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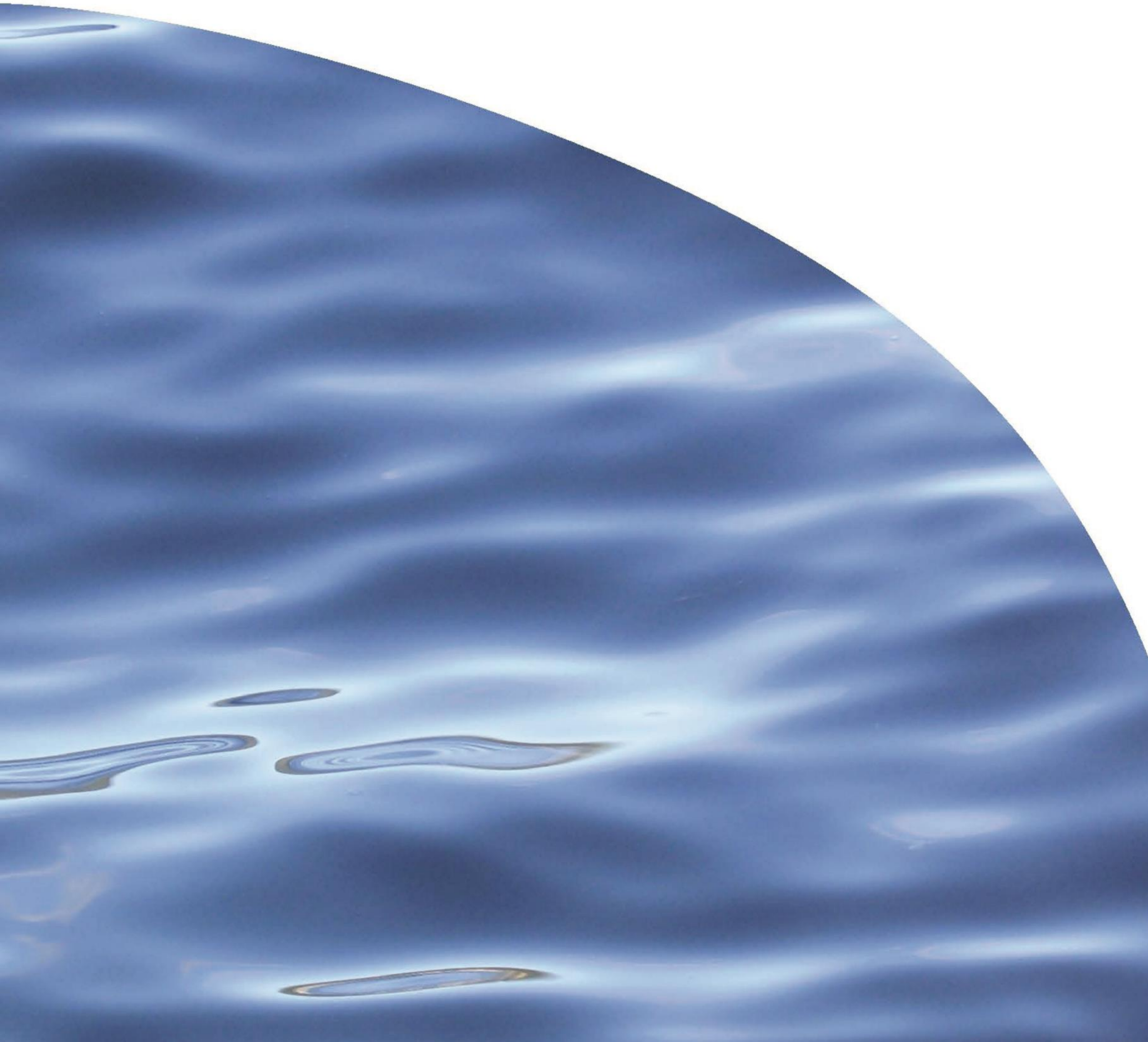
REGIONAL APPLICATION OF ANTIFOULING AND IN-WATER CLEANING GUIDANCE



REGIONAL APPLICATION OF ANTIFOULING AND IN-WATER CLEANING GUIDANCE

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1. INTRODUCTION

1.1. Background and purpose of this advice

Hull biofouling on recreational and commercial vessels is a major contributor to regional and national biosecurity risk. Recent studies of recreational boats in the top of the South Island (TOS) have shown that many vessels in active use are harbouring marine biofouling pests, and boat hulls are being cleaned in the water or on beaches throughout the region (Forrest 2017). In both situations there is a risk that marine pests will be spread to the wider environment, with cleaning activities leading to additional risks resulting from contaminant discharges caused by abrasion and erosion of antifouling coatings. Similar phenomena are being observed in other coastal areas of New Zealand, particularly in areas where recreational boating is popular. Mitigation of these risks requires: (i) an effective antifouling coating on vessels to minimise biofouling accumulation in the first instance; and (ii) hull cleaning practices that reduce biosecurity risk and simultaneously minimise the release of antifouling biocides to the aquatic environment.

To achieve these outcomes, Anti-fouling and In-water Cleaning Guidelines for vessels were jointly developed for Australia and New Zealand in 2013, based on a revision of the original ANZECC Code of Practice for Antifouling, Maintenance and In-Water Cleaning (1997). The 2015 guidelines (DOE/MPI 2015)[1] provide advice on best practices for antifouling, and a decision tree for assessing and managing biosecurity risks associated with in-water cleaning. While the guidelines seek to mitigate risks associated with the release of antifouling contaminants and biofouling organisms during cleaning, they defer the definition of thresholds for acceptable vs unacceptable risk to local jurisdictions and associated environmental regulations. Hence, while the DOE/MPI (2015) document provides a useful framework for minimising both biosecurity and contaminant risks, it lacks specific information to enable vessel owners and regulators to apply the framework in a meaningful manner. Accordingly, there appears to have been very little uptake of the guidelines at the regional level, and in some case a lack of awareness that the revised guidance even exists.

