

August 18-19, 2007

International Workshop on *Didymosphenia geminata*



Montréal

August 18-19, 2007

To be held at the
Palais des congrès de Montréal
Montréal Convention Centre

in association with the
**30th Congress of the International
Society of Theoretical and Applied
Limnology (SIL 2007)**

Didymosphenia geminata (*didymo*) is a freshwater benthic diatom (a type of alga) most often found in flowing waters. *Didymosphenia geminata* is expanding its range and is forming nuisance growths in streams and rivers of North America and worldwide. The objective of the meeting is to bring scientists, managers, and policy makers together to address the issues pertaining to nuisance growths. The workshop will consist of invited presentations and group discussions directed at addressing scientific issues and management concerns.

The workshop will feature:

- An international group of invited scientists that will present the results of recent research
- Specialists will examine the patterns and history of *Didymosphenia* incursions and blooms from diverse geographic regions for their similarities and differences
- Discussions are planned to advance our understanding of factors controlling the distribution and abundance of *Didymosphenia*
- Recent advances in genomics techniques as applied to *Didymosphenia* detection and spread will be presented
- Results on the ecological role of *Didymosphenia* in streams and its relationship to fisheries will be discussed.
- We expect to resolve recommendations for local and international action based on the participation of attendees at the workshop.

For information or registration (free of charge),
contact us at sil2007@JPdL.com

Workshop



Workshop Agenda
August 18, 2007
Morning Session

- 8:00-8:15 Max Bothwell, Environment Canada
Welcome
- 8:15-8:30 Sarah Spaulding, USGS/US EPA
Basic diatom biology and ecology
- 8:30-9:00 Marc Simoneau & Isabelle Simard, MDDEP
Status of didymo in Québec
- 09:00-09:15 Questions & Discussion

State of the Science, Part I - genomics/cell biology/autecology

- 09:15-9:45 Craig Cary, Univ. Waikato/Univ. Delaware
Didymo genomics, use in detection and phylogeographic studies
- 9:45-10:00 Questions & Discussion
- 10:00-10:15 Break
- 10:15-11:15 Brian Whitton, UK
Didymo in the British Isles/Europe, hypothesis for bloom formation
- 11:15-12:15 Cathy Kilroy, NZ-NIWA
Didymo in New Zealand, results of recent studies
- 12:15-12:30 Questions & Discussion
- 12:30-1:30 Buffet lunch for registered workshop participants

Afternoon Session

1:30-2:00 Mike Gretz, Michigan Technological Univ.
Chemistry and structure of didymo stalks

State of the Science, Part II Habitat characteristics of didymo

2:00-2:30 Andrea Kirkwood, Univ. Calgary
Factors controlling didymo biomass in Canadian Rocky Mountain Rivers

2:30-3:00 Andrew Rost, Univ. Nevada
Studies on didymo in Sierra Nevada streams

3:00-3:15 Questions & Discussion

3:15-3:30 Break

3:30-4:00 Sarah Spaulding, USGS/US EPA
Didymo in the continental United States and worldwide

4:00-4:30 Michelle Bowman, Utah State Univ.
Didymo response to low-level nutrient enrichment

4:30-4:45 Questions & Discussion

Dinner (Workshop participants make their own arrangements)

Workshop Agenda
August 19, 2007, Morning Session
State of Science, Part II - Impacts on Fish Ecology and Fisheries

- 8:00-8:30 Eli-Anne Lindstrøm, Norway
History of didymo in Norwegian rivers and Atlantic salmon
- 8:30-9:00 Ingi Rúnar Jónsson, Iceland
History of didymo in Icelandic rivers and Atlantic salmon
- 9:00-9:15 Questions & Discussion
- 9:15-9:45 Aaron Larson, South Dakota, USA
Didymo impacts on Rapid Creek, SD and brown trout
- 9:45-10:15 Max Bothwell, Environment Canada
Didymo impacts on steelhead trout and Pacific salmon
- 10:15-10:30 Questions & Discussion
- 10:30-10:45 Break

Management approaches to didymo

- 10:45-11:15 Christina Vieglais, Biosecurity New Zealand
The New Zealand experience with didymo
- 11:15-11:45 Panel Discussion of management options
Max Bothwell (moderator), Christina Vieglais (NZ), Sarah Spaulding (USA), Yves de Lafontaine (Can), Marc Simoneau (Quebec) and Fred Whoriskey (AFS)
- 11:45-1:15 Lunch (participants on their own)

Afternoon Session
Collaborative research efforts on didymo

- 1:15-1:45 Canadian research efforts on didymo
Joseph Culp & Yves de Lafontaine, co-leads
- 1:45-2:15 International collaborative studies on genetic and morphological relationships of didymo populations
Craig Cary & Sarah Spaulding, co-leads
- 2:15-2:30 Wrap up and comments.

