or river systems for management or protection. The procedure used is based on a the River Conservation System (RCS) developed for South African rivers by O'Keefe *et al.* (1987), and has been expanded to incorporate a wider range of criteria.

2. METHODS

2.1 Establishing the conceptual framework

The conceptual framework of an assessment system for New Zealand rivers was initially established during a workshop on "Identification of aquatic reserves" held at the 1987 Limnological Society conference (see Appendix 1 for workshop report). A major outcome of this workshop was the identification of six criteria that could be used to assess aquatic reserve value:

- ECOLOGICAL REPRESENTATIVENESS OR RARE TYPE OF ECOSYSTEM
- DIVERSITY AND PATTERN
- RARITY AND UNIQUE FEATURES OR SPECIES
- LONG-TERM VIABILITY
- HISTORIC OR RESEARCH VALUE
- DEGREE OF MODIFICATION

Collier and McColl (1992; see Appendix 2) discussed the application of these criteria in assessing riverine "natural value" as embodied by the goal of natural area protection presented earlier. They listed quantitative descriptors that could be used to assess DEGREE OF MODIFICATION, DIVERSITY AND PATTERN, and RARITY AND UNIQUE FEATURES OR SPECIES. They also discussed interpretation of the LONG-TERM VIABILITY criterion and suggested that it was composed of two factors: size and fragility (sensitivity to environmental change or perturbation). Several possible descriptors of FRAGILITY were discussed (see Appendix 2). HISTORIC OR RESEARCH VALUE was not considered as it was outside the definition of natural value.

A critical pathway by which assessments of natural value could be carried out was also presented by Collier and McColl (1992). They noted that assessment of REPRESENTATIVENESS OR RARE TYPE OF ECOSYSTEM would require some form of classification system that delineates riverine eco-regions and allows sites to be grouped into classes with similar attributes. Biggs *et al.* (1990) defined aquatic eco-regions for the North Island, but were unable to differentiate regions in the South Island. A DOC funded study being carried out by the Zoology Department, University of Canterbury, is currently attempting to define aquatic eco-regions for the South Island. The next step would be to determine an ecotype classification system that groups rivers with similar attributes in different eco-regions.

2.2 Refinement of descriptors and determination of descriptor weightings

A workshop was held at the 1991 Limnological Society conference to discuss the methodology for assessing riverine natural value (see Appendix 3 for workshop report). This workshop defined threshold descriptors that could be used to minimise the number of sites assessed in a regional evaluation of rivers. The workshop also discussed descriptors that could be used to assess DEGREE OF MODIFICATION, DIVERSITY AND PATTERN, and RARITY AND UNIQUE FEATURES OR SPECIES (Appendix 3).

Further refinements of descriptors and weightings that reflected their importance in determining natural value were sought through a questionnaire sent out to 36 limnologists (Appendix 4). The questionnaire included definitions of the criteria and explanations of descriptors. Questionnaire recipients were asked to score each descriptor with an integer value in a specified range according to its perceived importance in determining natural value. Mean scores were subsequently calculated. In order to reduce the number of descriptors, those with mean scores <50% of the maximum value (indicating relatively low perceived importance) or that had coefficients of variation >50% (indicating wide variation in views amongst respondents) were not used in the subsequent trial analysis.

Recipients were also requested to comment on the descriptors used and, if they wished, to suggest new descriptors with scores. In addition, the questionnaire asked for an indication of the specific area of interest of the reader (i.e., water quality, plants, invertebrates, fish or general freshwater ecology). Recipients who circled more than one option were classified as being primarily interested in general freshwater ecology.

2.3 Trial application: Tongariro River

A method of applying the weighted descriptors for DEGREE OF MODIFICATION, DIVERSITY AND PATTERN, and RARITY AND UNIQUE FEATURES OR SPECIES was evaluated for seven sections of Tongariro River (see Fig. 1; Table 1) in response to a conservancy request for information to establish management priorities for the river.

Table 1 Channel lengths, catchment areas and locations of lower boundaries for the 7 sections of Tongariro River (see Fig. 1) used in the trial application of the natural value assessment system.

Section	Channel length (km)	Catchment Area (km^2)	Location of lower boundary
1	46*	329	Confluence of Waipakihi R. and Waikato Stm. Official start of Tongariro R.
2	5	246	Rangipo Barrage. Regulated flow beyond this point.
3	4	318	Oturere Stm. Confluence. Increase in residual flow below this point.
4	8	71	Poutu Intake.
5	10	94	Whitikau Stm. Confluence. Charge in channel morphology below this point.
6	13	104	DeLatours Pool. Channel becomes more sinuous below this point.
7	8	5	Lake Taupo.

* 25 km for Waipakihi River and 18 km for Waikato Stream.

Descriptor values for the various sections were obtained from NZMS 260 (1:50 000) maps, Land Resource Inventory (1:63 360) maps, the Freshwater Fisheries database, Geopreservation Inventory, NIWAR flow records, and information from conservancy staff. Descriptors that required on-site assessment or for which no data were available, and new descriptors suggested by questionnaire respondents were not used in this trial application (see footnotes in Tables 3 and 4).

Upper limits for each descriptor were set arbitrarily so that any descriptor equal to or exceeding that upper limit was considered to be the maximum value, as was done in the RCS developed by O'Keefe *et al.* (1987). Scores were then calculated according to the method by O'Keefe *et al.* (1987), as shown in Table 2 for a subset of DEGREE OF MODIFICATION descriptors. Where weighting factors had negative values, the result of the calculation ({*value/limit*} X *weight)* was subtracted from the weighting factor to yield positive values that represented the descriptor evaluated. The sum of scores achieved in this way was then divided by the best possible score (sum of weighting factors ignoring signs) and multiplied by 100 to provide a value between 0 and 100. This figure was subtracted from 100 for DEGREE OF MODIFICATION, but not for the other criteria.