Tasman District Council (TDC) has received a Small Advice Grant from Envirolink to identify key information gaps and needs with respect to the above issues, and to enable the scoping of a larger project that would aim to comprehensively address them. The following report aims to meet the needs of TDC, and also considers costs and possible sources of funding to undertake the larger project. The report focus, as agreed between Cawthron and TDC, is the recreational boating sector, but many of the issues are relevant to commercial vessels.

[1] A pdf of the 2015 Anti-fouling and In-water Cleaning Guidelines was produced by the Australian Department of the Environment in association with the Ministry for Primary Industies in 2015, and is available at: http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant/pests-diseases/marine-pests/antifouling-consultation/antifouling-guidelines.pdf

1.2. Biofouling, antifouling and vessel cleaning context

Biofouling is one of the primary pathways that facilitates the rapid spread of marine pest species within and between regions. Biofouling on vessels is generally managed through the application of biocidal antifouling paints and, between successive coating applications, through hull cleaning on land (e.g. water blasting on hard-stand or in dry-dock) or in water (e.g. wiping, scrubbing, mechanical brush systems). Current practices, especially in the recreational boating sector, are likely to be exacerbating biosecurity risk, with mechanical cleaning methods also leading to the discharge of biocidal contaminants such as copper (Morrisey et al. 2013). Key issues in these respects are as follows:

- **Antifouling coatings are not meeting expected performance requirements:** Fouling can often accumulate on hulls in a short timeframe relative to the expected service life of antifouling coatings. This is likely to be caused by two issues: (1) vessel owners or contractors may chose antifouling coating products that are not suitable for their vessel's activity profile, and (2) vessel owners do not always apply antifouling coatings in accordance with manufacturers' recommendations (with respect to hull preparation, coating layer thickness, drying time, etc).
- **Antifouling coatings may be cleaned by methods that are too harsh for the coating type, or whose effect on the coating is unknown**: This situation appears to be leading to the following:
    - Coating damage, or alteration of efficacy, such that the rate of subsequent biofouling, hence marine biosecurity risk, can be exacerbated. This may be a result of mechanical cleaning undertaken both on land or in water.
    - Where cleaning in is undertaken in water or intertidally, the release of antifouling contaminants to the environment is likely being exacerbated relative to expected leaching rates of antifouling coatings.
- **Cleaning practices are likely leading to potentially harmful organisms being dislodged to the surrounding environment.** Many recreational vessels are scrubbed or scraped in water or on beaches, and often in remote or pristine coastal areas (Forrest 2017). Direct dislodgement of biofouling to the seabed during cleaning (i.e. without waste capture) may contribute to the spread of marine pests (Hopkins et al. 2011).

The DOE/MPI (2015) guidance is relatively comprehensive with respect to biosecurity matters, providing a decision-making flowchart for mitigation that is tailored to the level of risk (Appendix 1). However, there is a lack of supporting detail and context necessary for regional implementation (e.g. how should councils distinguish between local, domestic and international biofouling?). Additionally, the discharge of contaminants is not addressed in sufficient detail. Contaminant discharges are regulated by the Resource Management Act 1991. Most council policies and plans actively discourage or even prohibit in-water cleaning unless a resource consent has been obtained, based on the perceived risks. However, this current stance does not account for the potential biosecurity risk reduction *benefits* associated with *appropriate* in-water cleaning, nor the *relative* risks arising from the release of contaminants vs the failure to prevent the transport of marine pests to future destinations of fouled vessels.

Furthermore, in addition to lack of council awareness of the ANZECC (1997) redraft process that led to the DOE/MPI (2015) guidance being produced, many councils also appear unaware that a recent review of antifouling coatings by the Environmental Protection Authority (EPA) has led to some higher-risk biocides being banned. Essentially, some council staff preparing second-generation regional coastal plans are making decisions on in-water cleaning without a full appreciation of the issues and the mitigation options.

It is also relevant that many recreational boaters undertake in-water cleaning irrespective of regional or local requirements. Recent surveys of boaters across the TOS region have revealed that more than half clean their vessel hulls in-water, of which about one third clean 'out of sight' in pristine coastal areas like the Abel Tasman National Park coastline and the outer Marlborough Sounds (Forrest 2017). These figures are similar to surveys of recreational boaters across New Zealand that were conducted more than 10 years earlier (Floerl et al. 2009), suggesting that there has be no change in practices despite the development of the 2013 and 2015 guidance. Not only is it likely that marine pests are being dislodged to the seabed in such areas, along with pulses of antifouling contaminants, but incomplete removal of biofouling (via a rushed or incomplete in-water clean) may greatly increase the rate at which hulls subsequently become recolonised (Floerl et al. 2005).