***Didymosphenia geminata* Workshop**

**Abstracts for Presentations
on August 18, 2007**

Didymo situation in the province of Quebec

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The first *Didymosphenia geminata* (didymo) bloom to occur in Quebec was reported in the summer of 2006 in the Matapédia River, a major Atlantic salmon fishing river in the Lower St. Lawrence region. In November 2006, didymo cells were detected in six other rivers (Matane, Sainte-Anne, Nouvelle, Grande Cascapédia, Petite Cascapédia and Bonaventure) in the Lower St. Lawrence and Gaspé regions. This year, didymo blooms were reported again in the Matapédia River, but they appear to be less important than last year. Water levels are high in the river this summer and we believe that this may help limit the severity of the blooms. Sampling will be conducted this fall in the six rivers in which cells were detected to verify if the situation has changed.

As reported in the scientific literature, didymo is not harmful to human health. However, large mats of didymo on a river bed can impact the river's aesthetic quality, modify stream flow and change the community composition of aquatic organisms. To date, no report has been made on adverse effects of didymo blooms on salmonid fish populations of the Northern Hemisphere.

As a result of this new environmental issue in Quebec, an action plan was developed by the ministère du Développement Durable, de l'Environnement et des Parcs, and the ministère des Ressources Naturelles et de la Faune in close cooperation with regional stakeholders, particularly watershed and salmon river management organizations. The plan covers the aspects of user/stakeholder awareness, prevention and acquisition of knowledge.

Different documents were produced to inform and increase public awareness to the importance of adopting measures for limiting the spread of didymo to other Québec rivers. These documents are available in French and English on the ministère du Développement Durable, de l'Environnement et des Parcs web site using the following link: http://www.mddep.gouv.qc.ca/eau/eco_aqua/didymo/didymo.pdf. They are based on the CHECK, CLEAN, DRY campaign of Biosecurity New Zealand. The principal message carried out is that any river users should consider that the river they just visited contains didymo cells and the next one they will visit does not. So in order to stop the spread of didymo, and prevent the introduction of other aquatic invasive species, everyone should check any piece of equipment that came into contact with water. Users should remove clumps of algae, clean the equipment with recommended solutions, let it dry completely to the touch, inside and outside, then wait at least another 48 hours before using it again in another river.

Extreme low-level genetic detection of didymo: a new surveillance tool

Cary, S. C., B. J. Hicks, C.M.E. Barnett, C.E.C.
Gemmill, A. Rueckert, and K.J. Coyne.

Ongoing surveillance efforts to monitor the incursion and distribution of didymo in New Zealand is a key component of MAF Biosecurity New Zealand's response efforts. Our objective was to develop a sensitive molecular-based detection method for didymo that can be used as the basis of an early detection strategy before new infestations are visible. Early detection offers the best chance of eradication of new incursions of the organism preventing further spread. Developments in molecular technology now allow rapid and specific low-level detection and enumeration of algal species. These techniques involve targeted gene amplification technologies that provide greater sensitivity and specificity of detection and enumeration of algal species with higher throughput when compared to classical microscopy. Molecular methods are thus ideally suited for routine surveillance efforts where concentrations are thought to be low. We will present a newly developed, highly sensitive (<1cell/ml) quantitative real-time PCR protocol designed specifically for high-throughput detection and enumeration of didymo. This fully validated and highly controlled method can now reliably detect didymo from a complex environmental community with a high degree of specificity, and is amenable to a high-throughput processing pipeline. This protocol has been developed along with optimised field collection and preservation procedures to maintain the assured negative predictive value of the method. Data recently collected from New Zealand and other global sites demonstrating the efficacy of the method will be presented. In addition, we will also present results from our preliminary phylogeographic study to understand the global origin(s) of didymo in New Zealand.