Table 2 Simplified example of procedure for calculating scores using a subset of descriptors from the DEGREE OF MODIFICATION criterion for Tongariro River section 5 (see Tables 3 and 4 for weights, upper limits, etc).

Descriptor	Upper limit	Weight	Value
% CATCHMENT IN NATIVE VEGETATION	≥ 80	+17.1	81
% LENGTH LINED BY NATIVE VEGETATION	100	+15.7	90
% BASEFLOW ABSTRACTED	≥60	-15.4	50
NO. OF EXOTIC NUISANCE SPECIES	≥10	-10.5	2
Sum of weighting factors*		58.7	

	Calculation (value / limit × weight)		Score
% CATCHMENT IN NATIVE VEGETATION	80† / 80 × 17.1		17.1
% LENGTH LINED BY NATIVE VEGETATION	90 / 100 × 15.7		14.1
% BASEFLOW ABSTRACTED	50 / 60 × −15.4	(−12.8‡)	2.6
NO. EXOTIC NUISANCE SPECIES	2 / 10 × −10.5	(−2.1‡)	8.4
		Sum of scores	42.2

Score for section 5 on a scale of 0-100 is 42.2 / 58.7 X 100 = 71.9. This indicates the extent to which the river is unmodified. To indicate DEGREE OF MODIFICATION the score is subtracted from 100 (NB: this is not done for DIVERSITY AND or RARITY AND UNIQUE FEA1URES OR SPECIES).

DEGREE OF MODI FICATION score for section 5 using four descriptors = 28.1

* All factors converted to positive values to calculate sum of weightings
† Value exceeds upper limit for descriptor, therefore treated as equivalent to upper limit
± Where there are negative weights, scores calculated from the formula are subtracted from the weighting factor before being summed.

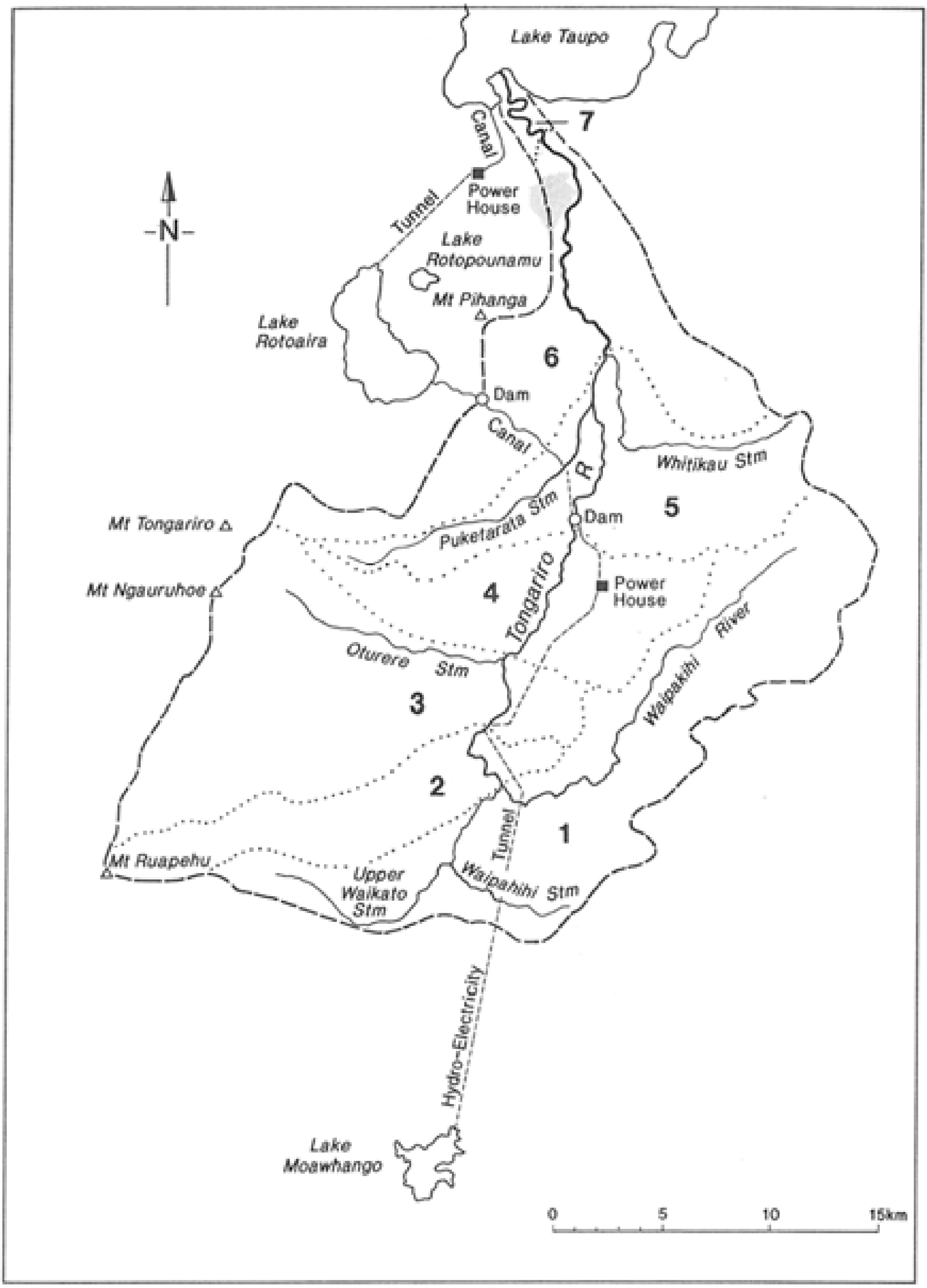

Fig. 1 Boundaries of sub-catchments of seven sections of Tongariro River used in the trial application of the natural value assessment system.

