A limited NZ-wide survey for the presence of non-indigenous freshwater diatom *D. geminata* in sites most likely for its introduction and establishment

NIWA Client Report: CHC2006-023
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Prepared for

Biosecurity New Zealand

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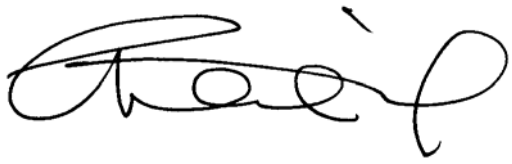

Kathy Kilroy Brian Sorrell

Executive Summary

1. The introduced invasive diatom *Didymosphenia geminata* (didymo) was first identified in the Mararoa and lower Waiau Rivers, Southland, in October 2004. An initial delimiting survey in December 2004 found no evidence of *D. geminata* in adjacent rivers.

2. Ongoing passive surveillance by Fish and Game Councils, Regional/District Councils, Department of Conservation and Crown Research Institutes who had been provided *D. geminata* identification sheets by Biosecurity New Zealand in December 2004 have resulted in the submission of multiple suspect samples from around New Zealand. All of these suspect samples had been negative until 27 September 2005, when a NIWA – Fish & Game team discovered *D. geminata* blooming in the Buller River. This spurred the rapid discovery of further occurrences reported within days from the Hawea and upper Clutha Rivers in Otago and the upper Waiau and Oreti Rivers in Southland.

3. Given the wide geographical spread of the new infestations, priority was given to determine quickly whether the distribution of *D. geminata* had extended to elsewhere in New Zealand. A second delimiting survey, originally planned for spring 2005 in Otago and Southland, was expanded to cover high risk sites nationwide.

4. The objective of the nationwide survey was to detect the presence of *D. geminata* in high risk sites where it was likely to be introduced by human activity and where it was likely to establish due to environmental suitability. That survey of 492 sites found *D. geminata* in samples from seven sites from four rivers in the nationwide survey. The Von River, Southland, was the only one from which *D. geminata* had not been previously identified from the ongoing passive surveillance.

5. Biosecurity New Zealand has planned quarterly *D. geminata* delimiting surveys, at least for 2006, with smaller surveys alternating with larger ones. The survey reported here is the second survey in the series and is one of the smaller surveys.

6. The 119 site survey reported here was mainly a subset of the sites for October 2005 survey. Sites for the nationwide survey were distributed between the North (38 sites, 30%) and South (87 sites, 70%) Islands and selected according the following criteria:

   (a) Sites regularly visited by people, such as those with high value in terms of recreation, tourism, and natural heritage (biodiversity), and therefore having the highest likelihood of introduction of *D. geminata* by humans.

   (b) Sites with environmental conditions that most closely matched those suitable for the establishment and growth of *D. geminata* according to the NIWA likely environments risk stratification.

7. *D. geminata* was found only at the Waitaki River at Glenavy, where it was not visible to the naked eye at the site and only a few cells were detected by microscopic analysis. The nearest visible colonies were over 40 km upstream where it was discovered only a few days before the survey.

8. No *D. geminata* was found in the North Island in the 38 sites and rivers where experts consider that it is most likely to be introduced to and established.

9. The latest discovery of *D. geminata* at a popular fishing spot on a river well suited to *D. geminata* establishment vindicates the site sampling strategy.

10. The ability of the sampling and analytical methods to detect only a few *D. geminata* cells from small samples from sites distant from visible colonies in this survey and the October 2005 survey engenders confidence in those methods.

11. As the 119 sites and rivers in the survey were those experts consider to be the most likely to be infected and to allow establishment, it is unlikely that *D. geminata* was more widespread, or at least established, at the time of the survey, at other than its known range before sampling began.

1. Introduction

The introduced invasive diatom (alga) *Didymosphenia geminata* (didymo) was first identified in the Mararoa and lower Waiau Rivers, Southland, in October 2004. Over the summer of 2004/05, the species formed thick growths throughout a 150-km stretch of river, which persisted over the following autumn and winter. *D. geminata* was declared an "unwanted organism" by Biosecurity New Zealand in November 2004 and measures were put in place to prevent its spread into other river systems. A delimiting survey undertaken in mid-December 2004 found no evidence of *D. geminata* growth in other major Southland Rivers (Kilroy 2004b). Therefore, it was assumed that there was a strong likelihood that the organism had not yet spread to these systems. Biosecurity New Zealand also set up a system of ongoing passive surveillance (OPS) that enabled local, regional and national agencies (Fish and Game Councils, Regional/District Councils, Department of Conservation and Crown Research Institutes) undertaking activities in rivers to report any sightings of suspicious algal growths. Samples are collected by AgriQuality staff, or by the person reporting the growth, and sent to NIWA, Christchurch, for microscopic examination.

A series of investigations was commissioned by Biosecurity New Zealand to improve understanding of this invasive, but poorly studied organism. These included a review of the biology, distribution, effects and potential risks of *D. geminata* for New Zealand (Kilroy 2004a), tests to determine the effectiveness of methods for sanitising material contaminated with *D. geminata* (Kilroy 2005), and an analysis of the ecological suitability of rivers for colonisation by *D. geminata*, assuming it could disperse throughout the country (Kilroy et al. 2005a). In addition, Meridian Energy, who has funded ecological studies in the lower Waiau River since 1993, contributed substantial baseline information on the development and effects of the infestation (Kilroy et al. 2005b, c). A further delimiting survey was planned for spring 2005, to coincide with the time when benthic algae generally bloom; in other words, this was the time when *D. geminata*, if present in a river, would be expected to become obvious.

However, before the second delimiting survey, on 27 September 2005, *D. geminata* was discovered blooming in the Buller River, with the infestation starting some 3 km downstream from the Lake Rotoiti outlet. Within a few days, further occurrences of *D. geminata* were reported from the Hawea and upper Clutha Rivers in Otago and the upper Waiau and Oreti Rivers in Southland.

Given the wide geographical spread of the new infestations, a priority was to quickly determine whether *D. geminata* had spread to other New Zealand rivers. A nationwide delimiting survey to determine the distribution of *D. geminata* was therefore initiated by Biosecurity New Zealand. Of the 492 sites surveyed in October 2005, the Von

River was the only one from which *D. geminata* had not been previously identified from the ongoing passive surveillance (Duncan et al 2005).

An important outcome of the October 2005 survey was the detection by microscopic analysis of *D. geminata* where it was not visible to the naked eye at the site. Detection of *D. geminata* in the Oreti River more than 80 km downstream of the most visible growths serves to raise confidence that the sampling and analytical method were adequately detecting the presence of *D. geminata*. This ability to detect *D. geminata* well downstream of visible growths increases the confidence that sampling strategy employed in this survey of sampling the downstream extents of tributaries and rivers, will detect *D. geminata* if it is established upstream.

Since the October 2005 delimiting survey *D. geminata* has been found in the Waitaki River. An algal specimen from the Waitaki River adjacent to Wainui Station was given to Graeme Hughes of Fish and Game on Saturday 21 January 2006 and identified by him as *D. geminata.* Environment Canterbury staff retrieved the sample on 23 January and the identification was confirmed by NIWA on 24 January. On 24 January Graeme Hughes found and identified *D. geminata* well established in the Waitaki River at the Otiake confluence and the next day Environment Canterbury staff found further infestation approximately two kilometres upstream of the Otiake confluence (J Graybill pers comm.).

The survey described in this report is one of a series of surveys planned by Biosecurity New Zealand. Surveys are scheduled to be undertaken at approximately 3-monthly intervals with full detailed surveys (~500 sites) alternating with smaller scale operations covering ~100 representative sites. The present survey, undertaken in January and February 2006, is in the latter category.

Like the October 2005 nationwide survey, the present survey aimed to address the following question: **To what extent is *D. geminata* present in sites where it is likely to have been introduced and become established?** Two important assumptions underlie this question. The first is that the principal means by which *D. geminata* can be spread from river to river is via human vectors. The second is that some sites provide much more suitable environments for *D. geminata* establishment than others. Both these assumptions were central to the selection of sites for inclusion in the survey, and emphasis is placed on their justification. They form the basis for a sampling survey design that is commonly used as a means of maximising the information gained with the available resources (Biggs & Malthus 1983).

2. Nationwide survey, January and February 2006-02-2006

2.1. Logistics and organisation

The survey was managed by NIWA Christchurch. NIWA was contracted to co-ordinate site selection, survey team selection and training, provide field staff, and analytical services. Additional field staff were provided by Fish and Game Councils and Regional/District Councils.