Didymosphenia in Europe: distribution, ecology, physiology and environmental change

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The distribution and occasional mass growths of *D. geminata* in Europe are described, including direct observations from the UK, Ireland, Poland and Slovakia. UK records start in the mid-19th century and it is unclear to what extent increases have occurred in recent years. A detailed study of water chemistry and *Didymosphenia* ecophysiology in an upland Yorkshire stream suggests that high N : P and high organic to inorganic phosphate ratios in the water are key environmental factors favouring the alga and this is backed by observations at other sites. The lack of reliable data on aqueous organic P is a hindrance to interpreting the wider literature and means that general surveys on diatoms in rivers of several European countries are of little help to understanding the ecology of *Didymosphenia*.

A comparison is made with the ecology of other algae which important at sites sharing features of the *Didymosphenia* environment, including *D. tatrensis* in Poland (joint data with B. Kawecka). An assessment is made of other factors which tend to favour *D. geminata*, though perhaps not always essential. This is followed by observations and speculation about cell and stalk growth through the season, the maintenance of populations at a particular site, competition with non-stalked diatoms and factors likely to influence grazing pressure. The evidence is brought together to suggest approaches towards reducing nuisance growths.

Broader topics relating to the study to be discussed include the possible contributions of atmospheric N deposition, climatic warming and catchment disturbance to enhanced organic phosphate in streams and rivers and hence enhanced *Didymosphenia*. Finally, observations are reported which indicate the need for caution in assuming *D. geminata* is an invader in any particular country rather than a rare organism which has sometimes increased dramatically due to rapid environmental changes and possibly also genetic adaptations to these changes.

Didymosphenia geminata in New Zealand

Cathy Kilroy

The benthic diatom *Didymosphenia geminata* (didymo) was unknown in New Zealand until October 2004, when proliferations were discovered in a single river system in the South Island. The find caused immediate concern because of the organism's recent history of prolific blooms in other parts of the world. The alien status of *D. geminata* in New Zealand, and the potential for serious environmental effects on indigenous ecosystems, prompted a rapid biosecurity response from central government. This included initiation of a research programme aimed at understanding didymo's distribution and ecological impacts, and investigating potential control measures. Despite efforts to contain it, the species has now spread to 17 catchments, but has not yet been detected in the North Island. Its spread has been documented with delimiting surveys, which suggest that inter-catchment transfer is mainly due to human activities. Laboratory experiments have indicated that didymo cells can survive for long periods outside the river environment. Therefore, without decontamination measures, the risk of transfer is high. Didymo appears to thrive in a wide range of hydraulic conditions, but floods are a primary environmental controlling factor. Models developed using data from affected South Island rivers have identified that blooms are favoured by: stable flows (especially lake-fed rivers); hard, stable substrates; and "continental" climates. Didymo growth is largely absent in groundwater-fed systems but the reasons for this are unclear. Like other algal proliferations, didymo blooms are associated with increases in invertebrate densities, particularly of non-EPT taxa such as chironomid larvae and oligochaetes. Didymo continues to bloom prolifically in several South Island rivers, and its adverse aesthetic effects are obvious. However, there are still large gaps in our knowledge about its ecological effects, particularly on native algae and fish.

The stalks of didymo

Michael R. Gretz, Biotechnology Research Center and Department of Biological Sciences, Michigan Technological University, Houghton, MI 49931

Production of prodigious amounts of stalk material differentiates *Didymosphenia geminata* (didymo) from other benthic diatoms and is a very important aspect of its biology which contributes to nuisance blooms. If didymo was just another benthic diatom producing a uniform 1- 5 mm thick brown scum/slime on rocks, it would most likely not be the subject of discussion. Attempts at control or mitigation of didymo should include limiting stalk proliferation or eliminating stalk mass.

When didymo cells divide, the stalk bifurcates, the end result of which is an overall branched structure with stalks intercalating and coalescing to form an aggregate “woven fabric” mat that contains algae, macroinvertebrates, detritus and other stream debris. *D. geminata* stalks are composed primarily of sulfated polysaccharides with significant uronic acid content, and protein. Monosaccharide analysis has revealed predominately galactosyl and xylosyl residues and linkage analysis has showed predominately 3,4-Gal and 4-Xyl. The polysaccharide portion of the stalk therefore appears to be primarily sulfated xylogalactan, which has been reported for stalks of related diatoms *Gomphonema* and *Cymbella*, where it was shown to be intrinsically hydrophilic and linked by ionic cross-bridging.