3. RESULTS

3.1 Questionnaire response

Twenty-nine replies were received out of the 36 questionnaires sent out. Most were from NIWAR (41%), and 10-17% came from universities, Regional Councils, Department of Conservation or private consultancies. Most respondents (48%) indicated that their specific area of interest was general freshwater ecology (includes those who circled more than one option). Several respondents (14-17%) indicated that their primary area of interest was water quality, invertebrates or fish, whereas only 7% were mainly interested in aquatic plants. Additional descriptors with scores suggested by respondents are listed in Table 3, and comments made on these and the other descriptors are presented in Appendix 5. It was apparent from these comments that more refinement of descriptors is needed before they should be generally applied to rivers for wide-scale natural value assessment.

Table 3 Mean weights, standard deviations (S.D.), coefficients of variation (C.V.), minimum and maximum values, and numbers of respondents for descriptors (No.), under four assessment criteria.

1. DEGREE OF MODIFICATION						
Descriptor	Mean weight	S.D.	C.V. (%)	Min.	Max.	No.
% catchment in native vegetation	17.1	4.1	24	2	20	29
% length lined by native vegetation	15.7	3.4	22	5	20	29
% length lined by non-production woodland	13.2	3.7	28	5	20	29
% length with bank fencing	13.1	4.3	33	5	20	29
road distance to nearest town*	5.0	4.1	82	0	16	29
road distance to nearest city*	6.3	4.7	74	0	15	29
% catchment in production forest	13.0	3.8	29	5	20	28
% catchment in crop/improved pasture	15.6	3.8	24	2	20	29
no. open cast mine in catchment	12.6	5.1	40	0	20	28
density goats and cattle in catchment	12.2	4.1	34	2	18	28
no. natural barriers to exotic fish movement	13.4	4.7	34	5	20	29
distance first natural barrier from headwaters†	12.0	4.3	35	1	20	29
no. exotic nuisance species	15.1	4.1	27	5	20	28
no. exotic non-nuisance species	10.5	4.6	44	2	20	29
degree native species exploitation*	8.5	3.8	44	2	15	29
no. road/rail bridges*	4.7	2.8	59	0	10	29
no. unbridged road crossings*	7.0	3.2	45	2	15	29
no. downstream culverts*	9.9	4.1	42	3	18	29
no. downstream weirs	12.2	4.4	36	3	20	29
no. downstream dams	15.2	4.4	29	5	20	29
% length channelised	16.4	3.9	23	7	20	29
no. water abstraction points*	9.8	4.5	46	3	20	29
% baseflow abstracted	15.4	4.3	28	5	20	29
% length with regulated flow	13.8	3.6	26	7	20	29
% flow from intercatchment transfer*	10.3	5.4	53	0	20	29
no. point source discharges	13.7	4.9	36	3	20	29
% baseflow as organic effluent	15.3	3.6	23	6	20	29
% baseflow as inorganic effluent	14.5	4.1	28	5	20	29
% catchment with artificial drainage‡	10	–	–	–	–	1
% catchment erosion‡	16	–	–	–	–	1

* Dropped from list because mean weight <50% of maximum or C.V. >50%

† Not relevant when assessing different sections on a single river. Not used in trial application.

‡ New descriptors suggested by questionnaire respondents. Not used in trial application.

3.2 Descriptor weightings

Mean weightings for the original descriptors and other relevant statistics are presented in Table 3. Signs (+ or -) associated with descriptors are indicated in Appendix 3. For DEGREE OF MODIFICATION, the highest weighted descriptor was % catchment in native vegetation (17.1 out of a possible 20), followed by % length channelised (-16.4) and % length lined by native vegetation (15.7). Eight descriptors achieved mean weights less than half the possible maximum score or had coefficients of variation >50% (see Table 3), and were dropped from use in the trial application.

The three highest scoring original descriptors for DIVERSITY AND PATTERN were number of tributaries with low degree of modification (7.6 out of a possible 10), substrate heterogeneity (7.5) and number of associated wetlands, lakes and tarns (7.3). Several descriptors, including substrate heterogeneity, were omitted from the list used in the trial application because field surveys were required to obtain measurements, and/or because mean weights were <50% of the maximum possible (see Table 3).

Table 3 *(Continued)*

2. DIVERSITY AND PATTERN

Descriptor	Mean weight	S.D.	C.V. (%)	Min.	Max.	No.
no. stream orders	6.8	3.3	49	0	10	29
altitudinal range	6.9	2.4	35	1	10	29
no. riparian vegetation types per km	5.6	2.4	43	1	10	29
no. geological rock types per km	5.1	2.5	50	0	10	29
no. associated wetlands, lakes, tarns per 100 km^2 of catchment	7.3	2.2	30	2	10	29
no. discontinuities per km	5.1	2.3	46	1	9	29
no. interconnecting headwater catchments*	4.7	2.7	56	1	10	29
no. tributaries with low modification per km	7.6	1.9	25	3	10	29
no. pool/riffle sequences per km†	6.4	2.1	33	2	10	29
no. cascades per km†	5.0	2.4	49	0	10	29
substrate heterogeneity†	7.5	1.6	22	5	10	29
% cover by native aquatic plants†	4.6	2.2	47	0	9	29
no. aquatic plant types†	5.1	2.5	50	1	9	29
no. known native aquatic plant species†	5.1	2.5	48	1	9	29
% cover for fish†	6.8	2.0	29	2	10	29
no. known native fish species	6.7	2.5	37	1	10	29
No. Ecological Regions‡	3.8	1.6	43	2	5	5
Distance from sea§	10	–	–	–	–	1
No. stable large woody debris dams§	7	–	–	–	–	1
% channelised§	9	–	–	–	–	1
% hard and soft rocks§	8	–	–	–	–	1
average slope/slope range§	8	–	–	–	–	1
flow variability§	8	–	–	–	–	1
Average depth, width§	7	–	–	–	–	1

* Dropped from list because mean weight <50% of maximum or C.V. >50%.

[Table 3 continued next page]>>

† Site visit required to make assessment. Not considered in subsequent analyses.