1.3. What is needed?

Councils, vessel owners and other stakeholders need specific information and guidance to enable vessel owners and regulators to apply the DOE/MPI (2015) guidelines in a meaningful manner that balances both biosecurity and contaminant concerns. The work scoped below would fill this gap, and also identify adaptions that may improve the existing guidelines or foster improved uptake and implementation in a way that is consistent among regions. To this end, in the report below we focus on issues and information needs covering:

- selection and application of vessel antifouling coatings, to ensure adoption of best practices that promote antifouling efficacy (i.e. to ensure that the best coating type is applied well) (Section 2)
- identification of hull cleaning methods *appropriate* for each coating that do not damage it or reduce its service life (Section 3)

- guidance on cleaning of vessels that accounts for both biosecurity and contaminant discharge risks and their mitigation (Section 3)
- guidance on regional implementation of best practice approaches to vessel antifouling and cleaning, including development of Resource Management Act 1991 (RMA) and regional coastal plan provisions (Section 4).

The outcomes sought by this work closely align with the needs of a review of the DOE/MPI (2015) guidelines that is being undertaken in Australia by the Department of Agriculture and Water Resources (DAWR), with an intended completion date of July 2018. Our understanding based on communications with DAWR project staff is that key objectives of the review are to: (i) update the existing guidelines with consideration of audience and scope (e.g. there is consideration of including aquaculture operations and UWILD[2] certification surveys), (ii) support the implementation of processes in Australian states and territories to assess and approve in-water cleaning activities, and (iii) promote and increase uptake of the guidelines. A similar review that considers the guidelines in the New Zealand context will be conducted by MPI, but it has not yet started.

[2] Underwater Inspection in Lieu of Dry-Docking

2. ANTIFOULING

2.1. Synopsis of the key technical issues

Having an effective antifouling coating is the primary defence against biofouling for vessels kept in the water permanently (e.g. in marinas and on swing moorings). A coating that prevents biofouling development for its recommended service life will minimise the need for ongoing hull cleaning. Studies in New Zealand suggest that recreational boaters typically antifoul at intervals of 24 months or slightly longer (Floerl et al. 2009; Forrest 2017). However, with current practices, available data suggest that an interval of 12 months is needed to minimise the proportion of 'fouled' vessel hulls within the domestic fleet. Even then, existing data show that c. 15-20% of vessels may become conspicuously fouled in as little as 6 months (B. Forrest, unpubl. data). Part of this situation may be attributable to the failure of the coating itself, in particular where vessels maintain inadequate activity profiles relative to those required for good coating performance. In addition, biofouling can develop rapidly in 'niche' areas of vessel hulls that are not antifouled effectively, if at all.

The process of fouling development on hulls is complicated by the fact that it is not just the coating itself, or its maintenance, that determines the nature and extent of biofouling, but also factors relating to the operating profile of the vessels, and the environment in which they operate. Generally, biofouling tends to accumulate more readily on vessels that get used very little and travel at slow speeds during use (Inglis et al. 2010; Forrest 2017). Accordingly, the development of best practice antifouling guidance, as part of a larger project, will need to address a number of key points that are outlined below.

2.2. Key matters to address with respect to best practice

2.2.1. Available paint types and biocides

Broadly, the paint types used by most recreational boaters fall into two main categories according to how they counteract biofouling development: biocidal coatings and non-biocidal coatings. The latter include fouling-release coatings that prevent effective attachment of biofouling, and non-toxic, mechanically resistant coatings that are tough and durable, and can withstand cleaning operations (Floerl et al. 2010). By contrast, biocidal coatings contain chemical additives that either kill or deter the settlement stages of biofouling. There are a range of biocidal coating types, each with different levels of efficacy under different operating conditions, and with varying susceptibility to damage during cleaning. On recreational boats 'ablative' coatings are most commonly used, but these are easily damaged by abrasion and so are not suitable for vessels that are subject to mechanical wear or frequent cleaning (Yebra et al. 2004).

The most commonly used biocides internationally are copper or zinc oxides, combined with secondary 'booster' biocides, which are often herbicides that are intended to prevent algal biofouling (Dafforn et al. 2011). In New Zealand, the EPA review of antifouling paints has resulted in changes to the products available on the market. The development of antifouling guidance needs to recognise the products that are now available, and their operational and maintenance requirements for optimal performance. This information can be obtained via desktop review, and through consultation with the EPA and the main coating manufacturers.

2.2.2. Antifouling paint selection and application

Antifouling coatings need to be matched to the operating profile of the vessel, and the type of maintenance planned. Paint manufacturers and retailers are able to provide advice on these matters. However, in particular for recreational vessels it is not known (i) which criteria boat owners use to decide on antifouling products (e.g. cost or immediate availability might be more important for some than suitability for their activity profile) and (ii) whether all retailers are sufficiently trained to provide the best advice. It may also be appropriate for different paint types to be applied in different hull areas of a given vessel; however, our impression (based on vessel surveys carried out in the TOS by B. Forrest) is that recreational boaters do not routinely adopt such practices. In addition to selecting the best coating(s) for a given vessel and operating profile, there is a related need to ensure appropriate application of antifouling coatings, in particular to niche areas of vessels that have an elevated susceptibility to becoming fouled.

We are aware of a range of existing practices undertaken by some recreational boat owners, which likely lead to compromised antifouling efficacy. For example:

- spreading coatings thinly across the hull to make the paint 'go further' and reduce cost
- thinning the coating with inappropriate additives (e.g. petrol)
- adding biocides to the coating (e.g. herbicide, pesticide) to try to enhance efficacy
- use of inadequate curing times to save hard-stand costs.

There is an apparent lack of effective antifouling in key niche areas of many vessels. For example, studies in the TOS reveal that the keel bottoms of yachts and other slow-moving vessels can harbour marine pests, even when the rest of the hull, including other niche areas, is clean (Forrest 2017). In current hard-stand facilities for boat maintenance, most vessels rest on their keel (or on small blocks), meaning the bottom of the keel is typically difficult to access, hence it: (i) may not be antifouled; (ii) may have a 'last-minute coat' applied just before it is lifted back into the water (i.e. when the coating has not fully cured, and is likely to slough off); or (iii) may be antifouled except where supported by blocks.