Partial degradation of stalks with several chemical and enzymatic agents revealed that stalks consisted of concentric layers of material with differing chemical composition. The hydrated xyloglucan component of the stalk was surrounded by an outer striated layer which was resistant to degradation. All tested mechanical methods to degrade stalk mats were ineffective on hydrated mats although dry mats could be chopped. Chemical agents that degraded stalks included concentrated HCl and HNO₃, NaOCl and the chelator EDTA. EDTA and NaOCl were effective over long exposure periods. Treatment with acids required high concentrations and elevated temperatures to achieve significant stalk degradation, limiting effectiveness in natural environments. Enzymatic degradation of stalks was most effective and crude enzyme extracts from the fungi *Penicillium funiculosum*, and *Aspergillus niger*, as well as the enzyme based dietary supplement *Omega-zyme* showed significant degradation potential.

The success of enzymatic degradation of stalk masses has application in future mitigation and biocontrol initiatives. We are currently in the process of identifying specific inhibitors of stalk synthesis.

Didymosphenia geminata distribution and bloom formation along the south-eastern slopes of the Canadian Rockies

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The earliest anecdotal reports of *D. geminata* outbreaks along the eastern slopes of the Canadian Rockies occurred in the late 1990s, in both Banff and Jasper National Parks. Our research group began the documentation of *D. geminata* distribution in 2006, by assessing preserved periphyton samples collected from two main-stem headwater rivers (Bow and Red Deer) in 2004-2005. This project was expanded to include dozens of rivers and sampling sites from the South Saskatchewan River basin in the summer of 2006, whereby a comprehensive database was produced detailing *D. geminata* spatial and temporal distribution, and environmental tolerance range. Since much is still being learned about the ecology of *D. geminata*, and etiology of blooms, I will use this workshop venue as an opportunity to present field observations in more detail. In addition, I will discuss the interpretations of our findings, and offer working hypotheses as to why *D. geminata* is ubiquitous in the Canadian Rockies, yet only blooms at certain sites.

Environmental controls and potential food web impacts of *Didymosphenia geminata*, a comparative ecosystem study

Andy Rost, University of Nevada, Reno, Desert Research Institute

Chris Fritsen, Desert Research Institute

Jeramie Memmott, Desert Research Institute

Clint Davis, University of Nevada, Reno, Desert Research Institute

Eric Wirthlin, University of Nevada

Similar stream reaches, (one with and one without *Didymosphenia geminata*) in the eastern Sierra Mountains of California were monitored in 2005 and 2006 to better determine the environmental controls and potential food web impacts of a stalked diatom bloom containing didymo. Data shows creeks are similar in geography, aspect, slope, wetted width, substrate, canopy cover, and nutrients (nitrite, nitrate and phosphate). The creeks differ in that the creek with didymo has reduced disturbance regime, EPT taxa, seasonal variation in the BMI and algal community composition and elevated ion chemistry (calcium, sulfate and silicate) and water temperature (2-3 C higher). Preliminary stable isotope data shows disparate carbon signatures between periphyton, grazers and predators in the didymo creek while carbon signatures in the non-didymo creek are similar between multiple trophic levels. From this comparative ecosystem study, a series of in-situ, mesocosm and in lab autoecological studies will begin in the spring of 2007 to further our understanding of the ecosystem controls and consequences of stalked diatom blooms dominated by didymo.

History and environment in diatom biogeography

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The geographic distribution of freshwater diatoms is the result of both history and environmental factors. The question concerning a given taxon is, “Where do history and environment intersect in controlling the distribution of that taxon?”