2.2. Site selection

2.2.1. Criteria for selecting sites

Rivers where *D. geminata* had already established were avoided to reduce the risk of contamination. The one exception to this was the Waitaki River at Glenavy. In the time between finalising the sites and sampling, didymo was discovered by Fish and Game Central South Island on 24 January 2006 growing vigorously about 40 km upstream of Glenavy. After discussion with BNZ staff the sampling went ahead even though *D. geminata* may have been present at the site. The sampler was instructed to be meticulous about decontamination at this site. Other locations were selected based on the following criteria:

1. Sites where *D. geminata* is likely to have been introduced

We make a single crucial assumption for this condition, viz., that the spread of *D. geminata* within New Zealand is entirely or almost entirely attributable to transfer by humans. The robustness of this assumption is discussed in Duncan et al 2005. Therefore selected sites were at river access points that are visited regularly by people (fishermen, kayakers, trampers, tourists, scientists, swimmers etc.), and therefore have the highest likelihood of inter-waterway *D. geminata* transfer. Particular emphasis was placed on usage by highly mobile international anglers. The Ministry for the Environment document Water Bodies of National Importance (MfE 2004) was used as a key reference to locate popular sites.

2. Sites where *D. geminata* is likely to have become established

The assumption here is that specific environmental conditions exist under which *D. geminata* will establish and grow, and in the absence of these conditions, the likelihood of establishment/growth decreases. These conditions are detailed in Duncan et al. 2005. Selected sites were within the strata of high to medium habitat suitability for the establishment and growth of *D. geminata* based on the NIWA likely environments analysis (Kilroy et al. 2005a).

2.2.2. Number of sites

The number of sites for this survey was prescribed by BNZ to be in the region of 100 sites for fiscal reasons. Their main interest was to see if *D. geminata* had reached the North Island. Starting with the list of sites for the October 2005 survey, sites were culled for a variety of reasons including.

- Sites where *D. geminata* was known to be present
- Sites on rivers with a lower risk of establishment
- Sites on rivers with poor public access, e.g., "the Blue Duck sites" in the Wanganui River headwaters where access is restricted.
- Sites close to others on the same tributary
- Sites on a main stem upstream of a tributary that also has a site were often replaced by a new site downstream of the confluence.
- Remote (helicopter accessible) sites were deleted when there was a downstream site with road access
- Sites of importance to local anglers only. Care was taken to retain in each area the sites judged to be most likely to be infected and to support establishment.

The resulting site network commonly had one site on major tributaries and smaller rivers and two on the larger rivers with the downstream site being as far downstream as possible, while maintaining conditions for good establishment.

This process reduced the number of sites in the North Island to 36 sites. A similar process was used to select sites for the South Island, except that the culling process was more harshly applied to reduce the total number of sites to less than 100.

The site lists were distributed for comment to Fish and Game Councils, Regional Councils and the Turangi office of the Department of Conservation. The comments resulted in site deletions, substitutions and additions. Only two sites were added to the North Island list and about 18 to the South Island list in reflection of the harsh application of the selection criteria. A proportion of those were remote sites with a high cost of sampling. Six of these sites were marked for "passive surveillance".

A pleasing feature of this exercise was organisations volunteering to sample sites for the survey and/or to sample the "passive" sites. Many Fish and Game Councils, and Regional Councils took part in the survey. While specific sites we allocated to each group, participants were encouraged to discuss sites in their regions and to reallocate the sites if it was beneficial.

2.3. Survey procedures

Appendix 1 is the brief used to manage the survey. It contains details of the purpose, scope of the survey, a description of *D. geminata,* copies of field sample forms (Appendix 2), sampling and decontamination instructions, and other logistical matters.

2.3.1. Briefing/training for field surveys

Most of the staff used for sampling had been trained for the October 2005 Survey. Experienced NIWA staff trained one Taranaki Regional Council staff member in the course of sampling and one NIWA staff member was coached by phone.

All sampling teams were supplied with sample jars, pipettes, scrapers and chilly bins, with the rest of the sampling equipment and bleach being sourced locally. Most South Island teams routinely use disinfection procedures and were not normally supplied with disinfection equipment.

North Island teams were supplied with a full set of equipment required for sampling and decontamination, including sampling forms, sampling containers, buckets, sample scrapers and pipettes, chilly bin(s), and protective gloves. Refer to Appendix 2 for the complete list. Each team also carried a GPS unit and camera for recording location and site appearance for sites not previously photographed.

2.3.2. Survey method

Teams were instructed to access river sites as close as possible to the locations defined during the site selection exercise, and to work within a reach of up to ~50 m length (or more if practical). The reach would generally be downstream of public access to the river. Areas surveyed were, for safety reasons, wadeable, but any growths of interest in deeper, faster-flowing areas were to be noted. The survey protocol had two aims:

1. To inspect the entire site for presence of visible *D. geminata* and to sample suspected colonies.
2. To collect a representative (random) sample of algae growing at each site.

For site inspections, teams were instructed to scan the substrate of the entire reach for algal growth and to take samples of any growth that resembled colonies of *D. geminata*. During the site inspection, representative samples of algae growing at the site were collected along transects. At each site, five transects were positioned at right angles to the bank, downstream of public access points to the river. The location of the first (most upstream) transect was assigned randomly, and the remaining transects were generally 0.5 to one channel width apart with a maximum distance apart of 50 m. Where different habitat types (riffles, runs and pools) were present within the sampling reach, transects were located in proportion to these habitat types. Coarse,

periphyton-covered bed material (usually stones/rocks) was removed from the bed at five equally spaced locations along each transect. Samples of each colony type on each sample clast were scraped off with a disposable wooden scraper into a container. Where samples were sparse, scrapings were washed off with a disposable water-filled pipette. Samples were normally consolidated into one sampling container. Generally one or two sampling containers were collected from one site, e.g., from one from transects and one from suspected *D. geminata* samples.

If the site had not been sampled in the October 2005 survey, sampling teams were also instructed to collect basic information about the physical characteristics of the site: stream width, bed composition, shade and water clarity (see sampling form in Appendix 2). For new sites, and where possible, a photograph was taken of the site, looking downstream from the upstream end of the study reach. The habitat information was not used in the analysis of results from the present survey, but it was anticipated that the data would be useful for comparative purposes should *D. geminata* be found at new sites in future surveys.

During the October 2005 survey there was some concern that floods would slough off periphyton, including didymo, and that sampling after flooding may fail to detect didymo. However, during the October 2005 survey, didymo was detected in the Von River, even though the stones sampled appeared periphyton free and the nearest visible colony was several kilometres upstream. This result gave confidence that there was a high probability of detection of didymo if it was there, even though river bed disturbance by flooding may have caused loss of periphyton by sloughing or abrasion. Thus, for this survey, field staff were instructed to sample rivers for didymo, regardless of previous flow conditions and apparent periphyton cover on the river bed.

2.3.3. Decontamination

Field staff were required to start their surveys at the most upstream site to avoid contamination of an upstream site from downstream, and to work from an upstream to downstream direction within each site. They were also required to decontaminate before moving to tributaries or different rivers. Decontamination consisted of collecting disposable materials used at each site (e.g., scrapers, pipettes, rubber gloves) into a rubbish bag, and subjecting all other equipment exposed to river water or periphyton scrapings to a 2% solution of bleach for one minute. Staff stood in their waders in a tray of bleach solution while the waders were washed down with the solution.

2.3.4. Microscopic examination of samples

Samples were couriered directly to NIWA's Christchurch Laboratory at the end of each day for assessment of *D. geminata* presence/absence.

Samples were concentrated as necessary by pipetting or pouring off excess water, following a settling period of up to eight hours. Aliquots of approximately 1 ml of the algal suspensions were transferred to the well of an inverted microscope and allowed to settle briefly (30 s). Entire sub-samples were then scanned at magnifications of 100x to 200x. At least three aliquots from each sample were examined in order to increase the chances of finding *D. geminata* in a sample, even if it was very rare.

Precautions were taken in the laboratory to prevent cross-contamination of samples and to eliminate any chance of *D. geminata* entering the local environment. The microscope well was rinsed twice between each sub-sample and thoroughly cleaned after examining samples from each site. A new pipette was used for samples from each site, or from each sub-sample if *D. geminata* was found. Excess water was pipetted into a waste container and was not washed into the drainage system. All sub-samples examined were rinsed into the waste container.

After examination of each sample the remaining algal material was frozen (–20ºC). The material will be kept until this report and its results have been accepted by Biosecurity New Zealand. It will then be disposed of as detailed in the next paragraph.

All liquid waste material was treated with bleach (to a concentration of at least 5%) then disposed of into the sewerage system. All solid waste was autoclaved for 20 min at 15 psi before disposal.