2.3. Scoping a project that addresses knowledge gaps

The key needs with respect to antifouling best practice, and ways to address these needs, are as follows:

1. A desktop review of antifouling coatings available for small vessels in New Zealand, and coating biocides, ideally supplemented by consultation with the EPA and the main coating manufacturers.
2. A desktop review of the information currently available for effective antifouling application, maintenance and renewal, including suitability for interim manual cleaning of coatings and availability of suitable boat maintenance facilities. Information sources would include manufacturer websites and personnel, retailers, vessel maintenance providers, professional coating applicators, and existing guidance documents (including DOE/MPI 2015).
3. A questionnaire-based survey to better understand existing knowledge, attitudes and practices with respect to paint selection, sale and application, and the willingness to adopt improved approaches. Such a survey should include the boating population, hard-stand operators, coating retailers, and professional coating applicators.
4. As a separate exercise or supplement to the survey suggested in (3), a specific piece of work could be undertaken to review hard-stand practices in New Zealand and internationally, to determine the scope for improving antifouling of difficult niche areas, in particular the bottom of the keel. This approach could include internet searches and consultation with New Zealand (and possibly international) hard-stand operators.

Fulfilling the above steps would enable the development of comprehensive best practice guidance for antifouling, and contribute to the review process for the DOE/MPI (2015) guidelines. Whereas desktop syntheses of existing information as described in 1 and 2 are a minimum requirement, acquisition of new information is desirable in some instances, and as a minimum should include informal consultation with key stakeholders, including technical experts as necessary. The option to conduct a systematic survey (i.e. 3 and 4 above) to elicit further information from a wider group is desirable, but will add a level of complexity and cost to the work. However, undertaking this step would be a useful precursor to the development of practical guidance and will serve the purpose of making the final guidelines more acceptable to affected stakeholders (see Section 4.4).

3. VESSEL CLEANING

3.1. Synopsis of the key technical issues

Historically, cleaning on designated intertidal grids was a common and accepted practice. Most such grids now have been closed in New Zealand regions, due to contaminant concerns. Nonetheless, intertidal cleaning is still undertaken by some recreational boaters. As noted in Section 1.2, in-water cleaning is also commonly conducted by recreational boaters, irrespective of regional regulatory requirements. In fact, due to current regional restrictions (or lack of clarity) on in-water cleaning, and a lack of land-based facilities in some regions, many recreational vessel owners undertake cleaning activities 'out of sight', such as in anchorages associated with natural, 'pristine' coastlines (pers. obs. and communications from recreational boaters). Furthermore, in both the recreational and commercial sectors there is increasing interest in using in-water cleaning as an alternative to haul-out and land-based cleaning. Despite the prevalence of in-water cleaning, land-based cleaning is still an important practice that is relevant in the context of cleaning effects on antifouling coating integrity and service life.

An understanding of the present situation with respect to the tools available for cleaning, and the way they are used, is central to understanding of cleaning risk. Related to this need, it is essential to determine: (i) what is known or can be inferred in terms of antifouling coating damage as a result of cleaning practices (on land and in water); (ii) the extent to which biofouling and biosecurity risk is altered due to coating damage or change in efficacy, for commonly used coating types or products; and (iii) the environmental implications (considering both biosecurity and contaminant issues) that arise from waste discharge, and the extent to which discharge impacts can be mitigated by waste capture (Morrisey et al. 2015). Simultaneously, to make sense of such information for management purposes, it is necessary to understand how the nature and extent of biosecurity and contaminant risk differ, and what may be desirable trade-offs in a range of realistic scenarios.

3.2. Key matters to address with respect to best practice

3.2.1. Cleaning tools and practices

Understanding available or emerging cleaning methods and cleaning practices is a fundamental requirement. Various in-water cleaning methods are in use, or being developed. These include mechanical and other methods that aim to remove biofouling while minimising the release of fouling material and associated contaminants (e.g. by waste capture). Sitting alongside methods that remove biofouling, are various treatments that kill the fouling *in situ*. Examples are direct heat treatment of hull surfaces (Wotton et al. 2004), and hull encapsulation treatments that sometimes involve the addition of treatment chemicals such as chlorine compounds (Morrisey 2015). While these *in situ* methods are not routinely used (except in marine pest response), it is worthwhile including them as part of the larger picture on best practice for vessel cleaning.

A comprehensive understanding of cleaning methods can be gained from an in-depth appraisal of existing information, much of which is available from studies by Cawthron, NIWA and others (e.g. in the form of science publications or reports prepared for MPI). However, to thoroughly understand current practices (e.g. method used, cleaning frequency, paint type), additional surveys of vessel operators, cleaning service providers and stakeholders (including MPI) involved in tool development or testing, will be required.

3.2.2. Coating damage or altered efficacy from different cleaning practices

Considerations of coating damage due to cleaning should be part of a broader assessment of the alteration to coating efficacy (and effect on service life) that results from different cleaning practices. Coating damage is actually the worst-case outcome, in that it can reduce coating efficacy (thus promote biofouling) while releasing significant pulses of chemical contaminants. On the other hand, applying cleaning methods appropriate to the coating type may in fact have a dual benefit of minimising contaminant release, while leading to a biosecurity benefit through ‘reactivation’ of the coating via exposure to ‘fresh’ antifouling compounds (Tribou & Swain 2010).