How are we to discern the processes that led to modern patterns, and how does the role of history and environment change for different taxa? In this presentation, I will examine modern distributions of diatom species and lineages. Not surprisingly, sampling methods have a strong impact on perceptions of biodiversity and lead to disparate conclusions about biogeography. Diatoms in permanently ice-covered Antarctic lakes, ancient tectonic basins, fens of Iowa, and streams of western North America all illustrate varying roles of history and environmental processes. On the Antarctic continent, geographic isolation leads to speciation and a high proportion of endemic taxa. On the other hand, non-isolated sub-Antarctic regions also have high numbers of endemic taxa. In another example, the ancient tectonic basin of Lake Ohrid in Macedonia contains a number of closely related species. Such endemic species flocks are well known features of ancient lakes, yet ancient river drainages contain also endemic lineages. Geologically old erosional surfaces have received less attention than geologically old lakes, but contain similar species flocks. Finally, we have not recognized the degree to which freshwater diatom species are spread by human activities. In particular, the diatom *Didymosphenia geminata* is successful, in part, due to human dispersal. Distributions of freshwater diatoms are rapidly changing due to alteration of aquatic environments as well as by direct human transport of organisms.

Formation of didymo masses in response to low-level eutrophication of oligotrophic mountain rivers in Canada

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The diatom *Didymosphenia geminata* Schmidt or ‘didymo’ is endemic to cold and oligotrophic waters of northern North America, Europe, and Asia. In the past few years didymo has increasingly been found to form thick and extensive masses both inside and outside this geographic range. These persistent nuisance blooms have occurred for over 150 years in the United Kingdom but have only recently been documented below reservoirs in North America and Poland, and throughout New Zealand. Recent formations of didymo masses in rivers of the Canadian Rockies were associated with low-level eutrophication during low and stable flows. The didymo masses were coupled with increased relative abundances of chironomids in benthic invertebrate communities. A compilation of the chemical and physical habitat characteristics where masses form and their biological and hydrologic effects are needed to predict and manage the global spread of didymo.

***Didymosphenia geminata* Workshop**

**Abstracts for Presentations
on August 19, 2007**

History of Didymo in Norwegian rivers and Atlantic salmon

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The first published records of *Didymosphenia geminata* in Norway are almost 150 years old. These early findings (including Sweden) indicate wide distribution of the species in Scandinavia at that time. It has also been found in postglacial diatom deposits. Today *Didymosphenia* is common in unpolluted rivers and lakes. Profuse developments have been observed regularly during the last century. *Didymosphenia* has well defined preferences towards water quality. It requires fairly nutrient rich water and the Ca content must be above 2 mg/l. Some typical localities for the species are rivers well known for its fine stock and good catch of Atlantic salmon. The largest catch of Atlantic salmon in Norway is frequently reported from the River Tana in North-Norway, close to 100 metric tons per year. *Didymosphenia* was first recorded in this river in 1868. It is still an important component of the algal vegetation. It can develop high biomass and cover whole reaches of the River Tana. The catch of Atlantic salmon is however very good and few complaints about fouling of fishing equipment are reported. Similar observations have been done in other rivers well known for its fine stock of Atlantic salmon. In 2006 Norway accounted for 46 % of the total catch of Atlantic salmon reported by the countries located around the Atlantic Ocean.

History of *Didymo* in Icelandic rivers and Atlantic salmon

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Iceland is a geology diverse island in the North Atlantic Ocean. The flora and fauna of the freshwaters are sparse and only five freshwater fish species exists; Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*), arctic charr (*Salvelinus alpinus*), threespine stickleback (*Gasterosteus aculeatus*) and eel (*Anguilla anguilla*). Salmon and trout fishery has been of high value in Iceland since the first settlement. The diatom *Didymosphenia geminata* was first reported in Icelandic rivers in the West of Iceland in 1994. The diatom showed a rapid colonization within several river systems and became a nuisance in many of them. According to local farmers, the diatom was first noticed two years earlier and its abundance increased rapidly in subsequent years. In a survey carried out in 1997, it appeared that the diatom was in the stage of expanding its distribution in the country. Now *D. geminata* is found in most parts of the country. The nuisance appearance seems to have decreased in some of the rivers where it was first encountered. No records are available of earlier presence of the species in Iceland. Within river systems, the diatom usually colonizes first the lower reaches and then it spreads upstream. The influence of the algae on the river flora, invertebrates and fish has not been studied in details, but no obvious negative influence on fish stocks has been identified.

Relationships between nuisance blooms of *Didymosphenia geminata* and measures of aquatic community composition in Rapid Creek, South Dakota

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Nuisance blooms of *D. geminata* are increasingly reported by the public and media. However, little is known about its environmental preferences or ecological impacts. Nuisance blooms have been observed in Rapid Creek throughout approximately 20 stream miles between two reservoirs, Pactola Reservoir and Canyon Lake, since June 2002.