2.4. Data analysis

This survey had two possible outcomes:

1. Cells or other traces of *D. geminata* would be detected in one or more samples outside its known range. This result would imply that the species had already spread from the Mararoa / lower Waiau, Oreti, Von, Clutha Buller and lower Waitaki catchments.

2. No traces of *D. geminata* would be detected in any of the samples. This would imply *either* that the species was not present in the rivers at the time of sampling *or* that the sampling was not sufficiently effective to pick it up.

For the second outcome, the question to be answered would be: how confident can we be that the survey would have detected the species if, in fact, it was present? This issue is addressed in Duncan et al (2005). Assuming the sites are independent, and there is a 1% probability of *D. geminata* being present at any one site then the probability of detection is 70%. In this survey few sites are on the same river and those that are sufficiently far apart to be considered independent.

2.5. Results

2.5.1. Sites and samples

Of the 125 sites identified for the survey, 119 sites were visited in 11 working days (25 January to 9 February 2006). The remaining 6 remote sites await passive surveillance. Samples were taken at all sites visited, yielding 135 samples of algae scraped from the surfaces of river stones.

Figures 1 and 2 show the locations of sites included in the survey, and Table 1 lists the numbers of sites sampled in each local authority region for both the October 2005 and January 2006 surveys. Site and sample details are listed in Appendix 3. While many sites were at the general location of the October sampling sites, the precise location is given by the GPS co-ordinates many of which are marginally different from those of the October survey. Also for most of the sites substrate composition, channel width, shading and water clarity information were recorded. For many sites water samples were also taken for conductivity measurements in the laboratory. Data in Appendix 3 from the October 2005 survey are shown in italic font. The site that was positive *D. geminata* for is shown in bold font.

2.5.2. Microscope analysis

D. geminata was found in a sample from one site from one river in the South Island (Table 2, Figure 2). The site was on the Waitaki River at Glenavy where it was not visible. Two dead cells were found in the first three sub-samples, and it was absent in 10 other sub-samples. Two days before it was sampled *D. geminata* was found over 40 km upstream in the Waitaki River at the Otiake confluence where it was abundant and at Duntroon where it was visible. At the Glenavy sampling site there was a sparse covering of periphyton on the large gravel and small cobble substrate. The flow was of moderate velocity.

North Island survey

All 38 North Island sites returned negative results, i.e., no *D. geminata* was discovered at those sites.

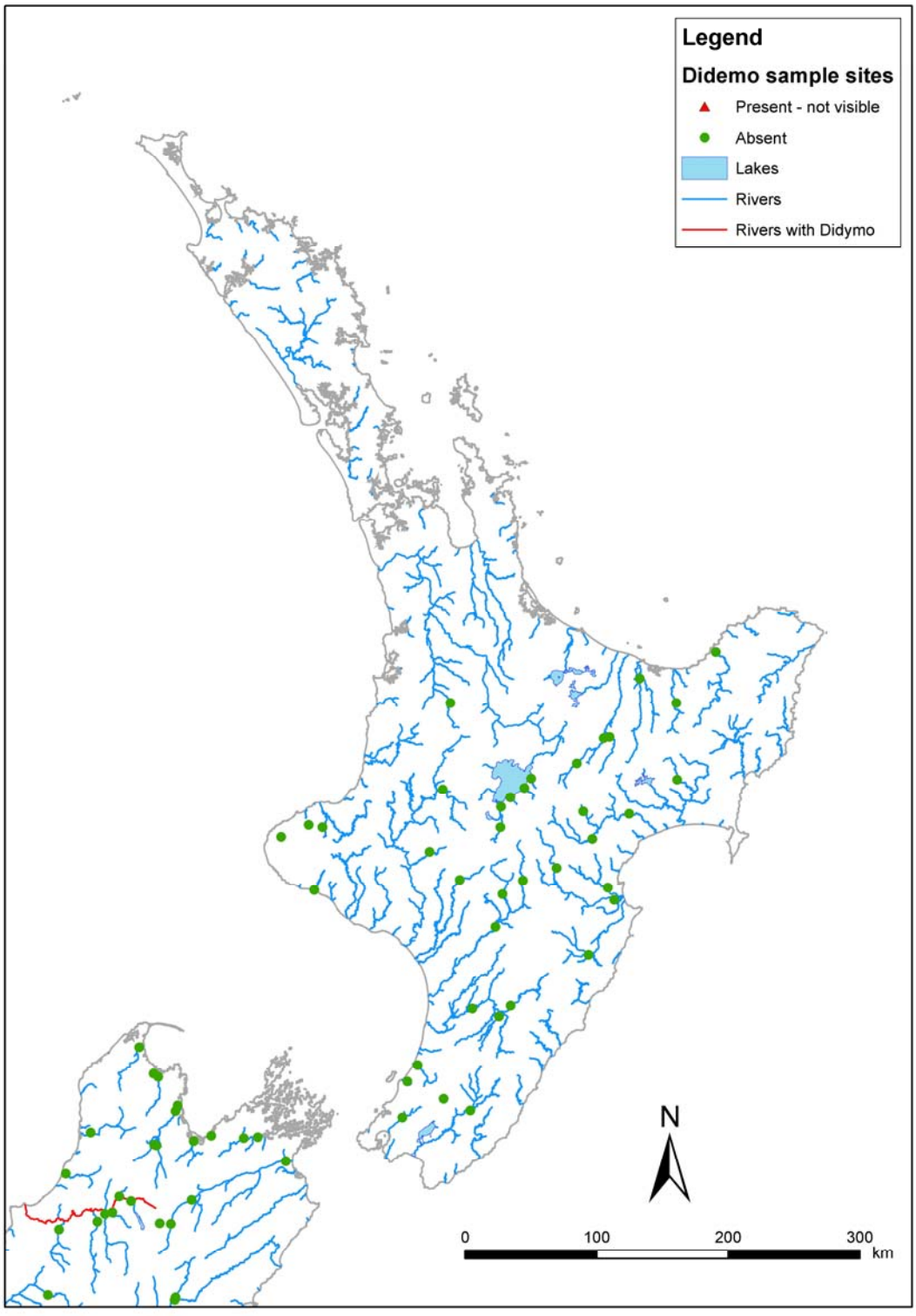

Figure 1: **North Island and top of the South Island locations of the *D. geminata* sampling sites with those where *D. geminata* is in microscopic quantities (South Island only) shown as red triangles and those where it is not present shown as green dots. Rivers coloured red are those known when the field sampling was carried out to be affected by *D. geminata*.**

