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## **Canadian Science Advisory Secretariat (CSAS)**

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**National Capital Region**

### **Proceedings of the National Advisory Meeting to Provide Science Advice on “Clean, Drain, Dry and Decontaminate” Treatments and Protocols to Prevent the Introduction and Spread of Aquatic Invasive Species**

**March 30 to April 1, 2021  
Virtual Meeting**

**Chairpersons: Gilles Olivier and Sophie Foster**

**Editor: Alex Tuen, Andréa M. Weise, Nathalie Simard, and Jaclyn M. Hill**

Fisheries and Oceans Canada  
200 Kent Street  
Ottawa, ON K1A 0E6

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## Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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[http://www.dfo-mpo.gc.ca/csas-sccs/  
csas-sccs@dfo-mpo.gc.ca](http://www.dfo-mpo.gc.ca/csas-sccs/csas-sccs@dfo-mpo.gc.ca)



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### ***Aussi disponible en français :***

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## SUMMARY

The Canadian Science Advisory Secretariat held a National Advisory Meeting from March 30 to April 1, 2021 to evaluate the effectiveness of “Clean, Drain, Dry and Decontaminate” (CDD+D) treatments and protocols to prevent the introduction and spread of freshwater and marine aquatic invasive species via watercraft, trailers, and equipment that are moved from water to land before entering a new waterbody. A literature review was conducted on existing methods, and numerous treatments and protocols were presented and compared for several freshwater and marine species. Treatments were strongly species-specific, treatment-specific, and environment-specific. Therefore, no single decontamination treatment can be applied to a broad range of species for consistent results in all situations. Effective species-specific decontamination treatments as well as summary tables of effective decontamination treatments to remove and/or kill the greatest number of freshwater and marine AIS were provided. The advice generated from this meeting will help to develop CDD+D guidelines for Fisheries and Oceans Canada’s regulatory programs and the Canadian public. These Proceedings document the peer review discussions, including the feasibility, limitations, and sources of uncertainty related to the available methods.

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## INTRODUCTION

From March 30 to April 1, 2021, a virtual National Advisory Meeting was held to peer review the science advice on “Clean, Drain, Dry and Decontaminate” (CDD+D) treatments and protocols to prevent the introduction and spread of aquatic invasive species (AIS). This meeting provided science advice on a comprehensive evaluation of the effectiveness of decontamination treatments and CDD+D protocols used in Canada or abroad for marine and freshwater AIS (see Terms of Reference in Appendix 1 for details).

The Chairs welcomed participants and provided an overview of the Canadian Science Advisory Secretariat (CSAS) peer review process and of the objectives found in the Terms of Reference (Appendix 1), which this meeting sought to address.

Representatives from Fisheries and Oceans Canada (DFO) AIS National Core Program, the governing body responsible for the implementation of federal AIS regulations at both national and regional levels, provided context on this science advice request. Although many countries around the world are using CDD+D approaches to prevent AIS spread, Canada lacks guidance or a standard on CDD+D recommendations. The aim of the science advice is to help develop national CDD+D recommendations and provide advice to DFO’s regulatory programs and the Canadian public. As such, this work should help AIS management programs to:

- Identify common elements across CDD+D protocols
- Derive best management practices for CDD+D in Canada
- If possible, adopt one set of science advice to inform the national CDD+D standard

The advice generated from this meeting will provide guidance for DFO regulatory programs including:

- AIS regulatory tools such as Fisheries Act S.34/35 authorizations
- Conservation and Protection activities
- DFO regulatory programs, including:
  - Fish and Fish Habitat Protection Program
  - Species at Risk Program
  - Small Craft Harbours

Furthermore, information gained from this Science Advice can be used to inform the Canadian general public, including recreational watercraft owners and operators.

The Science Advisory Report and supporting Research Document are posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#).

## CONTEXT ON EVALUATING THE EFFECTIVENESS OF CLEAN, DRAIN, DRY (CDD) AND DECONTAMINATE (+D)

The author team presented the objectives, scope of the work, and described Clean, Drain, Dry (CDD) steps versus Decontamination (+D).

Suggested improvements for the Research Document and Science Advice included:

- Describing in more detail the differences between CDD and Decontamination. For example,
  - CDD is a voluntary approach meant for the general public to prevent introduction and spread of AIS. Cleaning and drying are often not quantified in this approach.

- 
- Decontamination involves either a temperature, pressure, or chemical treatment and/or a combination of these to induce 100% AIS mortality. It is usually performed by trained personnel with specialized equipment and/or the public using a step-by-step protocol.
  - Including a glossary in the Research Document to clarify several terms and concepts related to CDD+D (e.g., drying, mortality, pressure washing, etc.)