To understand these factors and their interactions, it is important to separate what is known from existing studies from what can be inferred from these, and to identify whether there are significant knowledge gaps that will require additional technical investigations. As such, key components to this work should include a comprehensive literature review, supplemented by consultation with technical experts and key stakeholders.

3.2.3. Cleaning risks – biosecurity

The issue of cleaning risks is in part linked to questions in the previous section relating to change in coating efficacy due to different cleaning methods and practices, in particular the worst-case scenario in which biosecurity risk is exacerbated. However, the broader picture of biosecurity risk is far more complex, and must consider factors such as those outlined by Hopkins and Forrest (2008), for example:

- the likelihood and consequences of cleaning-related disturbance initiating spawning in reproductively mature biofouling, in the event that advanced biofouling is removed
- the likelihood and consequences of potentially harmful species in defouled material falling to the seabed or re-attaching to artificial structures

- the implications for cleaning risk in relation to the origin of the biofouling (e.g. whether locally acquired or from other domestic or international source regions)
- the relative biosecurity risk of cleaning vessel biofouling in-water versus leaving it on the vessel
- the mitigation steps required to address the above, including the nature and extent of waste capture.

As noted in Section 1.2, some of these issues, and appropriate mitigation steps, are already addressed in the DOE/MPI (2015) guidelines, either in the main decision-making flowchart (Appendix 1) or Conditions A-D in the flowchart. For example, the acceptability of in-water cleaning and need for waste capture are scaled to the nature of the biofouling (whether microfouling or macrofouling) and its origin (whether local, domestic or international). The guidelines further link the acceptable approach to matters of coating type, cleaning method and contaminant release.

However, in Section 1.2 it was also noted that the framework cannot presently be applied because the supporting detail and context necessary for regional implementation are generally lacking. For example, councils need guidance to be able to distinguish between local, domestic and international biofouling and how the interaction of biofouling origin with biofouling type (i.e. micro- vs. macrofouling) determines the biosecurity risk of cleaning. Similarly, the framework allows in-water cleaning only for coatings that are within their active service life and that are suitable for manual cleaning. While this is a very meaningful requirement, at present neither regulators nor vessel owners have comprehensive and easily accessible resources for reliably producing this information. While it would be easiest to put the onus on the vessel owner/operator, the likely outcome is that most will not know how to access such information. Finally, the ‘acceptable’ contamination thresholds referred to in the decision framework have not been defined for most jurisdictions, and considerable thought needs to be given to how such thresholds should be determined (see next section).

3.2.4. Cleaning risks – contaminants

The nature and extent of contaminant release from antifouling coatings is inextricably linked to a range of factors, including the biocidal compounds present in the coating (which relates to the EPA review), the type of coating (e.g. as per Section 2.2.1) and its age, and the nature and extent of cleaning. In turn, the consequences of contaminant release depend on the timing and magnitude of pulse releases, the size of coating fragments released, the total mass load of contaminants (e.g. based on the number of vessel cleaning events), the sensitivity of the receiving environment, and the associated values that may be adversely affected (Turner 2010; Morrisey et al. 2013). A recent comprehensive MPI report assessed copper release from different types of cleaning, and provides a useful basis for considering potential risks and maximum allowable contaminant loads (Morrisey et al. 2013). However, other types of chemical contaminant may also need to be considered. Additionally, some councils may regard the release of the biofouling material itself (i.e. organic matter deposition to the seabed) to be a discharge in the context of the RMA (Sinner et al. 2012). Accordingly, an assessment of risk needs to account for these broader matters.

3.2.5. Biosecurity vs contaminants in a relative risk context

The base assumption in the MPI report by Morrisey et al. (2013) was that *chemical and biosecurity risk associated with in-water cleaning are equal*. This was a necessary simplifying assumption in the context of that work, based on trade-offs. However, biosecurity and contaminant risks are not necessarily equal, and the relative magnitude should be an important factor that is accounted for by regulators when making in-water cleaning management decisions.

For example, various studies have considered relative risk based on criteria relating to the magnitude of a potential effect (e.g. severity per unit area of seabed), the spatial extent of the effect (e.g. whether localised or broader in influence) and its duration (e.g. whether a short-term effect that can be mitigated or an effect that is essentially irreversible). By these types of criteria, biosecurity risk (e.g. a marine pest incursion) would typically emerge as more significant than a chemical contaminant (Forrest et al. 2009). For example, the effects of most contaminants, including antifoulants like copper, are localised to the release point, are in theory reversible (e.g. contaminated sediments can be removed by dredging) and are mainly accumulated in environments that are already highly modified (e.g. ports). By contrast, harmful organisms in marine biofouling can be spread by vessels from local to international scales, including into pristine environments. Moreover, as eradication or long-term control are seldom feasible (Hunt et al. 2009; Forrest & Hopkins 2013), any adverse effects are irreversible.

3.3. Recommended approach for a larger project

Options described above (Section 3.2) for a larger project on in-water cleaning involve combinations of desktop review, targeted consultation with key stakeholders, and wider questionnaire-based surveys. As was noted in Section 2, we recognise the increased cost associated with the latter approach. With this in mind, key needs with respect to development of guidance on in-water cleaning best practice, and ways to address these needs, can be summarised as follows:

1. A desktop review of the literature on cleaning tools and their efficacy, including New Zealand studies by Cawthron, NIWA and others. This review should be supplemented by consultation with MPI and organisations/companies involved in the development or testing of emerging tools.