Historically, Rapid Creek was considered one of the most productive trout fisheries in the western United States, averaging approximately 25 g/m² in Rapid City, South Dakota. More recently, the brown trout population has experienced significant declines in adult fish with an abundance of young-of-year and age-1 brown trout. This distinct “bottlenecking” of the brown trout population has coincided with the appearance of *D. geminata*.

A nutrient enrichment project was initiated in May 2007 in Rapid Creek near the outlet of Pactola Reservoir in order to stimulate productivity and, ultimately, the growth and survival of the abundant juvenile fish. Water quality and biological monitoring will be conducted through the duration of the enrichment project, which is scheduled to end in September 2009. Preliminary results of this monitoring effort will be presented.

Prior to the enrichment project, a stream assessment was conducted to examine the relationships between *D. geminata* blooms and other benthic (stream bottom-dwelling) organisms in Rapid Creek. Biological and water quality samples were collected from May through October of 2005 and 2006 at five monitoring sites. Several benthic macroinvertebrate and algal metrics were correlated with visual estimates of *D. geminata* areal coverage of the stream bottom, suggesting that impacts to biological communities are directly related to the spatial extent of nuisance blooms. Results of this assessment indicate that nuisance blooms of *D. geminata* have likely altered the taxonomic composition of benthic macroinvertebrate and algal communities in Rapid Creek. Consequently, higher trophic level organisms, such as brown trout, may be affected by shifts in benthic taxonomic composition through food web interactions.

Do Blooms of *Didymosphenia geminata* affect runs of anadromous salmonids in rivers on Vancouver Island?

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Starting in 1989 heavy blooms of *Didymosphenia geminata* (didymo) began appearing in many rivers on Vancouver Island that support anadromous salmonids (steelhead trout, chum and coho salmon). Between 1989-1994 didymo biomass in many of these rivers was nearly an order of magnitude greater than levels considered to be a nuisance in lotic systems. An analysis of the numbers of spawners, the recruit to spawner ratio and the recruit to spawner ratio adjusted for the number of spawners, reveals inconsistent patterns in the response of different species of salmon to didymo infestation among rivers. A comparison of steelhead trout escapements in adjacent didymo infected (Heber River) and a non-infected river (upper Gold River) suggests that didymo might actually stimulate steelhead productivity.

Management approaches to didymo: the New Zealand experience

Christina MC Vieglais, MAF Biosecurity New Zealand, Wellington, New Zealand

In New Zealand, the legal basis for excluding, eradicating and effectively managing pests and unwanted organisms is provided under the Biosecurity Act 1993, administered by the Ministry of Agriculture and Forestry (MAF). Responses to risk organisms are led or coordinated by MAF Biosecurity New Zealand where the impacts pose nationally significant threats to New Zealand's people, environment or economy and/or where there is a need for rapid response to mitigate impacts. Responses aim to achieve the best overall outcome for New Zealand by minimizing the impacts of both the risk organism and the response itself. A portfolio approach is taken to response management, and responses are delivered in accordance with available resources and overall biosecurity priorities. Other government agencies, regional councils and pest management agencies can also use powers under the Biosecurity Act to manage risk organisms of importance to their constituents.

When the non-indigenous alga *Didymosphenia geminata* (didymo) was first discovered in New Zealand in October 2004, its invasive characteristics in the affected river system along with anecdotal evidence from overseas led to an assessment that the organism was likely to have considerable impacts on New Zealand's freshwater environment by affecting recreational, biodiversity, cultural and economic values. The focus of MAF Biosecurity New Zealand's response was determined by the practicalities of managing a freshwater incursion of an organism that is not always visible to users and by the general lack of information on impacts and response options globally.

An extensive MAF-sponsored science program has reduced uncertainties underlying response decision-making, as well as provided operational tools to manage the risks of the organism. The development of the 'Check Clean Dry' method for decontaminating gear used in affected waterways along with the strong social marketing campaign to encourage freshwater users to change their behaviour is likely to have slowed the spread of didymo around New Zealand. Didymo is currently found in 14 major river and lake systems within the South Island, but has not been detected in the North Island.