The literature review methodology was presented by the author team and focused on physical and chemical decontamination treatments as well as existing CDD+D protocols. Representative AIS species from different functional and taxonomical groups were selected according to their presence, or probability of presence, in Canadian freshwater and marine environments.

## **FRESHWATER AQUATIC INVASIVE SPECIES, TREATMENTS, AND PROTOCOLS**

The literature search results were presented regarding the effectiveness of physical and chemical treatments resulting in  $\geq 99\%$  mortality of freshwater AIS. These were compared to several protocols (e.g., UMPS IV: Uniform Minimum Protocols and Standards for Inspection and Decontamination Programs for Dreissenid Mussels in United States) for watercraft and equipment.

Suggested improvements for the Research Document included:

- Clarifying the methods used to obtain the results
- Indicating whether the data was obtained in the field or in the lab
- Explaining how mortality was defined for the species considered
- Including more information on pressure washing (e.g., nozzle type, etc.) when this information is available
- Specifying life stages of organisms when possible
- Adding more details to improve context where necessary
- Indicating where there is high variability due to conditions (e.g., air drying is affected by relative humidity and temperature)

A suggestion was made to include additional treatments (e.g., zinc and copper treatments) but it was decided that it was beyond the scope of the study.

There were discussions on some treatments (e.g., pressure washing and thermal treatments). For example, it was noted that high water pressure spraying could result in splash back, redistributing material over the surfaces that had already been cleaned. Lower pressure can reduce splattering but might not be strong enough to remove organisms. With regards to temperature treatments (immersion), it was noted that most residential hot water tanks have maximum temperatures that are not high enough to be lethal to organisms. It was suggested to include more details on these treatments in the Research Document.

## **MARINE AQUATIC INVASIVE SPECIES, TREATMENTS, AND PROTOCOLS**

The literature search results were presented regarding the effectiveness of physical and chemical treatments for marine AIS. These were compared to existing marine protocols developed by Canada (DFO, Introductions & Transfers Committee), Australia, Sweden, and IMO (International Maritime Organization).

Suggested improvements for the Research Document included:

- 
- Indicating whether the data was obtained in the field or in the lab
  - Clarifying where these treatments referred to mortality vs. removal
  - Explaining how mortality was defined for the species considered
  - Indicating where there is high variability due to conditions. For example, air drying is affected by relative humidity and temperature
  - Adding blue mussels as a representative of bivalves, but recognizing the focus was on AIS that were the most important to address as per the Terms of Reference, and thus many species were excluded. Insufficient data on organisms is a knowledge gap and should be identified as a source of uncertainty

### **FEASIBILITY, LIMITATIONS, AND SOURCES OF UNCERTAINTY RELATED TO MARINE AND FRESHWATER TREATMENTS AND PROTOCOLS**

A decontamination treatment feasibility table was presented and included practicality, equipment requirements, human health and ecosystem risks, and disposal. Participants found the feasibility table to be useful for management and requested that it be included both in the Research Document and Science Advice.

Key uncertainties and limitations were also presented (e.g., different experimental designs, scales, and methods of measuring mortality). Several studies were designed to answer questions for different applications. This was particularly true for marine decontamination treatments which were developed for reducing AIS introductions during aquaculture transfers. Freshwater work was usually more focused on recreational boating and/or biosecurity.

As such, key uncertainties and knowledge gaps included:

- Making comparisons between studies that had different experimental designs, scales, and methods of measuring mortality and/or removal
- Applying conclusions from laboratory studies to field conditions
- Interpreting the effectiveness of decontamination treatments that were designed for different applications (e.g., aquaculture transfers, cleaning of infrastructure)

In order to fill certain knowledge gaps, a suggestion was made to perform more real world experiments in addition to laboratory studies.

It was also noted during the meeting that:

- Treatments were strongly species-specific, treatment-specific, and environment specific. As such, no single decontamination treatment is applicable to all freshwater and marine AIS or to all watercraft and equipment. This should be made clear so that management and the public will apply the protocols accordingly.
- Empirical data was missing for several groups of concern and for several treatments
- There is limited knowledge on some treatments (e.g., effective pressures to remove and kill AIS while limiting splash back)
- New innovative strategies are needed for Asian clams which are very difficult to kill

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## **ENDPOINTS AND OTHER APPROACHES**

Different endpoints of CDD+D (e.g., AIS removal vs. AIS mortality) were discussed as these may have important consequences for the enforcement of AIS regulations in certain provinces and territories. Reducing propagule pressure on recreational boats can be achieved by physically removing propagules (i.e., cleaning, scrubbing, hand-picking) and/or by causing mortality of propagules (e.g., chemical or temperature treatments). In theory, a single treatment can induce mortality that leads to removal, but there are cases where only one endpoint is achieved. It was suggested to add details in the Research Document on the potentially different endpoints of CDD+D (e.g., AIS removal vs. AIS mortality). For example, decontamination could lead to 1) removal without mortality of AIS, 2) mortality without removal of AIS, and 3) both removal and mortality of AIS (the preferable endpoint). If AIS are removed but not killed, these can be washed and spread to waterways. Conversely, if AIS are killed but not removed (e.g., encrusted organisms), questions may remain regarding their viability. Most studies focused on mortality as an endpoint.