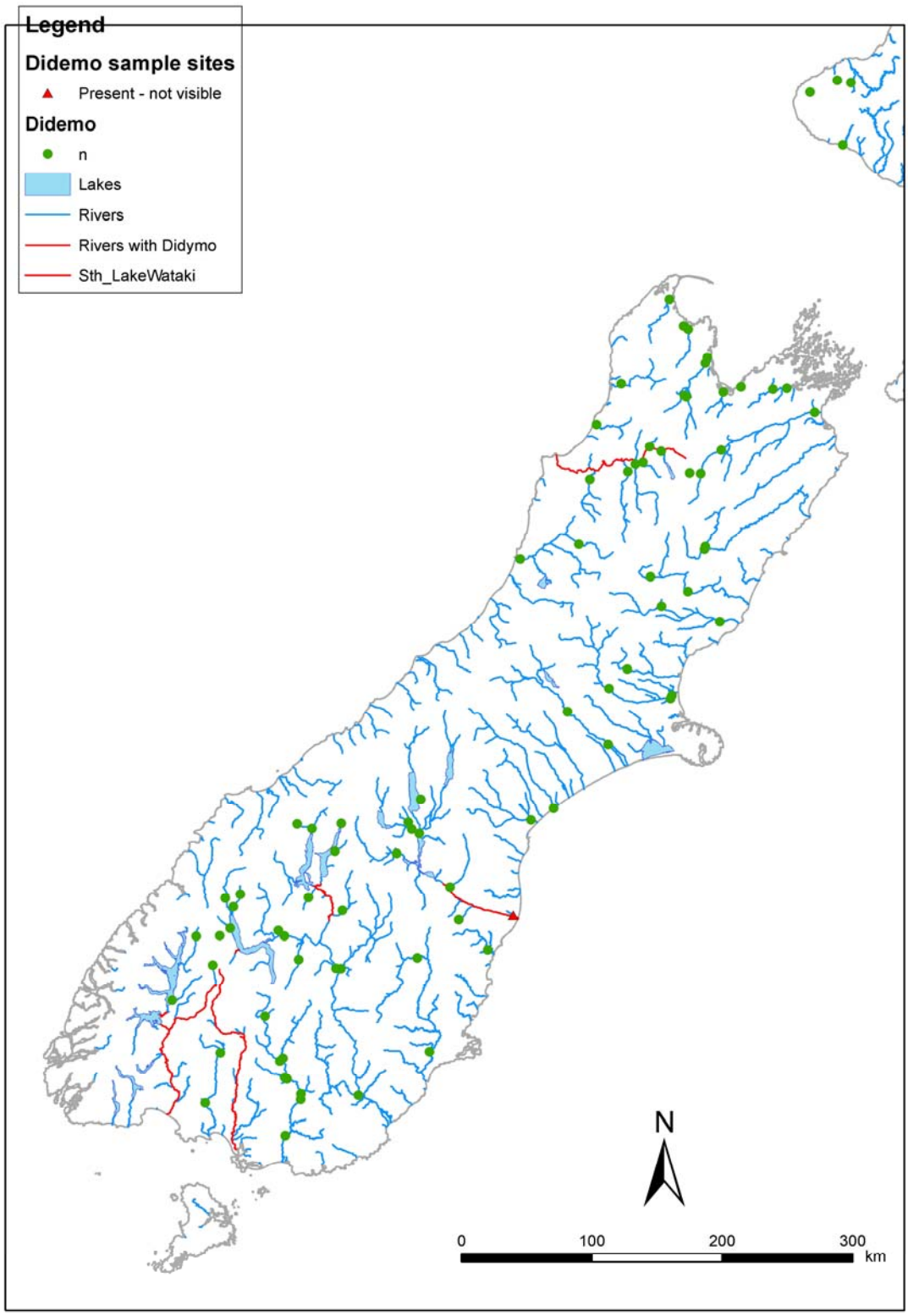

Figure 2: **South Island locations of the *D. geminata* sampling sites with those where *D. geminata* is in microscopic quantities shown as red triangles, and those where it is not present shown as green dots. Rivers coloured red are those known when the field survey was carried out to be affected by *D. geminata*.**

Table 1: ***D. geminata*** **sampling sites by Territorial Local Authority region for the October 2005 and the January 2006 surveys.**

Region	Number of sites October 2005	Number of sites January 2006
Bay of Plenty	13	7
Hawke's Bay	22	7
Manawatu-Wanganui	26	9
Taranaki	12	4
Waikato	13	6
Wellington	22	5
NORTH ISLAND TOTAL	106	38
Canterbury	75	20
Marlborough	37	8
Nelson (city)	1	1
Otago	92	19
Southland	72	17
Tasman	61	10
Westcoast	48	12
SOUTH ISLAND TOTAL	386	87
NEW ZEALAND TOTAL	492	125

Table 2: **List of sites where** ***D. geminata*** **was found**

Status	Site no.	River	Location	Notes
Known before survey	1393	Waitaki	At Glenavy boat ramp	Rare in sample, not visible

2.6. Discussion

2.6.1. Confidence in sample analysis method

In this survey *D. geminata* was found in one river (the Waitaki River, Canterbury) where it had been discovered about 40 km upstream of the sampling site only a few days before the sampling commenced. It was detected at the single cell level with a total of two cells (both dead) being found in thirteen sub-samples. The sub-samples were derived from a small sample of less than 5 ml of alga scraped from 25 stones. The sampling team reported that the river was essentially free of visible algae. This shows that the sampling and analysis methods used were capable of detecting very low levels of *D. geminata.*

In the previous nationwide survey (Duncan et al. 2005) there was discussion on the site selection strategy, i.e., selection of popular river access points where river conditions favour establishment. If this strategy was wrong the likelihood of detecting

D. geminata, if present, would be lower than ideal. The discovery of *D. geminata* at a popular fishing site on a river providing ideal conditions, according to the NIWA classification (Kilroy et al 2005a), for *D. geminata* vindicates the site selection strategy used for this and the October 2005 survey.

3. Summary and conclusions

1. Since the initial discovery of the invasive alien diatom *Didymosphenia geminata* in the Mararoa and lower Waiau Rivers in October 2004, and a local delimiting survey in December 2004, limited passive surveillance showed no evidence that the alga had spread from these rivers until late September 2005. Passive surveillance refers to reports from the public and local organisations to the Biosecurity New Zealand emergency 0800 number or website, or direct to BNZ or AgriQuality Limited staff, of suspected *D. geminata* growths.

2. Discovery of *D. geminata* in locations beyond its previously known range in September 2005 brought forward a planned second delimiting survey and expanded it to cover high risk sites nationwide.

3. In October 2005, 492 sites nationwide were systematically sampled for *D. geminata*. The sites were chosen on the basis of having a suitable environment for *D. geminata*, and a high level of human activity. In this survey *D. geminata* was found at seven sites on four rivers, of which one site was beyond its previous range. At that site on the Von River, *D. geminata* was present in microscopic quantities.

4. For this survey 119 sites nationwide were systematically sampled for *D. geminata*. The sites were chosen on the same basis as for the October 2005 survey. In this survey *D. geminata* was found at one site on one river, where it had been discovered beyond its previous range a few days before the survey. At the sampling site on the Waitaki River, 40 km downstream of the discovery, *D. geminata* was present in microscopic quantities.

5. In the North Island *D. geminata* was not found at any of the 38 sites that were sampled at locations in the vicinity of popular access points where river conditions were estimated to be suitable for *D. geminata*'s establishment and growth. This indicates a high probability that *D. geminata*, if present at all, was absent from nearly all such North Island sites at the time of sampling.

6. The lower Waitaki River, where *D. geminata* was found a few days before this survey started, is well known as an excellent fishery providing a rewarding fishing experience. The lower Waitaki River has been classified by NIWA as providing ideal conditions (stable substrate, few floods, low nutrient status

and not shaded) for establishment of *D. geminata*. The discovery of *D. geminata* at a popular fishing site on a river providing ideal conditions for *D. geminata* vindicates the site location strategy used for this and the October 2005 survey.

7. The finding of microscopic quantities of *D. geminata* in the Waitaki River more than 40 km downstream of the most downstream known and visible colonies of *D. geminata*, and similar findings in the October 2005 survey, serve to raise confidence that the sampling and detection method used was adequately detecting the presence of *D. geminata*.

4. Acknowledgements

A large team of people has been involved and our thanks to all of them for their hard work. Special thanks go to Fish and Game Council and Regional/District Council staff who volunteered to collect samples. Alison Tipping (AgriQuality Limited) distributed sampling and disinfection kits to the field team. Nelson Boustead is thanked for his conscientious effort for the long hours he spent at the microscope hunting for *D. geminata*. Sampling sites were selected using the invaluable local knowledge of staff of the Department of Conservation, Fish and Game Councils and Regional/District Councils. Helen Hurren of NIWA compiled the maps.

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Appendix 1: Briefing for the survey

Briefing Report: New Zealand delimiting survey brief and sampling procedures for *Didymosphenia geminata*

Briefing report:	Didymo	Report Number:	6
Incident Controller:	Graham Burnip	Technical :	NIWA
Date of report:	20/01/2006		

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1. Purpose

The purpose of this survey is to detect if *D. geminata* is present, in selected South Island and North Island tributaries and rivers to provide short term containment options and longer term response options.

2. Scope

The rivers selected for survey include sites that have 'high use' and/or 'high value'. These include catchments, tributaries and rivers that provide suitable habitat and/or are used for various recreational and commercial activities.

The NIWA Likely Environments model will be overlaid with 'high use/value' sites as determined by information provided by Councils.

3. Introduction

Absence of an algal species in a river can never be *absolutely* established because it is generally only possible to sample a small proportion of the places where the alga might grow. Therefore, to ensure that a negative survey result has a high chance of reflecting the absence of the species from the river, it is necessary to maximize the chance of finding the alga. This can be achieved by: (1) sampling many sites, (2) targeting the sampling at points where the alga is most likely to have been introduced, and (3) sampling the habitats that the alga is most likely to colonise first.

This delimiting survey will cover selected 'high use/value' sites in the North Island, and South Island. The focus will be to detect if *D. geminata* is present, in selected North Island and South Island land catchments, tributaries and rivers where the algae is currently not known to be established.

High use sites will be prioritised including kayaking, fishing and jet boating as high risk activities.

4. Timeline and coverage

One hundred and nineteen sites will be sampled by NIWA, Fish and Game Council, and Regional Council staff. All survey areas will be sampled concurrently with the sampling being complete by 9 February 2006.

Local support and assistance for surveillance will be used.

- A list of site names and GPS locations will be provided for each site to be sampled will be issued at the start of the survey
- Equipment required includes;
  - Waders (North Island only)
  - GPS units (if people have them)
  - Car
  - Mobile phones
  - Camera
  - Disinfection kits

5. Sampling and samples

Refer to Datasheet BioNZ for sampling procedures for *D. geminata* (Appendix 2).