2. A questionnaire- and/or interview-based survey to better understand existing knowledge, attitudes and practices with respect to cleaning, the willingness to adopt improved approaches, and the availability of suitable facilities. Such a survey would logically be conducted in tandem with the survey outlined in Section 2.3, and should include vessel operators, hard-stand operators, cleaning service providers, councils and MPI.
3. A literature review, and consultation with technical experts, antifouling coating manufacturers and other key stakeholders as necessary, to evaluate: (i) acceptable cleaning practices (including unsuitability for cleaning) for different commercially available antifouling coating types; and (ii) the actual or potential effect of cleaning (using recommended and unsuitable approaches) on antifouling coating efficacy and service life. Similarly, information on contaminant release associated with appropriate vs inappropriate cleaning practices should be collated.
4. If 3(ii) of the preceding bullet identifies the need for additional technical investigation(s), the nature of any such investigation will need to be assessed. For example, it could involve controlled laboratory or field experiments to assess biofouling on different coating types subjected to different cleaning methods.

4. REGULATORY AND RELATED CONSIDERATIONS FOR ANTIFOULING AND IN-WATER CLEANING

4.1. Issues and options

Developing guidance is the first stage of a process towards a goal of having cleaner vessels and better cleaning practices. Implementing that guidance in a consistent way across regions, and having buy-in from affected stakeholders, are critical pieces of the puzzle.

Effective regional management of biosecurity risk requires appropriate management of all vessels—those that are resident within regions and those that travel among regions. One of the greatest risks to regions, and a significant challenge to address, are boats that arrive from other regions carrying new harmful marine organisms. In the TOS, for example, many such vessels go undetected when arriving in a new region, as they do not necessarily visit ports and marinas, or register their arrival using other means (Forrest 2017).

Steps taken in New Zealand to address some of these regional issues have included the formation of multi-region biosecurity partnerships, and scoping exercises to review practical measures and policy options for reducing the national spread of potentially harmful marine organisms via human transport pathways (Sinner et al. 2013). Simultaneously, several of the councils that are active in marine biosecurity have developed standards for hull biofouling and/or cleaning.

Unfortunately, the standards that have been adopted by councils (e.g. allowable hull fouling thresholds), and the measures to achieve them, differ among regions. Clearly, a national approach is needed to foster consistency among regions, and to ensure that all regions become actively engaged in marine biosecurity (some councils are not currently engaged). However, assuming that the timeframe for development of a national approach will be very slow, it is probably the case that regions wishing to address issues around antifouling and in-water cleaning will need to continue to develop their own approaches.

4.2. Addressing the issues from a national perspective

The National Policy Direction for Pest Management[3] was developed by MPI in 2015, and aims to improve the alignment and consistency of pest and pathway management plans and programmes across New Zealand. For example, it clarifies the Biosecurity Act requirements for these plans, ensures that plans are aligned and consistent (both

[3] https://www.mpi.govt.nz/dmsdocument/9464-national-policy-direction-for-pest-management-2015

nationally and regionally), and outlines requirements for developing good neighbour rules (to manage pests spilling across boundaries) in regional pest management plans. However, this framework has not yet led to any regional consistency with respect to biofouling management. Moreover, it does not easily cater for issues around antifouling best practice and contaminant issues from vessel cleaning.

By contrast, the National Environmental Standards (NES), issued under section 43 of the RMA, provide a potential mechanism to address issues of regional inconsistency, and cater for both biosecurity and contaminant issues. NES are regulations that prescribe standards for environmental matters, and their development is led by the Ministry for the Environment. They can prescribe technical and non-technical standards, methods or other requirements including use of the coastal marine area and discharges. Each regional council or unitary authority must enforce the same standard, although in some circumstances where specified in the NES, councils can impose stricter or more lenient standards. The history of NES development to date is one of very slow progress. Hence, while it is important to keep this larger picture in mind, it is also important that regions active in marine biosecurity have sufficient guidance for moving forward.

4.3. Regional options

The lack of national guidance to date has already necessitated regionally-driven approaches being developed by some of the councils active in marine biosecurity and vessel biofouling management. Examples of regional regulatory approaches to biofouling and vessel cleaning that have been adopted or proposed so far include:

- the use of Biosecurity Act provisions to manage pathways (pathway management plans) or specific pests (e.g. small-scale management plans, regional pest management plans)
- RMA-based approaches such as development of regional rules (e.g. Auckland Council's permitted activity rules relating to biofouling thresholds and in-water cleaning practices), or stipulation of biosecurity requirements on resource consents
- other local approaches; e.g. implementation by marina operators of biosecurity conditions as a requirement of marina berth agreements.

Combinations of the above are used by some councils. Probably the most comprehensive approach to date is the package of biosecurity measures developed by Northland Regional Council in the Northland Regional Pest and Marine Pathway Management Plan[4]. To develop regional options for TDC (or other interested

[4] Northland Regional Pest and Marine Pathway Management Plan. See: https://resources.nrc.govt.nz/upload/25001/Northland%20Regional%20Pest%20and%20Marine%20Pathway%20Management%20Plan%202017-2027%20(Jan18).pdf

councils), it would be helpful to collate the types of approaches that have been implemented to date, and assess their pros and cons (and costs) via interviews with those who championed their development or are responsible for their implementation. However, to get council uptake/buy-in is likely to require an effective strategy to get key council staff (e.g. biosecurity staff and RMA planning staff) on the same page with respect to the issues and their mitigation options.