‡ Inadvertently excluded from questionnaire table.

§ New descriptors suggested by questionnaire respondents. Not used in trial application.

Two of the descriptors for RARITY AND UNIQUE FEATURES OR SPECIES were also excluded from the trial because mean weights were less than half the maximum possible (5) (see Table 3). The highest scoring descriptor was number of known rare/endangered species (4.4), followed by number of unusual vegetation types (3.2) and number of unusual geological formations (3.0).

Only two descriptors of FRAGILITY had C.V.s >50% or required a site visit for assessment. The highest scoring descriptors were % catchment as erosion prone land, importance for sensitive life stages (both 3.8 out of a possible 5), and proximity of areas for recolonisation (3.4). Fragility was not assessed in the trial application because of the difficulty in quantifying most of the descriptors. Final lists of descriptors used in the trial application totalled 19 for DEGREE OF MODIF1CATION, 8 for DIVERSITY AND PATTERN, and 4 for RARITY AND UNIQUE FEATURES OR SPECIES (see Table 4).

Table 3 ***(Continued)***

3. RARITY AND UNIQUE FEATURES OR SPECIES

Descriptor	Mean weights	S.D.	C.V. (%)	Min.	Max.	No.
no. large waterfalls	2.8	1.4	49	1	5	29
no. unusual rock types*	2.4	1.5	64	0	5	29
no. unusual vegetation types	3.2	1.4	44	0	5	29
no. unusual geological formations	3.0	1.4	48	0	5	29
length of river or river segment*	2.3	1.4	60	0	5	28
no. known rare/endangered species	4.4	0.8	18	3	5	29
Important spawning grounds†	5	-	-	-	-	1
No. human activities supported†	5	-	-	-	-	1

4. FRAGILITY

Descriptor	Mean weight	S.D.	C.V. (%)	Min.	Max.	No.
stability of flow *	2.7	1.7	61	0	5	28
% catchment as erosion-prone land	3.8	1.4	38	0	5	28
importance for sensitive life stages	3.8	1.2	31	0	5	27
importance of downstream conditions	3.2	1.2	37	0	5	28
vigour of riparian vegetation †	3.3	1.2	37	0	5	28
proximity of areas for recolonisation	3.4	1.3	39	0	5	26

* Dropped from list because mean weight <50% of maximum or C.V. >50%.

† New descriptors suggested by questionnaire respondents. Not used in trial application.

3.3 Trial application: Tongariro River

Values of descriptors used to assess DEGREE OF MODIFICATION, DIVERSITY AND PAITERN, and RARITY AND UNIQUE FEATURES OR SPECIES for the seven sections of Tongariro River are listed in Table 4. Descriptor scores for the three criteria (calculated as described in Table 2) are presented in Table 5, and are summarised for each criterion in Table 6.

The analysis indicated that, based on the descriptors and weightings used, DEGREE OF MODIFICATION generally increased with distance down the river. The upper two sections of Tongariro River (i.e., above Rangipo Barrage) had low DEGREE OF MODIFICATION reflecting the pristine nature of the subcatchments and the absence of flow regulation. Sections 3-5 (Rangipo Barrage-Whitikau Stream confluence) had higher DEGREE OF MODIFICATION caused largely by flow management, and scores were

Table 4 Values of descriptors used under three criteria to assess natural value of seven sections of Tongariro River.

1. DEGREE OF MODIFICATION								
		SECTION						
Descriptor	**Weight**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
% catchment in native vegetation	+17.1	100	100	100	97	81	47	90
% length channelised	-16.4	0	0	0	0	0	0	0
% length lined by native vegetation	+15.7	90	100	100	100	90	60	10
% catchment in crop/improved pasture	-15.6	0	0	0	0	5	21	0
% baseflow abstracted *	-15.4	0	0	62	42	50	35	35
% baseflow as organic effluent	-15.3	0	0	0	0	0	<O.3†	<O.3†
no. downstream dams	-15.2	2	2	1	1	0	0	0
no. exotic nuisance species	-15.1	0	0	0	0	0	0	0
% baseflow as inorganic effluent	-14.5	0	0	0	0	0	0	0
% length with regulated flow	-13.8	0	0	100	100	100	100	100
no. point source discharges	-13.7	0	0	0	0	0	1	0
no. natural barriers to exotic fish movement ‡	+13.4	2	2	2	1	0	0	0
% length lined by non-production woodland §	+13.2	100	100	100	100	100	100	90
% length with bank fencing ‖	+13.1	0‖	0‖	0‖	0‖	0‖	40	20
% catchment in production forest	-13.0	0	0	0	3	14	32	0
no. open cast mine in catchment¶	-12.6	0	1	0	0	0	0	0
no. downstream weirs	-12.2	0	0	0	0	0	0	0
density goats and cattle in catchment**	-12.2	0	0	0	0	0	38	20
no. exotic non-nuisance species††	-10.5	1	3	1	1	2	2	4
Sum of weighting factors ‡‡	268.0							

* Water from Moawhango diversion not considered. Mean flow used instead of base flow in trial application. See Appendix 6 for calculations.
† Maximum value used.
‡ Only barriers downstream of river sections considered (i.e., Waikato Falls and Tree-trunk Gorge). Waikato Falls is included in Section 4 as it is at the downstream end of that section.
§ Includes native forest and protection forest in this example.
‖ Bank fencing only relevant where goats and cattle present. Where absent, sections were given the full score in Table 3.
¶ Includes quarries. Only active sites were counted. Expressed as density per km^2. Information provided by local conservancy.
†† Brook trout, rainbow trout, brown trout, brown bullhead catfish, goldfish, *Ranunculus.*
‡‡ All weights considered as positive to calculate sum.

[Table 4 continued next page]>>

highest for the lower two sections because of catchment development (for forestry and farming), and the presence of goats and cattle where the river banks were not extensively fenced.