All samples together with sample sheets should be couriered to the following:

National Institute of Water and Atmospheric Research
10 Kyle St, Riccarton
CANTERBURY

6. Mapping

Overlay of NIWA *D. geminate* Likely Environments model and 'high use/value' sites. Data-entry of site localities and results into a GIS overlay.

7. Logistics

Each NIWA (or RC, F&GC or DOC field team will be responsible for their own logistics.

8. Communications

Refer members of the public with suspected findings of *D. geminata* to 0800 80 99 66.
Refer members of the public requesting information on *D. geminata* to please visit:
www.biosecurity.govt.nz/didymo

Confidentiality should be maintained at all times.

9. Site selection

Sites have been based on those of the October 2005 delimiting survey. The sites have been selected by Maurice Duncan of NIWA in consultation with Regional Councils, Fish and Game Councils and some DOC offices.

10. Morning briefing

There will be no briefings apart from this paper.

Appendix 2: **Survey of New Zealand catchments for macroscopic/microscopic presence of *Didymosphenia geminata***

Site number from list:…… **River:……**

Site location description:……

Sampling team ……..

Date: ……. Time: …… ……..……

GPS: E…… **N**……OR. Map ref. ……..……..

River Use Tick., fishing☐, kayaking☐, rafting☐, tramping☐, swimming☐. picnicing☐,camping☐, 4WD☐

Samples: label with river name, site no. (upstream to downstream), sample no., team initials.

NB. Samples from transects with the same habitat may be pooled; extras are optional

Transect	Sample no.	Habitat (run, riffle, pool)	Didymo? (yes/no)	% Didymo cover	Notes (e.g. other algae present)
1	……	……	……	……	……
2	……	……	……	……	……
3	……	……	……	……	……
4	……	……	……	……	……
5	……	……	……	……	……
extra	……	……	……	……	……
extra	……	……	……	……	……

Reach:

Width (tick one box)

< 2 m	☐
2 – 5 m	☐
5 – 10 m	☐
10 – 20 m	☐
20 – 40 m	☐
> 40 m	☐

Bed composition (tick main category, or indicate % cover if mixed)

(see over for size guide)		% cover (if applicable)
Bedrock	☐	……
Boulders	☐	……
Large cobbles	☐	……
Small cobbles	☐	……
Gravel	☐	……
Sand/silt	☐	……

Shade (tick one box)

Mostly shaded	☐
Partly shaded	☐
Mostly open	☐
Unshaded	☐

Water:

Clarity:

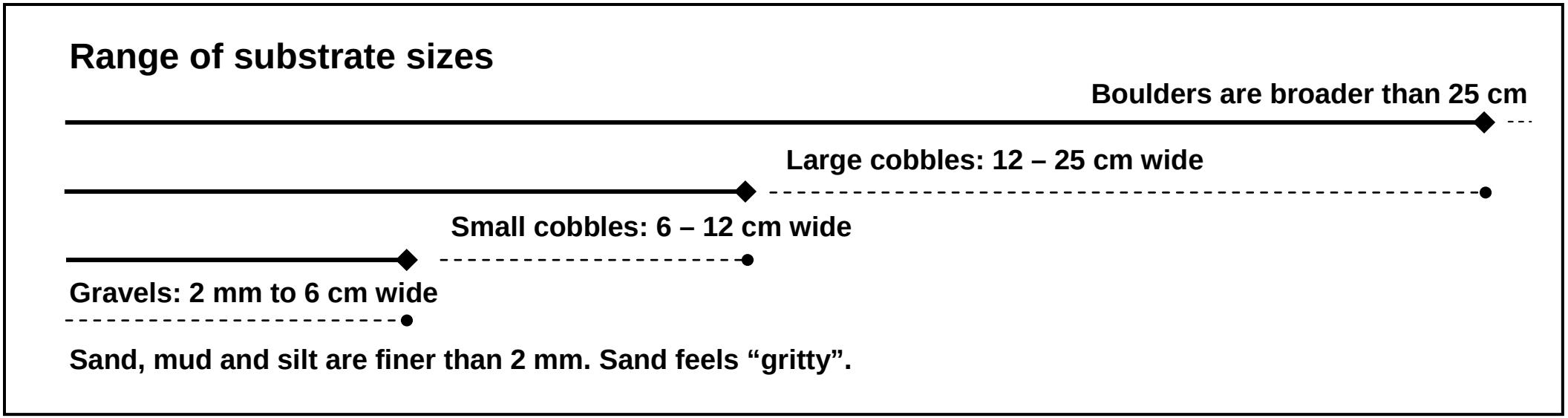
Clear	☐
Slightly turbid	☐
Very turbid	☐

Conductivity: Please take a water sample in a sample container.

…….. µS/cm

If possible, take a photo of the site, looking down river from the upstream end of the surveyed reach

Photo ID: ……



Habitat definitions:

Run: smooth, unbroken flow
Riffle: fast, shallow flow over boulders and cobbles; water surface broken and turbulent.
Pool: areas of deeper slow-flowing water, often on the outside of bends.

Add any other observations (e.g., vegetation, algal cover).

Also note here any samples taken in addition to those listed overleaf.

Survey of New Zealand catchments for macroscopic/microscopic presence of *Didymosphenia geminata* (didymo)

1. Sampling sites

A "site" is any river reach. Reach length is variable, but should encompass areas with stony substrate within reasonably easy reach of the access point. Up to 25 – 50 m length is suggested, depending on river conditions. We assume highest chance of infestation by didymo is at public access points.

In each river, sample from upstream to downstream (to eliminate any chance of transferring didymo, if it is present, upstream in a system).

2. Field procedure

The sampling has two aims:

1. to inspect the site, looking for any algae that resembles didymo, especially young colonies (Figure 1), which are brown/pinkish-brown round bobbles. Collect samples, if found;
2. to collect a representative sample of algae growing at each site. It is important to sample the typical algae from a site – as well anything that looks suspiciously like didymo (Figure 2) – because didymo cells may be mixed with other algae.

For the first aim, look for small round algal colonies, particularly in the habitats listed below, but also check edge areas, and algae growing on/amongst aquatic plants, submerged wood, etc. Take samples of any suspicious-looking growths.

Figure 1: Small didymo colonies

Figure 2: Colonies of a red alga that look a bit like didymo.

For the second aim, as you inspect the site, take samples along transects across the river, following the method described overleaf.

Good habitat for didymo is:

1. Moderate velocity waters (i.e., not in very still waters, not in very fast flowing waters more than ~1 m/s). The species may be present in backwaters of rivers (out of direct flow, but subject to constant water movement) so these also need to be inspected/sampled. Virtually all places where didymo has been sighted in the Mararoa/lower Waiau catchments have been wadeable, though the alga may occur on the margins of faster-flowing, deeper areas. In the early stages of colonization it is likely that didymo will not be in fast-flowing areas (> 1 m/s).
2. Well-lit stream bed (but this does not preclude areas that are in shade for part of the day);
3. Stable substrates: i.e. most likely to occur on substrate of cobble-size or larger (>150 mm diam.), but smaller rocks may be examined in areas of very stable flow

In other words, **look for stable cobbles in open, wadeable areas with moderately flowing water**. Particularly look for rocks with small, tightly adhering light brownish bumps (see photos), but include rocks, plants and other substrates with all types of algae.

3. Equipment:

- Wooden scrapers (disposable ice-cream sticks) (***dispose of after use at one site***)
- A metal knife may also be useful – anything that can be wiped thoroughly clean (***spray and soak for at least one minute and wipe down with bleach after each site, rinse out with river water at the next site***)

- Disposable pipetters for rinsing or sampling from bedrock (***dispose of after use at one site***)
- Bucket – for collecting rocks etc. during visual survey (***spray and soak for at least one minute and wipe down with bleach after each site, rinse out with river water at the next site***)
- Paper towels
- Containers for samples (e.g., 110 ml stackable "Elkays", 100 ml bottles)
- Pens/pencils/markers
- Chilly bins for holding samples
- Data sheets
- Disposable gloves (for use with bleach)
- Rubbish bags for used scrapers, pipetters, towels, gloves, etc.
- 10L bottle of bleach
- A large plastic bin (for soaking waters and equipment in bleach solution)
- GPS unit
- Water containers
- Maps

4. Method

- Complete site information on data sheet (GPS is *very* important, and/or supply an accurate 1:50 000 map reference). Also please write your full names (not just initials). Site location is very important.
- Before starting your inspection of the site, determine the approximate locations of five transects from which you'll collect samples. Space every few metres (depending on reach length) but if the site contains different habitat (runs, riffles, pools – see definitions on sampling form), make sure that the transects include each habitat type, e.g., three transects in runs, two in riffles.
- Depending on river size, transects will extend across to the opposite bank, or to water up to about 0.7 m deep (as long as it is flowing at a safe velocity). **STAY IN SAFE DEPTHS/VELOCITIES AT ALL TIMES.**
- Start inspecting the site at the **upstream** end. At each transect walk across the reach and collect rocks from 5 points, roughly equally spaced.
- Pool the five rocks from the transect into a bucket. These can be pooled with rocks from other transects.
- For each set of pooled stones, scrape a sub-sample of algae from each stone and transfer to a small sampling container. Try to include all types of algae present (distinguishing algae by colour and texture). Also pipette out some of the river water from the bottom of the bucket and add to the sample. If algal growth is very thin, use a metal blade, rather than the wooded scrapers provided.
- **NB. Please sample all rivers and scrape all stones even if there appears to be no algae present. After scraping stones with little or no visible algae wash the**

scraped area of the stone with the pipette filled with water from the bottom of the bucket.