An economic impact assessment estimated the expected total present value impacts of didymo, in the absence of government intervention, to be \$158 million over the eight years post discovery. It is estimated that even a two year delay to the arrival of didymo in the North Island would reduce the economic impacts by between \$5 million and \$62 million over the extended period of 10 years. There is currently no established method to eradicate or suppress didymo within affected waterways. Work undertaken to date and the program for on-going management is therefore aimed at reducing the risk of didymo being introduced to the North Island as well as slowing its spread around the South Island.

MAF has developed a program with partners, including the Department of Conservation, local government, Fish and Game New Zealand, specific Maori entities and industry, that sets out future management arrangements and activities for didymo. A partnership approach to managing didymo, where everyone is taking responsibility and working collaboratively, should also reduce the spread of new and other existing aquatic pests.

29 June 2007

Didymosphenia geminata Sample Request

Background: The expanding global nature of *Didymosphenia geminata* (didymo) has prompted a genetic survey of the invasive alga's current distribution around the world. The purpose of this work is to elucidate a genetic marker that can be used to compare global populations in an effort to establish the likely origin of the New Zealand strain(s). In addition, the survey will provide vital clues about the spread and genetic variation of didymo throughout the world and possibly assist in the identification of biocontrol agents from native populations.

Professor Craig Cary, University of Waikato, is the lead investigator for the didymo genetic detection study being conducted in New Zealand, funded through Biosecurity New Zealand (<http://www.biosecurity.govt.nz/pest-and-disease-response/pests-and-diseases-watchlist/didymosphenia-geminata/science-technical#detec>). In an effort to conduct a global population genetic study of didymo, we are asking everyone, including attendees of the 30th Congress of the International Society of Theoretical and Applied Limnology (12 – 18 Aug 2007) and the International Workshop on *Didymosphenia* (18 - 19 Aug 2007) being held in Montreal, Canada to donate ethanol-fixed *D. geminata* samples to Prof. Cary. We intend to provide all those interested with the results of these analyses. We are especially interested in acquiring samples from the broadest distribution possible, including but not limited to samples from Canada, United States, Greenland, Iceland, Ireland, Scotland, England, Norway, Sweden, Finland, Estonia, Latvia, Lithuania, Russia, Belarus, Poland, Ukraine, Czech Republic, Slovakia, Austria, Switzerland, Hungary, Slovenia, Croatia, Serbia, Montenegro, Romania, Turkey, Kazakhstan, Afghanistan, India, Nepal, Bhutan, Myanmar, China, Mongolia, and North Korea.

Sampling Protocol: By placing *Didymosphenia* in ethanol, the organism is no longer viable and therefore will not pose a biosecurity threat during transport and importation. Please collect a clean (outer pigmented area of colonies) sample (1-2 gm wet weight) and immerse in 10 v/v of 70% ethanol for at least six hours. Excess ethanol can be decanted prior to transport, but leave at least the minimum volume required to fully immerse the sample. If ethanol is not available, any high grade clear alcoholic beverage (ie. vodka) will suffice. Room temperature storage is fine. Please use clean (sterile if possible), tightly sealed, screw-capped vials made from an alcohol-resistant plastic (polypropylene). Clearly label both the tubes and lids and provide accompanying documentation noting that the samples are *Didymosphenia geminata* stored in ethanol (or vodka). Note the sample location (name of river, GPS coordinates or approximate latitude-longitude, closest mapped town, country), site description, date collected, and contact details of person responsible for the collection. Tape the lids with parafilm or electrical tape. Wrap an absorbant paper towel around the tubes and transport in a plastic bag. If travelling by air, be prepared to stow the samples in your checked baggage. Whether you are accompanying the samples to Montreal or sending them directly to New Zealand, please follow the above protocol and include a copy of this letter.

We thank you for your contribution to this effort.



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Airmail or Courier samples to:

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(Airmail) Private Bag 3150
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Phone: +64-07-838-4593
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BIOSECURITY NEW ZEALAND

Ministry of Agriculture and Forestry
Te Manatu Ahuwhenua, Ngaherehere

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GRIL - Didymosphenia geminata Workshop - Participants List

30th Congress of the International Association of Theoretical and Applied Limnology

30ème Congrès de l'Association internationale de limnologie théorique et appliquée

12-18 août 2007 - Palais des Congrès de Montréal, Canada

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TOTAUX : 54 registrations