DIVERSITY AND PATTERN was highest in Section 3 (Rangipo Barrage-Oturere Stream confluence), and this largely reflected the short length of this section (4 km) relative to the number of tributary confluences, discontinuities, and riparian vegetation and rock types. DIVERSITY AND PAITERN was low in Section 4-6, but increased in Section 7 because of the association of this section and subcatchment with wetlands and Lake

Table 4 *(Continued)*

1. DEGREE OF MODIFICATION

Descriptor	Weight	SECTION 1	2	3	4	5	6	7
no. tributaries with low modification per km*	+7.6	1.5	1.6	2.0	0.9	0.1	0	0
no. assoc. wetlands , lakes, tarns per 100km² †	+7.3	0	0.4	0	0	0	6.7	40
altitudinal range	+6.9	780	60	80	160	140	80	10
no. stream orders ‡	+6.8	4	1	2	1	1	1	1
no. known native fish species§	+6.7	0	0	0	0	1	3	3
no. riparian vegetation types per km ‖	+5.6	0.1	0.2	0.3	0.1	0.1	0.2	0.1
no. geological rock types per km ‖	+5.1	0.1	0.6	0.8	0.4	0.3	0.1	0.1
no. discontinuities per km ¶	+5.1	1.5	1.6	2.0	1.0	0.4	0.5	0
Sum of weighting factors	**51.1**							

* Defined as tributaries flowing through catchments predominantly in native vegetation. Expressed as number of confluences per km of main channel.
† As recorded on NZMS 260 (1:50 000) maps.
‡ As represented by the main channel.
§ Determined from NIWAR Freshwater Fisheries Database and local information.
‖Determined from Land Resource Inventory (1:63 360) maps. Only vegetation types that comprised >40% of cover were considered.
¶ Expressed as number of natural discontinuities (tributary confluences (including modified tributaries) and waterfalls) per km of channel. Determined from NZMS 260 (1:50 000) maps.
** All weights considered as positive to calculate sum.

3. RARITY AND UNIQUE FEATURES OR SPECIES

Descriptor	Weight	SECTION 1	2	3	4	5	6	7
No. known rare/ endangered species *	+4.4	1	1	1	1	1	0	2
No. unusual vegetation types	+3.2	0	0	0	0	0	1†	0
No. unusual geological formations ‡	+3.0	0	0	0	2	0	0	1
No. large waterfalls	+2.8	0	0	0	1	0	0	0
Sum of weighting factors §	**13.4**							

* Determined form local conservancy knowledge. Considered rare/ endangered if listed in Molloy and Davis (1992).
† Stand of mountain beech
‡ Determined from Geopreservation Inventory and 1:50 000 maps.
§ All weights considered as positive to calculate sum.

Table 5 Scores for descriptors, total scores and criteria scores (out of 100) calculated as described in Table 2 for 3 criteria applied to 7 sections of Tongariro River.

1. DEGREE OF MODIFICATION								
Descriptor	Upper limit	SECTION						
		1	2	3	4	5	6	7
% catchment in native vegetation	≥80	17.1	17.1	17.1	17.1	17.1	10.0	17.1
% length channelised	≥60	16.4	16.4	16.4	16.4	16.4	16.4	16.4
% length lined by native vegetation	100	15.7	15.7	15.7	15.7	14.1	9.4	1.6
% catchment in crop/improved pasture	≥60	15.6	15.6	15.6	15.6	14.3	10.1	15.6
% baseflow abstracted	≥60	15.4	15.4	0	4.6	2.6	6.4	6.4
% baseflow organic effluent	≥60	15.3	15.3	15.3	15.3	15.3	15.2	15.2
no. downstream dams	≥1	0	0	0	0	15.2	15.2	15.2
no. exotic nuisance species	≥2	15.1	15.1	15.1	15.1	15.1	15.1	15.1
% baseflow inorganic effluent	≥60	14.5	14.5	14.5	14.5	14.5	14.5	14.5
% length with regulated flow	≥60	13.8	13.0	0	0	0	0	0
no. point source discharges	≥5	13.7	13.7	13.7	13.7	13.7	11.0	13.7
no. natural barriers to exotic fish movement	≥1	13.4	13.4	13.4	13.4	0	0	0
% length lined by non-production woodland	100	13.2	13.2	13.2	13.2	13.2	13.2	11.9
% length with bank fencing	100	13.1	13.1	13.1	13.1	13.1	5.2	2.6
% catchment in production forest	≥80	13.0	13.0	13.0	12.5	10.7	7.8	13.0
no. open cast mine in catchment	≥5	12.6	10.1	12.6	12.6	12.6	12.6	12.6
no. downstream weirs	≥2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
density goats and cattle in catchment	100	12.2	12.2	12.2	12.2	12.2	7.6	9.8
no. exotic non-nuisance species	≥10	9.5	7.4	9.5	9.5	8.4	8.4	6.3
Total		251.8	246.4	222.6	226.7	220.7	190.3	199.2
DEGREE OF MODIFICATION score		**6.0**	**8.1**	**16.9**	**15.4**	**17.6**	**29.0**	**25.7**

2. DIVERSITY AND PATTERN								
		SECTION						
Descriptor	**Upper limit**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
no. tributaries with low modification per km	≥3	3.8	4.1	5.1	2.3	0.3	0	0
no. assoc. wetlands, lakes, tarns per 100 km^2	≥50	0	<0.1	0	0	0	1.0	5.8
altitudinal range	≥2000	2.7	0.2	0.3	0.6	0.5	0.3	<0.1
no. stream orders	≥6	4.5	1.1	2.2	1.1	1.1	1.1	1.1
no. known native fish species	≥10	0	0	0	0	0.7	2.0	2.0
no. riparian vegetation types per km	≥1	0.6	1.1	1.7	0.6	0.6	1.1	0.6
no. geological rock types per km	≥1	0.5	3.1	4.1	2.0	1.5	0.5	0.5
no. discontinuities per km	≥5	1.5	1.6	2.0	1.0	0.4	0.5	0
Total		13.6	11.2	15.4	7.6	5.1	6.5	10.0
DIVERSITY AND PATTERN SCORE		**26.6**	**21.9**	**30.1**	**14.9**	**10.0**	**12.7**	**19.6**