- If during your site inspection you see any suspicious algae colonies in areas other than the transects, also collect samples of these. Check submerged plants and wood, as well as stones.
- **We expect to receive 1 or 2 samples per site. One from the scrapings and one from any suspicious algae colonies in areas other than the transects.**
- Write sample numbers on the containers and datasheet and indicate habitat type against each sample. (There is space on the sheet for one sample per transect, but generally transects will be pooled.)
- Indicate the coverage of suspected didymo against the transects where it was noted; or add a note describing coverage at the whole site. Also note appearance, growth form.
- **Complete extra information for each site (width, substrate type, shade, river use) if it is shown on the site list that it is a new site, i.e., that the site was not sampled in the October 2005 survey. Please always note water clarity.**
- **For new sites, take a water sample in a clean sampling container (label with river name and site no.) from a free flowing part of the river, for conductivity assessment at the lab.**
- Keep all samples cool and in the dark. Keep the datasheets with the samples, for microscope analysis and entry into master list.

5. Inspection and Sampling Hygiene

- Samplers must take precautions to minimise the risk of unintentional transfer of *D. geminata* from affected to non-affected sites.
- Specific hygiene instructions are outlined in bold italics in the text above.
- Use a new set of equipment in each river or tributary.
- Start inspection and sampling at the clean, upstream end of a river or tributary and work downstream.
- Remove all macro material from hands, boots/waders, clothing, equipment, etc, before leaving each sampling and inspection site.
- Spray and soak all potentially contaminated boots/waders and equipment, etc for at least one minute after completing sampling on a single river or tributary, before leaving the last site.
- Samplers should carry sufficient bleach solution made up for a day's sampling, i.e. 10 litres. Disinfection using the bleach solution should be carried out in a place where splashing and/or disposal of the used solution will not cause environmental damage.

- At the end of each sampling day, visually check all potentially contaminated boots/waders, clothing and equipment to ensure they are cleaned, disinfected, dry and ready for the next inspection and sampling cycle.

Important

NEW FOR THE JANUARY 2006 SURVEY

1. **If possible pool all the periphyton scrapings into one sample container.**
2. **MOST IMPORTANT. Please take samples even if the stones appear to be algae free. See the bold section in methods above. In the October survey didymo was found on one such sample.**
3. **Record extra information for each site (width, substrate type, shade, water use) and take a water sample for conductivity ONLY if it is shown on the site list that it is a new site, i.e., that the site was not sampled in the October 2005 survey.**
4. **Always take a GPS reading and note water clarity.**
5. **Please note site location as well as river name, e.g**., River name: Otaki Site location: 50m downstream of State Highway One Bridge

Appendix 3: Selected survey results. Samples positive for *D. geminata* in bold font. Data from October 2005 survey in italics.

Shade

Class	Description
1	Mostly shaded
2	Partly shaded
3	Mostly open
4	Unshaded

Water clarity

Class	Description
1	Clear
2	Slightly turbid
3	Very turbid

NZMG New Zealand Map Grid
Sh=Shade
Cl=clarity
Cond=conductivity

Site No.	River Name	Site location	NZMG_E	NZMG_N	Date sampled	River Use	Habitat	Reach width (m)	BR	BO	Bed LC	Composition SC	G	S/S	Sh	Cl	Cond (mS/cm)
1	Maitai	Hardy St	2534400	5992630	31/01/2006	swim, fish	run	5-10	0	20	50	20	0	0	3	1	130
2	Motueka	Blue Gum Corner	2507241	6011265	31/01/2006	fish, swim, kayak, tramp	ru	>40	0	0	30	65	5	0	4	1	120
4	Riwaka	Rugby Ground SH60	2508739	6015645	31/01/2006	fish	ri	2-5	0	2	50	48	0	0	2	1	180
7	Pelorus	Fishermans Flat	2569697	5991520	01/02/2006	fish,kayak,swim,irrigation	ru, po	10-20	0	0	20	60	10	10	4	1	60
12	Rai	Rai Falls	2559017	5990942	31/01/2006	fish,kayak,swim,irrigation	ru, ri	5-10	0	0	20	50	20	10	3	1	60
21	Whangapeka	Walters Peak	2490947	5985974	31/01/2006	fish ,tramp	ru,ri	5	3	15	70	10	5	0	3	1	120
22	Motueka	Whangapeka	2492600	5985400	31/01/2006	na	ru	10-20	0	0	30	50	10	10	3	1	*90*
26	Waimea	Highway Bridge Appleby	2520903	5988612	01/02/2006	fish,swim,4x4, kayak	ru.ri	5-10	0	0	0	30	40	0	4	1	*na*
35	Owen	1 km upstream of SH6	2464500	5946700	02/02/2006	na	ri, ru	20-40	0	25	50	25	0	0	4	1	*130*
44	Wairau	Kowhai Flat	2519334	5943904	31/01/2006	fish	ru. Ri	10-20	0	0	10	80	10	0	4	1	40
48	Mangles	Tutaui Valley 2k u/s Buller confluence	2459200	5934400	01/02/2006	na	*run*	5-10	25	40	30	5	0	0	*2.5*	1	*70*
54	Matakitaki	1km u/s SH 6	2453446	5933182	01/02/2006	fish	*riffle*	20-40	0	40	30	30	0	0	4	1	*70*
57	Wairau	Below SH1 bridge	2591015	5973368	31/01/2006	fish, swim	ru,ri	20-40	0	0	0	80	20	0	4	1	50
62	Travers	near Lake Head Hut	2495080	5926089	01/02/2006	fish, tramp, hunt	ru,ri	5-10	0	0	40	55	5	0	4	1	*30*
99	Clarence	Above Ackeron	2506493	5867803	01/02/2006	fish	ri,ru	>40	0	0	35	40	20	5	4	1	*30*
104	Acheron	Clarence	2507092	5869899	01/02/2006	fish	ri.,ru	>40	0	0	50	30	15	5	4	1	*40*
110	Wairau	Dip Flat	2503564	5925767	31/01/2006	fish	ri, ru	20-40	0	20	60	20	0	0	4	1	40
134	Pupu	upper	2490485	6039782	03/02/2006	swim, dive	pool	20-40	0	5	5	30	50	10	3	1	na
134	Pupu	lower	2490485	6039782	03/02/2006	swim, dive	pool	20-40	0	5	5	30	50	10	3	1	na
273	Waingongoro	Ohawe Beach	2612583	6179364	03/02/2006	swim, fish	ru, ri, po	5-10	0	20	40	30	10	0	3	2	140