4.4. Need for wider education and communication

In addition to the need to bring council staff up to speed with issues and options relating to antifouling and in-water cleaning, there will be a subsequent need to ensure the uptake by the wider community of any guidance that is produced. The wider communication network would need to include: boat owners; slip and hard-stand operators; marina operators; coating manufacturers, retailers and applicators; and so on. Essentially, these are individuals or organisations who can encourage or adopt best practice for antifouling and vessel cleaning, and discourage or cease inappropriate practices.

4.5. Infrastructure issues

The need for suitable cleaning facilities has been identified as an issue in the text above. Hence, consideration of the existing facilities, their availability during periods of peak demand (e.g. early summer), and their adequacy for vessel owner needs, is a critical part of the development of improved guidance, or regulatory approaches, to managing antifouling and in-water cleaning. A recent regional survey of c. 500 recreational boats across the TOS region (B. Forrest, unpubl. data) revealed boat owners who had the intention of cleaning their vessels before leaving port, but were unable to get a travel-lift booking. On two occasions these boats had the clubbed tunicate *Styela clava* on the bottom of their keel.

5. CONCLUSIONS AND RECOMMENDATIONS

The goal of an effective management strategy for antifouling and vessel cleaning should be to promote practices to ensure that vessels moving within and among regions pose a minimal risk with respect to both biofouling and antifouling contaminant discharge. Achieving this outcome involves a need to address and resolve some complex issues. As described in preceding sections of this report, and summarised in Table 1, there are several significant knowledge and data gaps relating to coating selection, suitability for cleaning, and the cleaning process itself, that need to be addressed before meaningful and effective decision-making on hull cleaning (both in and out of water) can be undertaken.

Any provisions, thresholds, or conditions arising from this work should be applied in a regionally consistent manner. This ideally requires a nationally-led approach to ensure inter-regional consistency and effective action. Hence, a useful step for TDC and other interested councils should be to investigate (among councils and with central government) the appetite and possible timeframe for a national approach. The development of an NES is arguably the most attractive option, as it could be used to address both biosecurity and contaminant issues. However, assuming such a process could take many years, some councils will want to develop or finalise interim measures for regional implementation. Where regional approaches are envisaged, the discussion of issues and options in this report can be used guide the priority information needed, and the approach that would need to be taken, in order to develop an effective management regime that was widely adopted by regions. By working from the ‘bottom up’, and assuming good communication and cooperation among councils, it may be that a coordinated regional approach would lead to inter-regional consistency in the absence of nationally-driven leadership.

Table 2 provides an estimated cost to progress the work to a satisfactory endpoint for the regions. The cost range of $221K to $298 K reflects the range of options from the minimum to the ideal package of work. We suggest there is little point pursuing the project piecemeal (e.g. via a series of Envirolink grants), as what is most needed is an entire package, with a national focus that delivers to councils a ‘product’ (e.g. a guidance document and associated RMA-based rules) that they can easily pick up without the need for further investigation. There are very few options for funding a project of this scope and size. One option for councils would be to develop an Envirolink Tools proposal; however, the likelihood of a successful application would need to be weighed up against the effort required to producing one. A second option is a regional ‘crowd funding’ approach (e.g. via the councils’ Biomanagers Group). For either option, the content of this report provides the necessary information that could be readily distilled into a focused project proposal with clear deliverables.

Table 1. Synthesis of key issues, information needs and approaches that underpin develop of improved antifouling and vessel-cleaning practices nationally

Issue	Key needs	Approach
1. Antifouling coatings not meeting expected service life	Guidance and education on choice and correct application of antifouling coating	• Review antifouling coatings available post-EPA reassessment, including consultation with EPA and paint manufacturers • Survey to understand existing knowledge, attitudes and practices with respect to paint selection, sale and application, and the willingness to adopt improved approaches. Target stakeholders include the boating population, hard-stand operators, coating retailers, and professional coating applicators. • Review, consult and develop guidance on: (i) coating selection in relation to vessel operation profile; and (ii) effective antifouling application, maintenance and renewal practices. Requires consultation with EPA, coating retailers & manufacturers, maintenance providers, and professional coating applicators.
2. Key niche areas inadequately antifouled	Improved practice for antifouling the bottom of vessel keels	• Internet search and consultation with NZ hard-stand operators to: (i) review hard-stand practices in NZ and internationally; (ii) determine the barriers to improved practices; and (iii) develop practical guidance
3. Cleaning compromises the service life of antifouling coatings, and exacerbates biosecurity risk and contaminant discharge	Generic guidance on acceptable cleaning practices for different coatings types, which maximises service life, and minimises biosecurity risk and contaminant discharge	• Review literature on cleaning tools, their efficacy, potential for coating damage, and related biosecurity and contaminant discharge risk. Requires consultation with coating manufactures, technical experts, MPI and tool developers. • Survey to understand existing knowledge, attitudes and practices with respect to cleaning, and the willingness to adopt improved approaches. Target stakeholders include the boating population, hard-stand operators, cleaning service providers, government agencies. • Evaluate the need for (and scope of) further technical investigation into cleaning effects on different coating types • Provide improved guidance on acceptable cleaning practices that address biosecurity and contaminant concerns
4. Lack of regional knowledge and uptake of antifouling and cleaning guidance and best practice	Region-specific guidance, including regulatory options and infrastructure needs, for regional councils and any other stakeholders able to set 'rules' (e.g. marina operators)	• Collate regulatory approaches used in New Zealand, and assess their pros and cons (including costs for implementation) • Provide discussion document to councils and MPI that describes ways to address the information gaps relating to Conditions A-D in DOE/MPI (2015) guidelines • Undertake consultation (e.g. via workshops) with councils (e.g. biosecurity staff and RMA planning staff) and MPI to ensure that all have a similar understanding of the issues and mitigation options. • Develop policies and rules for interested councils, for inclusion in their regional coastal plans, as well as rule-based approaches for other interested stakeholders
5. Lack of regional consistency in approaches to in-water cleaning	Evaluate options for a nationally-driven approach that addresses biosecurity and contaminants	• Consultation with central government agencies able to influence national policy and direction (in particular MPI and MfE)