{Table 5 continued next page}»

Table 5 *(Continued)*

3. RARITY AND UNIQUE FEATURES OR SPECIES								
		SECTION						
Descriptor	**Upper limit**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
no. rare/ endangered species	≥3	1.5	1.5	1.5	1.5	1.5	0	2.9
no. unusual vegetation types	≥3	0	0	0	0	0	1.1	0
no. unusual geological forms	≥3	0	0	0	2.0	0	0	1.0
no. large waterfalls	≥3	0	0	0	0.9	0	0	0
Total		1.5	1.50	1.5	3.4	1.5	1.1	3.9
RARITY AND UNIQUE FEATURES OR SPECIES SCORE		**11.2**	**11.2**	**11.2**	**25.6**	**11.2**	**8.2**	**29.1**

Table 6 Summary of scores (rounded off, out of 100) for three criteria used to assess natural value of seven sections of Tongariro River.

	SECTION						
CRITERIA	**1**	**2**	**3**	**4**	**5**	**6**	**7**
DEGREE OF MODIFICATION	6	8	17	15	18	29	26
DIVERSITY AND PATTERN	27	22	30	15	10	13	20
RARITY AND UNIQUE FEATURES OR SPECIES	11	11	11	26	11	8	29

Taupo. RARITY AND UNIQUE FEATURES OR SPECIES was relatively low for Sections 1, 2, 3, 5, and 6, but was considerably higher in Sections 4 and 7. This was because of Treetrunk Gorge and Waikato Falls in Section 4, the presence of bittern and dabchick associated with wetlands adjacent to the lower river, and because the river delta is considered an important feature in the Geopreservation Inventory.

4. DISCUSSION

The procedure for assessing the natural value of river systems which was trialled in this report quantitatively compared different sections of river. These comparisons were based on the average opinion of limnologists with a known range of specific interests and affiliations. This quantitative approach minimises the subjectivity associated with nonquantitative evaluations, but increases the amount of information required to make an assessment.

The system proposed is probably better applied to whole river systems rather than sections of river, as this would enable different rivers in the same region to be compared. When doing this, it would be important to compare only rivers of the same general type, indicating the need for an ecotype classification system that can be applied within eco-regions. For example, some types of rivers may have naturally low diversity associated with them and would rank low for DIVERSITY AND PATTERN when compared with different types of rivers in the same region. Collier and McColl (1992) discussed some possible options for an ecotype classification and suggested that origin of flow might provide the basis for a useful first dichotomy.

It is not intended that scores for the different criteria be combined to provide a single overall score for natural value, as this would result in loss of information and may lead to erroneous decisions being made. Rather, management decisions would need to be based on the priorities perceived by managers and the feasibility of different management options. However, before this proposed system can be generally applied for assessing natural value further refinements are needed.

- Descriptors for FRAGILITY need to be re-evaluated to make them easier to assess.

- Further work is required on the definition of descriptors based on the comments listed in Appendix 5, and weightings need to be re-evaluated in the light of further refinements.

- Discussions between limnologists are necessary to define the upper limits of descriptors based on existing biological knowledge. In the trial study example, most upper limits were set arbitrarily.

- The refined system should be operated as a user-friendly, expert system computer package similar to that developed by O'Keefe *et al.* (1987) to make it easy to use.

5. ACKNOWLEDGEMENTS

I am very grateful to all those who made the time to participate in the workshops and to answer the questionnaire. Thanks also to Harry Keys, Cam Speedy, Rob McLay and other staff of the Tongariro/Taupo Conservancy for providing some of the data for the trial application, and to Ian Mackenzie for final polishing of the manuscript. Special thanks to John Wiley & Sons Ltd for permission to reproduce as Appendix 2, the entire Chapter 13: "Assessing the Natural Value of New Zealand Rivers" by K.J. Collier and R.H.S. McColl, from *River Conservation and Management* edited by P.J. Boon, P. Calow, and G.E. Petts, published in 1992.

6. REFERENCES

Biggs, B.J.F., Duncan, MJ., Jowett, LG., Quinn, J.M., Hickey, C.W., Davies Colley, R.J. and Close, M.E. 1990. Ecological characterisation, classification, and modelling of New Zealand rivers: an introduction and synthesis. *New Zealand Journal of Marine and Freshwater Research* 24: 277-304.

Collier, K.J. 1992. Linking the mountains to the sea- conserving New Zealand's rivers. *Forest & Bird November:* 26-32.

Collier, K.J. and McColl, R.H.S. 1992. Assessing the natural value of New Zealand rivers. Chapter 13 in P.J. Boon, P. Calow, and G.E. Petts (Eds): *River conservation and management* John Wiley & Sons, London. (See Appendix 2)

Molloy, J. and Davis, A. 1992. Setting priorities for the conservation of New Zealand's threatened plants and animals. Department of Conservation, Wellington.

O'Keeffe, J.H.; Danilewitz, D.B. and Bradshaw, J.A. 1987. An "Expert System" approach to the assessment of the conservation status of rivers. *Biological Conservation* 40: 69–84.

Park, G.N., Simpson, P.G., Dingwall, P.R., Ogle, C.C., Mitchell, N.D. and Myers, S.C. 1986. The New Zealand Protected Natural Areas Programme : a scientific focus. *Biological Resources Centre Publication No.4.* New Zealand Department of Scientific and Industrial Research, Wellington.

Simpson, P. 1985. WERI: a plug for protection. *The Landscape, Autumn:* 5-19.