Site No.	River Name	Site location	NZMG_E	NZMG_N	Date sampled	River Use	Habitat	Reach width (m)	BR	BO	Bed LC	Composi SC	tion G	S/S	Sh	Cl	Cond (mS/cm)
281	Maketawa River	at Tarata Rd. d/s of bridge	2618867	6226927	03/02/2006	fish	ri., po	5-10	*0*	*25*	*25*	*25*	*0*	*25*	*2*	*1*	*90*
1066	Mokihinui r	200m d/s bridge	2423811	5963795	27/01/2006	kayak, fish, tramp	po, ri, ru	20-40	0	5	50	25	15	5	4	1	100
1097	Karamea	d/s kelly Creek	2442692	5995131	27/01/2006	kayak, fish, tramp	po, ri, ru	20-41	5	2	20	33	10	30	3	1	70
1119	Dingle	near homestead	2223021	5635128	31/01/2006	fish	ri	5-10	0	20	50	30	0	0	4	1	*50*
1122	Nevis	u/s of crossing	2195373	5551546	09/02/2006		ru,ri	5-10	0	0	5	45	40	10	4	1	*20*
1129	Greenstone	above Hut	2134835	5569809	20/01/2006	fish, tramp	ru, ri, po	20-40	0	20	60	10	10	0	3	1	*30*
1129	Greenstone	near carpark	2142726	5575586	20/01/2006	kayak, fish,tramp	ru,ri	20-40	0	20	60	10	10	0	3	1	*30*
1133	Route Burn	Lake Sylvan footbridge	2139039	5598695	31/01/2006	tramp, fish, kayak	ri, ru	20-40	0	0	25	50	15	10	2	1	*40*
1134	Diamond Creek	between fishtrap and creek	2145219	5592179	31/01/2006	tramp, fish, kayak	ru	10-20	0	0	0	70	20	10	2	1	*80*
1150	Taieri	at Outram	2295682	5480758	26/01/2006	fish , swim, tramp	ru, ri	10-20	0	1	2	2	90	5	2	2	*50*
1158	Pomahaka	ford at Balck Bridge	2241040	5446906	01/02/2006	fish	ru	20-40	0	0	10	50	40	0	3	2	*60*
1169	Maerewhenua	Danseys Pass Motor Camp	2318113	5582042	25/01/2006	fish	ri, ru, po	10-20	20	0	20	40	20	0	3	1	*60*
1172	Hakataramea	1.5 km u/s SH82	2311372	5607180	25/01/2006	fish	ri, ru, po	10-20	0	0	0	20	80	0	3	1	*65*
1189	Mataura	Nokomai Rd Br (3 km frm Nokomai farm	2169570	5507720	01/02/2006	fish	ru	10-20	0	0	10	30	50	10	3	*1*	*40*
1192	Mataura	150m d/s Bridge/gravel pit	2180937	5473434	31/01/2006	fish	ri, ru	10-20	0	0	10	30	50	10	3	1	*40*
1193	Waimea	SH 94, Mandeville	2184599	5460728	31/01/2006	fish	ru	*5-10*	0	0	30	40	30	0	3	1	*170*
1195	Otamita	u/s of bridge SH 94	2186488	5459560	31/01/2006	fish	ru	5-10	0	0	10	50	40	0	2	1	*100*
1196	Mataura	Gore, Surrey Street	2196841	5443711	31/01/2006	fish	ru, ri	20-40	10	0	10	30	40	10	4	1	*40*
1197	Waikaka	River Road, Gore	2197130	5447949	31/01/2006	fish	ru, ri	5-10	20	5	10	35	30	0	3	2	*110*
1202	Mataura	u/s Mataura Island Bridge	2185153	5416060	01/02/2006	*fish*	*run*	*6*	*0*	*0*	*20*	*10*	*50*	*20*	*4*	*2*	*70*
1205	Waikaia	below Waipounamu Bridge	2183222	5475599	31/01/2006	fish	ru	5-10	0	0	0	20	60	20	3	1	*30*
1220	Aparima	Dunrobin. 200m below confluence of Hamilton Burn Stream	2135163	5479776	01/02/2006	fish	ri	5-10	0	0	40	40	20	0	4	1	*40*
1223	Aparima	u/s bridge on Bayswater Rd.	2123714	5441039	01/02/2006	*fishing*	*run*	*5*	*0*	*0*	*0*	*100*	*0*	*0*	*4*	*1*	*80*

Site No.	River Name	Site location	NZMG_E	NZMG_N	Date sampled	River Use	Habitat	Reach width (m)	BR	BO	Bed LC	Composition SC	G	S/S	Sh	Cl	Cond (mS/cm)
1228	Upukerora	Te Anau	2098352	5520201	02/02/2006	*fishing, 4 wd, industrial gravel extraction*	*run*	*4*	*0*	*0*	*0*	*70*	*30*	*0*	*2*	*1*	*80*
1231	Eglinton	Knobs Flat	2116850	5569488	02/02/2006	*kayaking, Fishing, Tramping, some jetboating*	*run*	*na*	*0*	*0*	*0*	*80*	*15*	*5*	*4*	*1*	*50*
1244	Waitahanui	Waitahanui Bridge	2777460	6264031	31/01/2006	kayak, fish, swim	ru	5-10	0	0	0	30	50	20	2	1	*40*
1245	Hinemaraia	Hinemaraia	2772257	6256600	31/01/2006	kayak, fish, swim	ri, ru	10-20	0	0	10	70	10	10	2	1	*30*
1246	Tauranga Taupo	First exit point on river	2761657	6249494	31/01/2006	kayak, fis, tramp	ru, ri	10-20	0	0	0	80	10	10	3	1	*40*
1247	Tongariro	Lonely Pool	2754444	6242474	31/01/2006	raft, fish, swim	ru, ri	>40	0	50	30	10	5	5	2	1	*30*
1249	Tongariro	d/s Poutu Dam	2754029	6226906	31/01/2006	raft, fish, swim, kayak, tramp	Ru, ri	20-40	0	10	80	5	2.5	2.5	3	1	*70*
1254	Manganui-a-te-ao	Ruatiki Rd bridge	2700144	6208154	02/02/2006	na	ru, ri	>40	0	70	10	10	5	5	3	3	70
1260	Waipa	Toa Bridge	2716016	6321839	02/02/2006	swim, fish	ri, ru	5-10	0	0	5	80	10	5	2	1	30
1276	Stony	Mangatete Rd	2587522	6219589	03/02/2006	swim, fish	ri po	na	na	na	na	na	na	na	1	3	*90*
1277	Waiwhakaiho	SH3	2608436	6228763	03/02/2006	fish	*run, riffle*		*0*	*40*	*25*	*20*	*10*	*5*	*4*	*1*	*110*
1288	Rangitikei	Old Springvale suspension bridge	2771096	6186466	30/01/2006	fish	ru, ri	20-40	*0*	*50*	*10*	*0*	*40*	*0*	4	1	*40*
1292	Ngaruroro	Kuripapango	2796652	6195868	01/02/2006	kayak,fish,tramp	ri, ru	5-10	0	0	10	30	50	10	2	1	60
1299	Mohaka	McVicar Road	2823922	6217900	31/01/2006	kayak, fishing, camp	po. ru, ri	20-40	0	0	40	40	10	10	3	1	*60*
1300	Moawhango	Te Moehau Rd Bridge, Moawhango	2755656	6176232	30/01/2006	fish	ri, ru	na	na	na	na	na	na	na	na	na	*130*
1304	Mohaka	Willow Flat	2851910	6237090	01/02/2006	kayak, fishing, camp, tramp	ru, ri	>40	0	30	10	5	20	30	4	2	90
1308	Waipunga	Opoto Falls	2817006	6239001	31/01/2006	fish	ri, ru	5-10	0	40	30	20	5	5	1	1	*60*
1309	Manawatu	Kumeroa, Jacksons Road	2761923	6091388	30/01/2006	fish, swim	ri, ru	5-10	0	0	40	40	15	5	4	2	140
1310	Manawatu	Mangatainoka	2752841	6083204	30/01/2006	fish, swim	ru,ri	5-10	0	0	25	25	20	30	4	1	30
1313	Ruamahanga	Gladstone Rd,10 km d/s Masterton	2731063	6011697	01/02/2006		ri, ru	20-40	0	0	0	100	0	0	3	1	*90*
1315	Waiohine	near road end	2710871	6020641	01/02/2006		ru, ri	20-40	0	0	50	50	0	0	2	1	*50*
1317	Hutt	at Upper Hutt	2679631	6006377	07/02/2006	fish, swim, tube	po, ru, ri	20-40	0	2	25	55	16 +	2	4	1	60