Table 2. Indicative costs associated with key project elements to address needs underpinning regional-level management of antifouling and vessel cleaning risks. Cost does not include consultation to progress a nationally-led approach

Key needs	Cost estimate ($)
1. Guidance and education on choice and correct application of antifouling coating	68,600 – 94,000
2. Improved practice for antifouling the bottom of vessel keels	30,000 – 40,000
3. Generic guidance on acceptable cleaning practices for different coatings types*	24,500 – 34,000
4. Region-specific guidance, including regulatory options and infrastructure needs, for regional councils and any other stakeholders able to set 'rules'	98,000 – 130,000
TOTAL	221,100 – 298,000

* Costs of undertaking stakeholder survey under component 3 are reflected in component 2 (i.e. it is assumed that surveys relating to antifouling and cleaning practices would be undertaken together).

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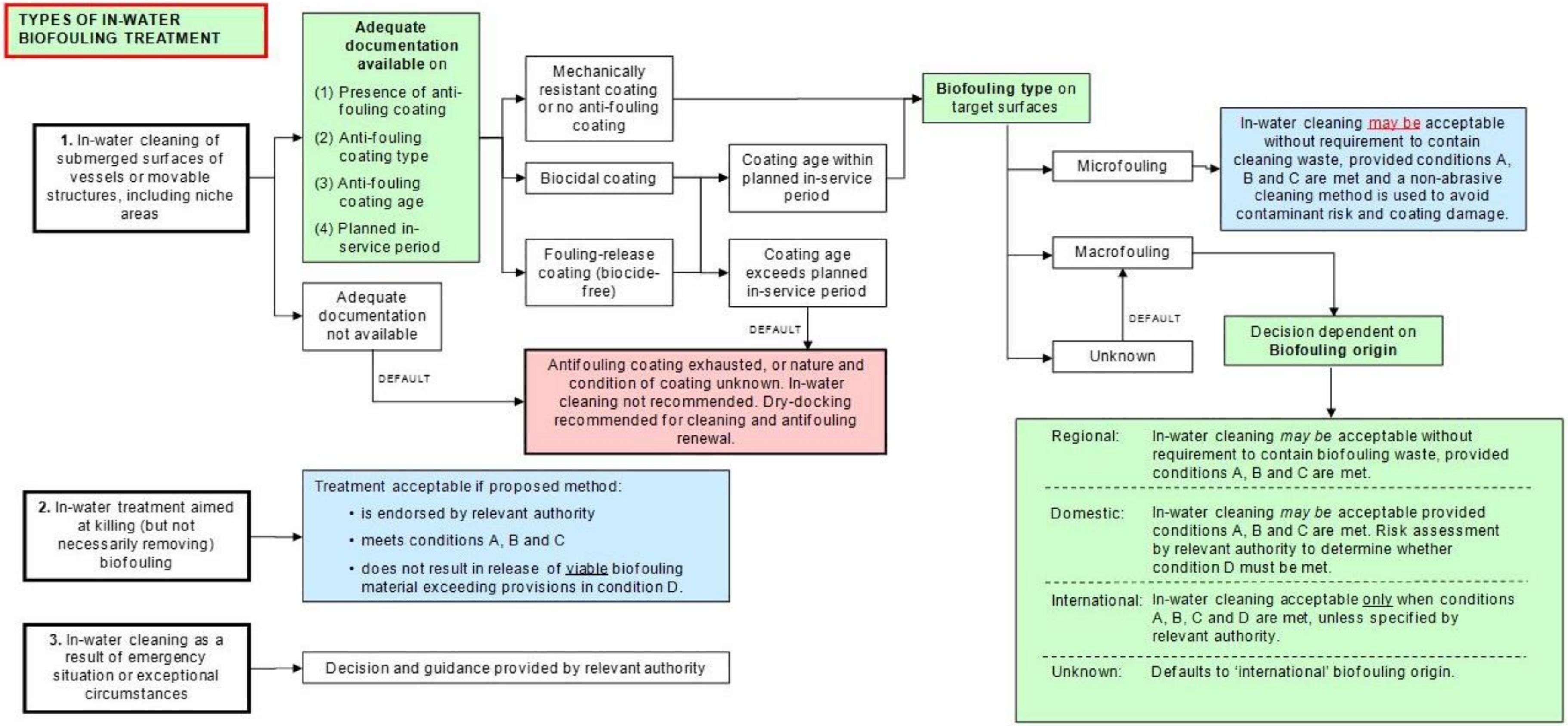
Appendix 1. Decision-support tool for in-water cleaning. This tool is designed to assist relevant authorities with making decisions about in-water cleaning practices. (DoE and MPI 2015).



Conditions for removal and/or treatment of biofouling:

A: Antifouling coating is suitable for cleaning/treatment.

B: Cleaning/treatment method does not damage coating surface.

C: Discharges meet local standards or requirements.

D: Cleaning/treatment method ensures that release of biological material into the water column is minimised through the capture and containment of biofouling waste. Cleaning methods should aim to, at least, capture debris greater than 50 µm in diameter which will minimise the release of viable adult, juvenile and larval stages of macrofouling.