APPENDIX 1
Proceedings of a workshop on aquatic reserve identification held during the Limnological Society Conference, Christchurch, May, 1987

IDENTIFICATION OF AQUATIC RESERVES

This workshop was suggested by the practical and administrative problems experienced in evaluating and actually setting up reserves for aquatic ecosystems, and the lack of recognition of these systems in present surveys and databases. It was an ideal opportunity to discuss mechanisms, especially with the government department reorganisation and much legislation under review.

Keynote speakers backgrounded different areas and highlighted problems which were used as the basic objectives for three working groups.

Janet Owen (Protected Ecosystems Directorate, DOC) outlined DOCs structure with reference to their quite extensive responsibilities for reserves and advocacy for freshwater areas and surrounds. They are also responsible for the Protected Natural Areas (PNA) system and are attempting to get funds for an initial N.Z. wide survey. The PNA process identifies priority and representative reserve areas. The steps involved are reconnaissance (rapid inventory into major types), survey (rapid again), analysis and evaluation, and then implementation to protect systems (see S. Myer's article for further details).

Problems with applying the PNA process to waterbodies were in both the overall structure and the survey method. PNA gives types based on land form and land vegetation and the ecological districts derived from this do not seem appropriate for representative areas for waterbodies. They do not comply with the natural catchment boundaries and some lakes or river types, e.g., glacial lakes could occur in several ecological districts. A river needed as a reserve for a fish species or a collection of waterbodies needed for migration routes for wildlife may be in a number of different districts.

The survey method seems to poorly identify and type waterbodies and the question of better ways of doing this was raised. The appropriateness of the evaluation criteria used for PNA was also queried.

Brent Cowie (Water & Soil, MWD) outlined the acts which pertain to water, or waterbody protection. He updated the water conservation order (WCO) process which highlighted the lengthy and costly process which has arisen from ambiguous legislation. The result is 12 applications over 4 years – with only 2 fully resolved.

Laurel Tierney (MAF) spoke on Faunistic Reserves which were MAF's (now DOC's) responsibility. A potentially powerful statute has been little used, because of lack of will and lack of procedures. It mainly prevents species introduction and it has been applied in situations where little threat occurs, at least from natural sources, and hence little management is required.

Participants then divided into three working groups.

1. Classification Methods for the Purpose of Prioritising Reserve Effort
Convenor: Sue Maturin, Scribe: Ann Graesser

In this group, classification methods for aquatic habitats were discussed that could be both:

- Easily and quickly used by non-experts, and
- Interpreted by experts for the assessment of protection needs and/or further biological investigation.

Terrestrial based systems do not provide enough information for the freshwater scientists to classify and assess the protection needs of the habitat.

It was suggested that particular biological groups, such as fish or aquatic macrophytes, could be used as indicators of the type and condition of aquatic habitat. However, this would involve intensive investigations of each aquatic habitat to document the diversity of the biota present, which is not feasible for DOC because of pre-existing time and financial constraints.

An alternative suggestion was to expand the currently implemented PNA system to include more information regarding the basic physico-chemical characteristics that are generally considered to be key features of aquatic habitats. Many physico-chemical parameters could be either observed in the field or determined from topographical maps. These include sources of water (depending on the timing of the survey), size of water body, channel morphology, substrate size range, and water colour and turbidity. Other characteristics could also provide useful information for protection assessment such as access for wildlife, especially fish, wildlife refuge value, "naturalness" or extent of man-made disturbance in the catchment, representativeness or uniqueness of the habitat. These could be also visually assessed in the field, or determined from discussions with experts.

Freshwater scientists working in the area (government bodies, catchment boards, acclimatisation societies, university and agricultural colleges and environmental consultancy groups) could be a source for the initial information needed to classify the aquatic habitats within an ecological district. Such discussions could be useful to both parties, reducing duplication of research effort as well as involving experts in the assessment procedures.

Recommendations

1. That "types" of waterbodies be classified using natural boundaries and taking into account the needs of the biota of those types.

2. That the PNA process use existing biological expertise (including Limsoc networks) to gather information before the field survey stage and to evaluate results.

3. That the PNA survey be expanded to include some basic physico-chemical information.

2. Criteria for Evaluation and Decision Making

Convenor & Scribe: Chris Richmond

This working group looked at the criteria for evaluating the "value" of a waterbody type once it has been identified as a type, e.g., the decision between one dune lake and another for reserve status. What criteria should we use? Should they be qualitative or quantitative? This is always easiest for obvious priority areas and less easy for representative areas.

The group worked with a number of different examples of evaluation criteria: WERI, PNA, the one used by Limsoc (previously) and a Swedish example and came up with two sets.

The first set identifies the reserve values:

1. Ecological representativeness, or, rare type of ecosystem
2. Diversity and pattern
3. Rarity and unique features or species
4. Long term viability
5. Historic or research value
6. Degree of modification

We place rarity with ecological representativeness you may value the waterbody equally for either criterion.

The second set determines the degree of modification:

1. Type of impact
2. Immediacy of impact

3. Size of impact
4. Positive or negative
5. Features that may be impacted
6. Opportunity to prevent, litigate or enhance

Quantitatively, attempting a simple sum of the "value" by using a 3-point assessment scale for each criterion did not work. The difference in "value" of Lake Hayes and Lake Taupo was not clearly distinguished. The task of providing weightings for each feature was seen to be a difficult but necessary one.

The priority for reservation then becomes a multi-function combination.

Priority = f $\sum$ value, threat, protectability.

Recommendations

1. That evaluation of aquatic ecosystems uses a set of identifying features to determine the degree of modification.

2. That priority for reservation is assigned by: Priority = f $\sum$ value, threat, protection.

3. That a weighting system should be developed by a joint MWD/DOC working party, possibly with Limsoc assistance. A pilot project in a district should aim for consensus of expert opinion using a modified Delphi technique.

4. That national databases be developed and implemented for rare plants, invertebrates and special natural features, acknowledging that the existing database for fish is adequate.