A reviewer suggested using a “good-better-best” approach and/or a “good-best” approach for decontamination. Under either approach, CDD with 90% adoption (good) is probably better than +D (best) with 10% adoption. Both approaches were attempted during the meeting but proved to be challenging. “Best” is very conservative and the most risk averse, while “good” is arbitrary, since what is good for industry could be different for the public. This is a management perspective and contrasts with the science advisory process which seeks to provide the best information on decontamination treatments with a measure of uncertainty. Furthermore, because this considers public uptake, this may be outside the scope of providing science advice for this CSAS process and was thus not discussed further.

## **SUMMARY TABLES OF DECONTAMINATION TREATMENTS TO REMOVE AND/OR KILL THE GREATEST NUMBER OF AIS**

During the meeting, participants asked the author team to create a series of summary tables with effective decontamination treatments to remove and/or kill the greatest number of freshwater and marine AIS and include uncertainty scores for each of these treatments. The approach used for these tables and their associated uncertainty scores was developed at the meeting and examples were presented. It was recommended to include these tables in the Research Document and Science Advice.

## **OTHER DISCUSSION POINTS**

There was a discussion on the need for the advice to remain general for management (e.g., rank and summarize the different treatments most effective at killing a broad range of species). As such, it was suggested that the above mentioned summary tables be provided in the Research Document and Science Advice. Additional detailed information on species-specific decontamination treatments should be provided in the Research Document. The authors agreed to make the changes to the Research Document prior to publication and provided feedback on what changes would be made.

The authors competently evaluated the effectiveness of CDD+D, as prescribed in the Terms of Reference. It was noted during the meeting that public uptake and compliance is beyond the scope of this work, but will play an integral part in the successful management of AIS in marine and freshwater ecosystems.



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## APPENDIX 1: TERMS OF REFERENCE

### Science Advice on “Clean, Drain, Dry and Decontaminate” Treatments and Protocols to Prevent the Introduction and Spread of Aquatic Invasive Species

#### National Advisory Meeting – National Capital Region

March 30 – April 1, 2021

Virtual meeting

Chairpersons: Gilles Olivier and Sophie Foster

#### Context

Aquatic invasive species (AIS) that are introduced or spread to ecosystems beyond their natural range can threaten Canada’s biodiversity, economy, and society. Water-based commercial and recreational activities can unintentionally spread AIS to new locations if species hitchhike on watercraft, trailers, equipment, and gear or if they are transported in standing water (e.g., bilge, livewell).

To prevent the introduction and spread of AIS, many government and non-government organizations operate Clean, Drain, Dry (CDD) programs. CDD is an established best management practice targeted towards the general public and owners or operators of watercraft, trailers, equipment, or gear used in and near water. CDD requires watercraft operators to undertake cleaning, draining, and drying steps to reduce the likelihood of transporting AIS on their equipment. In situations where there is a higher risk that AIS could be transported, an additional decontamination step may be applied (CDD+D). Decontamination generally includes disinfection and temperature treatments with variation depending on the target species or disease.

To date, a comprehensive evaluation of the effectiveness of CDD+D protocols used in Canada on marine and freshwater AIS has not been conducted. The need for a fulsome review is compounded by the fact that a wide variety of methods are endorsed and used by different organizations without national consistency.

#### Objectives

1. Review and characterize existing freshwater and marine CDD+D protocols used in AIS management across Canada or abroad, including specific decontamination methods.
2. Assess the effectiveness of existing CDD+D protocols and methods at reducing the propagule pressure of marine and freshwater AIS<sup>1</sup> along the overland transportation pathway.

The scope of this project will be limited to watercraft under 24m in length, trailers, equipment, and gear that move from water to land before entering a new waterbody, excluding those that remain in the water. Forest firefighting equipment and floatplanes are not within the scope of this work.

CDD+D effectiveness will be based on the extent to which protocols reduce the propagule pressure of AIS along the overland transport pathway. Following this work, common elements across protocols could be identified by AIS management programs to derive best management

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<sup>1</sup> Species of particular concern may include, but are not limited to: Zebra and Quagga mussels, tunicates, European Green Crab, and Eurasian Water Milfoil.