Site No.	River Name	Site location	NZMG_E	NZMG_N	Date sampled	River Use	Habitat	Reach width (m)	BR	BO	Bed LC	Composi SC	tion G	S/S	Sh	Cl	Cond (mS/cm)
1318	Waikanae	d/s SH1 Br.	2683272	6033853	07/02/2006	fish,swim	ru, ri	*10-20*	*0*	*0*	*50*	*50*	*0*	*0*	*4*	*1*	*90*
1319	Otaki	at SH1 Br.	2691055	6046175	07/02/2006	fish, swim	ru, ri	*>40*	*0*	*30*	*50*	*20*	*0*	*0*	*4*	*1*	*50*
1322	Ruakituri	Erepeti	2888499	6263152	01/02/2006	kayak, fish, tramp, camp	ru, ri	>40	0	35	40	10	10	5	4	1	110
1324	Waioeka	River gauge& C/w	2887736	6321798	31/01/2006	kayak, fish	ru, ri	20-40	0	10	20	50	20	0	3	1	*130*
1327	Whirinaki	Whirinaki Rd Br	2837030	6295890	31/01/2006		ru	20-40	0	0	20	20	30	20	4	1	70
1332	Rangitaiki	Rangitaiki	2812086	6275521	31/01/2006	fish, swim	ru	5-10	0	0	20	40	0	40	1	1	70
1335	Tukituki	Waipawa	2820967	6130152	01/02/2006	kayak, fish	ru, ri	10-20	0	0	80	10	5	5	4	1	120
1336	Tutaekuri, Puketapu	Puketapu-Sherenden	2835724	6181149	01/02/2006	kayak, fish	ru, ri	10-21	0	0	30	30	30	10	3	1	250
1337	Whangaehu	Whangaehu valley, Rd bridge	2723200	6186870	30/01/2006	kayak	ru, ri	5-10	*0*	*0*	*10*	*20*	*20*	*50*	3	3	*280*
1341	Whanganui R	Motor camp	2710191	6255498	02/02/2006	fish, swim	ru, ri	20-40	0	5	80	10	2.5	2.5	4	1	70
1344	Grey	Waipuna	2410142	5871747	26/01/2006	kayak, fish, tramp	ru, ri	10-20	2	5	25	50	10	8	3	1	50
1362	Hurunui	500m below SH 1 bridge	2518332	5811919	01/02/2006	fish, boat	ru, ri	>40	0	0	0	70	20	10	4	1	*80*
1364	Hurunui	mandamus	2473586	5823845	01/02/2006	fish, boat	ru, ri	>41	0	100	0	0	0	0	4	1	*60*
1377	Rangitata	just above lagoon in flowing reach	2390712	5668261	01/02/2006	fish, swim		10-20	0	0	20	25	40	15	4	1	90
1385	Twizel	Twizel at SH 8	2279268	5657308	25/01/2005	fish	po, ru, ri	10-20	0	0	0	100	0	0	3	1	*20*
1387	Tekapo	above Haldon Arm	2287713	5648567	26/01/2006	fish	po, ru, ri	20-40	0	0	0	20	80	0	3	1	*50*
1388	Ahuriri	SH 8 bridge	2270461	5633217	25/01/2006	fish	ru, ri	10-20	0	0	0	100	0	0	3	1	*40*
1393	**Waitaki**	**Glenavy**	**2359898**	**5585380**	**25/01/2006**	**fish, boat**	**po, ru, ri**	**>40**	**0**	**0**	**20**	**40**	**40**	**0**	**3**	**1**	***60***
1396	Ashley	Gorge Rd bridge	2447390	5775190	03/02/2006	fish, swim	po, ru, ri	5-10	0	20	40	20	20	0	3	1	100
1427	Manuherikia	Alexandra Motor Camp	2227679	5544775	01/02/2006	kayak, fish, tramp	ru	10-20	0	0	0	10	70	20	3	1	*50*
1437	Hunter	Cascade creek	2228065	5656307	31/01/2006	fish, tramp	ru, ri	20-40	0	20	40	40	0	0	4	1	*50*
1443	Wilkin	Keiran Forks	2194231	5655834	31/01/2006	fish, tramp	ru, ri	5-10	0	0	50	20	30	0	2	1	*70*
1451	Lake Hayes Stream	at water leve gauge, 400m u/s of lake	2179773	5573850	31/01/2006	swim	ru, ri	2-5	0	0	0	10	70	20	1	1	*130*
1456	Rees	at Muddy Creek	2150682	5601704	31/01/2006	kayak, fish, tramp	ri, ru	20-40	0	75	25	0	0	0	4	2	60
1522	Opihi	Grassy Banks	2373363	5659098	01/02/2006	fish, camp	ri, ru	10-20	0	0	0	40	60	0	4	1	80
1538	Rakaia	300m d/s Gorge Br	2401468	5742193	01/02/2006	fish, jet boat	ru	>40	0	0	5	60	30	5	4	2	50
1539	Rakaia	sh1	2432685	5716783	01/02/2006	fish, jet boat,	ru	10-20	0	0	10	50	30	10	4	2	90

Site No.	River Name	Site location	NZMG_E	NZMG_N	Date sampled	River Use	Habitat	Reach width (m)	Bed BR	Bed BO	Bed LC	Composition SC	Composition G	Composition S/S	Sh	Cl	Cond (mS/cm)
1545	Waimakakriri	d/s Gorge bridge	2433240	5760340	03/02/2006	fish, jet boat	ru	>40	*0*	*5*	*15*	*20*	*40*	*20*	1	1	*60*
1546	Waimakariri	50m below jetboat ramp	2481580	5754910	03/02/2006	fish, jet boat, swim	ru	>40	0	0	30	30	30	10	1	1	*60*
1555	Hope	under bridge	2465121	5846479	01/02/2006	fish	ru, ri	>40	0	0	0	40	30	30	1	1	*70*
1558	Waiau	d/s Leslie Hills Br	2493835	5835294	01/02/2006	fish	ru, ri	20-40	0	0	10	70	20	0	4	1	*70*
1560	Tekapo Canal	2 km u/s of stillingbasin	2288920	5675066	26/01/2006	fish	ru	20-40	0	0	0	30	70	0	4	1	*50*
1567	Ngarururo	u/s Chesterhope bridge	2840620	6171740	01/02/2006		ru,ri	20-40	0	0	25	25	25	25	3	1	120
1568	Rangitaikei	Rimu Road	2832490	6294850	31/01/2006	na	na	na	na	na	na	na	na	na	na	na	na
1569	Rangitikei	Mangaweka	2750381	6151246	30/01/2006	kayak, raft, fish, swim	ru,ri	>40	10	10	30	30	15	5	4	1	70
1570	Manawatu	Teachers College	2732707	6089240	30/01/2006	swim	ru	10-20	0	0	2	8	50	40	4	3	120
1571	Whakatane	Grace Rd	2859973	6340595	31/01/2006	fish, swim, kayak, tramp	ru	20-40	0	0	0	10	60	30	3	2	80
1572	Motu	Haupotu	2917657	6360611	31/01/2006	fish, j-boat, tramp,raft	ru	20-40	0		5	20	50	25	4	2	90
1573	Gowan	1 km u/s Buller confluence	2473430	5943000	01/02/2006	na	ri,ru	>40	0	70	20	5	0	0	3	1	30
1574	Maruia	d/s falls	2444670	5934570	01/02/2006	fish	ri, ru	20-40	0	50	40	8	2	0	4	1	60
1575	Grey	Dobson	2365160	5860037	26/01/2006	kayak, fish, raft	ri, ru	>40	0	5	30	50	15	0	3	1	50
1576	Otukaikino Creek	d/s Dickies Rd Br	2480470	5752410	03/02/2006	fish	ru	10-20	0	0	0	10	10	20	3	1	na
1577	Kakanui	Mill Dam	2340284	5559287	25/01/2006	fish	po.ru, ri	10-20	0	0	0	10	90	0	2	1	na
1578	Ohau	D/s Ruataniwha	2281934	5651876	26/01/2005	fish	ru, ri	5-10	0	0	100	0	0	0	3	1	70
1579	Inangahua	Landing	2418611	5921403	26/01/2006	fish, kayak	ri,ru	>40	0	15	60	20	5	0	3	1	50
1580	Kawarau	ChardsRd	2184453	5569728	01/02/2006	boat, fish	ru	>40	0	10	20	50	10	10	3	1	60
1581	Lindis	Ardgour	2228786	5589302	31/01/2006	fish, camp	ru, ri	<2	0	0	70	30	0	0	4	1	100
1582	Cardrona	Mt Barker	2202763	5599188	31/01/2006	fish	ru, ri	10-20	0	0	0	40	60	0	2	1	100
1583	Taieri	Waipiata	2286310	5552960	26/01/2006	fish, picnic, swim	ru	5-10	0	0	1	4	90	5	2	2	na
1584	Frazer River	Marshall Rd	2223987	5544926	01/02/2006	fish, swim	ru, ri	5-10	0	0	0	15	75	10	2	1	70
1585	Makarora	d/s Wilkin confl	2205616	5652285	31/01/2006	fish, tramp	ru	10-20	0	0	40	40	20	0	4	1	70
1586	Takaka River	Kotinga Bridge	2493940	6037340	31/01/2006	fish, camp, swim	ru, ri	20-40	0	0	50	50	0	0	4	1	60
1587	Aorere	Lecomte	2479606	6059765	03/02/2006	na	ru, ri	20-40	0	45	30	20	5	0	4	1	50
X14	Mararoa	North Mavora Lake	2129400	5547400	06/02/2006	na	na	na	na	na	na	na	na	na	na	na	*30*