3. Legal Mechanisms for Reservation of Waterbodies

Convenor & Scribe: Brent Cowie

This group discussed what legal means were available to protect aquatic biota or habitats and what improvements to these provisions seem necessary.

Aquatic fauna can be protected in several ways. The Wildlife Act allows for the establishment of wildlife refuges, reserves and management areas. These provisions have been widely used. Faunistic Reserves can be established under the Fisheries Act, but only four such reserves have been gazetted to date. There are presently no provisions for establishing aquatic floristic reserves, which there should be.

Rivers and lakes can be protected by water conservation orders. Proposed changes to the water and soil legislation would also help facilitate aquatic habitat protection, e.g., the proposed schedule of protected waters. The water conservation order process has become bogged down in legal technicalities.

It requires simplification.

Few means are available to protect wetlands or the land-water interface in general. Conservation orders cannot cover wetlands. The Town and Country Planning Act is also deficient in this area. However, the Court of Appeal has ruled that water rights for land drainage shall not necessarily be granted in highly valued wetlands (Whangamarino decision). Wetland protection merits legislative action.

Recommendation

That the Limnological Society take an active role as a group of informed scientists in promoting legislative changes to protect highly valued aquatic or wetland flora, fauna and habitats.

PLENARY SESSION

Convenor & Scribe: Lucy Harper

In the plenary session it was suggested decision making by managers would be helped by a survey to collate existing information. This would be used to construct a list of different information held by different agencies and a list of experts in different fields. The Biological Resources Centre, as part of DOC, would be an obvious agency to co-ordinate this.

It also became clear that as well as the gaps in the protective legislation, there is also a lack of a clear mandate or ethic to use it which leads to problems in implementation. Splits of responsibility, splits of the advocacy role and a general lack of finance means that buck passing (or "no-buck" passing) continues. Even when there is a strong responsibility for advocacy, e.g., water conservation orders, the strong opposition from development agencies, the legal ambiguities and the effect of fund cutting and user pays present problems.

The synthesis of the topic discussed provides a unified and practical system to achieve the objective of gaining aquatic reserve status for some of our waterbodies. We looked at what we want to reserve, how we type it, and how ideally we want to see it protected.

The recommendations of the workshop can be passed to the DOC divisions that are responsible for reserves and are also useful input to the Limsoc subcommittee on protected natural areas and legislation.

The next stage seems to be to follow the fisheries example and put more emphasis on identifying the actual requirements of space, area, water quality, etc needed to allow managers to evaluate the suitability of an area for reservation for a particular purpose.

THE PNA SURVEY PROCESS

Shona Myers

The following is a brief description of the survey phase of the Protected Natural Areas programme, which was presented at the aquatic reserves workshop of the Limnological Society's annual meeting. Responsibility for the PNA programme now rests with the Department of Conservation.

The Aims of the PNA Programme are:

- To seek basic information about the types, diversity, pattern and quality of the natural ecosystems in an ecological district and to identify representative examples of these areas for protection.
- The achievement of a network or protected natural areas that includes adequate examples of all classes of natural ecosystems.

An Urgent Task

The design of the programme has been strongly influenced by the knowledge that the task is urgent and many remaining ecosystems are being lost or depleted. There is a need therefore for rapid and urgent coverage of ecological districts where the representativeness of the existing reserves is poor.

Primary Focus on Terrestrial Ecosystems

The primary focus for PNA survey has been on terrestrial ecosystems for the following reasons:

1. The survey programme has needed to be manageable both administratively and politically in terms of cost and rate of coverage.
2. In defining the ecological character of a district during a survey, the readily recognisable formal properties of the land are used; predominantly landform and vegetation patterns.

From the onset however the PNA surveys have not excluded freshwater and some marine ecosystems and have identified a range of wetlands, including swamps, lagoons, estuaries and lakes, as important natural areas.

The PNA Survey of an Ecological District involves:

1. Reconnaissance

The reconnaissance phase is important for careful planning of the field survey. Existing knowledge of the district is gathered (e.g., from existing data bases, previous surveys, people with knowledge of the natural history of the area), a field understanding of the natural ecosystems is developed, and study sites selected from this information. The ecological district is divided into recognisable land systems and ecological units (an ecological unit is the combination of a natural community type, usually a vegetation type, and the landform it occurs on). The ecological unit is the key to describing the natural diversity, in the sense of the ecological character, of the district.

2. Survey

A detailed vegetation and landform survey of selected natural areas is undertaken using vegetation as the primary parameter. Vegetation is used because it is generally easier and quicker to measure than other components of the ecosystems. Survey sites are chosen to represent larger tracts of land, to sample unusual vegetation or natural community types, to survey discontinuous vegetation, landform types or other important ecological units not included in the existing network of protected natural areas.

3. Evaluation

The selection of the natural areas that best represent the ecological character and range of ecosystems and landscapes in the ecological district – "Priority for Protection" - forms the heart of a PNA survey report. Selection of these areas is based on a number of criteria including:

- representativeness
- diversity
- rarity and special features naturalness
- long term ecological viability
- size and shape buffering, surrounding landscapes

Representativeness is the primary criterion for selection, i.e, typical or characteristic natural areas which were formerly common and widespread in the district. The ecological unit (vegetation and landform) is the key to determining which areas are representative. Features which are important to protect for other reasons can also be identified.

4. Implementation

Implementation involves national evaluation and publication of a survey report. After scientific review of the survey proposals, the process then involves negotiation with landowners, landholders and managers to achieve levels of protection of important sites. In advancing the protection of important natural areas DOC will be looking at protection in terms of leases, covenants, rate relief, management agreements, etc., as well as purchase by Crown. Liaison with other agencies involved in protection of natural areas (e.g., QEII National Trust, Ministry of Works, local authorities) will be advocated.

Workshop Organising Committee: Sally Davis, Philippe Gerbeaux, Don Jellyman, Ian Lineham & Jonet Ward

Continue to next file: SR58a.pdf