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practices for CDD+D in Canada. Any advice generated from this work on best management practices will be subject to the caveat that CDD+D effectiveness relies heavily on public uptake and compliance, assessing which is beyond the scope of this project.

**Expected Publications**

- Science Advisory Report
- Proceedings
- Research Document

**Expected Participation**

- Fisheries and Oceans Canada (DFO)
- Provinces and Territories
- Academia
- Other Government Departments

## APPENDIX 2: AGENDA

### Science Advice on “Clean, Drain, Dry and Decontaminate” Treatments and Protocols to Prevent the Introduction and Spread of Aquatic Invasive Species

*Fisheries and Oceans Canada*

*Canadian Science Advisory Secretariat*

*National Science Advisory Process – National Capital Region*

#### Virtual Peer Review Meeting

**March 30 – April 1, 2021**

**Co-chairs: Sophie Foster and Gilles Olivier**

March 30, 2021		
Time	Topic	Lead(s)
11:00 – 11:10 A.M. EST	Welcome and Introductions	Co-chairs
11:10 – 11:20	Overview of National CSAS Peer Review Process and Terms of Reference	Co-chairs
11:20 – 11:30	Request for Advice and Context	Brendan and Lynn
11:30 – 11:40	Objectives, Scope, and Clean, Drain, Dry versus Decontaminate	Andréa
11:40 – 11:50	Literature Review Methodology	Valérie
11:50 – 1:00	Results: Physical and Chemical Treatments for Freshwater AIS	Andréa and Jaclyn
1:00 – 2:00	Break	
2:00 – 2:30	Results: Existing Freshwater Protocols	Andréa
2:30 – 3:30	Discussion: Effectiveness of Freshwater Treatments and Protocols	Jaclyn
3:30 – 4:00	Outstanding Items, Day 1 Recap	Co-chairs

March 31, 2021		
Time	Topic	Lead(s)
11:00 – 11:05	Brief Welcome, Roll Call	Co-chairs
11:05 – 12:05	Results: Physical and Chemical Treatments for Marine AIS	Nathalie
12:05 – 12:20	Results: Existing Marine Protocols	Nathalie
12:20 – 1:15	Discussion: Effectiveness of Marine Treatments and Protocols	Nathalie
1:15 – 2:15	Break	

<b>March 31, 2021</b>		
<b>Time</b>	<b>Topic</b>	<b>Lead(s)</b>
2:15 – 2:50	Feasibility, Limitations, and Sources of Uncertainty related to Marine and Freshwater Treatments and Protocols	Jaclyn
2:50 – 3:20	Additional External Reviewer Comments	Co-chairs
3:20 – 3:50	Conclusions/Recommendations	Andréa
3:50 – 4:00	Outstanding Items, Day 2 Recap	Co-chairs

<b>April 1, 2021</b>		
<b>Time</b>	<b>Topic</b>	<b>Lead(s)</b>
11:00 – 11:05	Brief Welcome, Roll Call	Co-chairs
11:05 – 1:00	Science Advisory Report Discussion <ul style="list-style-type: none"> <li>- Summary Bullets</li> <li>- Terms of Reference Objectives Review</li> <li>- Advantages, Limitations, Knowledge Gaps, and Uncertainties</li> <li>- Conclusions and Recommendations</li> </ul>	Co-chairs
1:00 – 2:00	Break	
2:00 – 3:45	Science Advisory Report Discussion Cont'd	Co-chairs
3:45 – 4:00	Outstanding Items, Closing Remarks	Co-chairs

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### APPENDIX 3: LIST OF PARTICIPANTS

<b>Name</b>	<b>Affiliation</b>
Beck, Martina	Government of British Columbia
Bernier, Renée	DFO Science
DiBacco, Claudio	DFO Science
Drake, Andrew	DFO Science
Foster, Sophie	DFO Science
Hill, Jaclyn	DFO Science
Johnson, Tim	Ontario Ministry of Natural Resources and Forestry
Kristmanson, James	DFO Science
Locke, Andrea	DFO Science
Lush, Lynn	DFO Ecosystems Management
Massé-Beaulne, Valérie	DFO Science
McKenzie, Cynthia	DFO Science
Mckindsey, Chris	DFO Science
Olivier, Gilles	DFO Science
Ramsay, Aaron	Government of Prince Edward Island
Sardelis, Stephanie	DFO Science
Simard, Nathalie	DFO Science
Spearin, Brendan	DFO Aquatic Ecosystems
Therriault, Thomas	DFO Science
Tuen, Alex	DFO Science
Weise, Andréa	DFO Science