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Tiakitanga Pūtaiao Aotearoa

Conduct of in-water biofouling surveys for domestic vessels

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By Dr Eugene Georgiades and Dr Daniel Kluza
Biosecurity Science and Risk Assessment Directorate

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This technical advice supports the development of criteria and processes for in-water biofouling surveys of domestic vessels.

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1 Document purpose

This document informs the development of guidance, protocols and resources for an approved provider to conduct in-water biofouling surveys of New Zealand domestic vessels. This technical advice will assist the Ministry for Primary Industries (MPI) and our stakeholders such as, Regional Councils and Unitary Authorities, in making informed decisions regarding the assessment of a vessel's hull cleanliness in the context of New Zealand's domestic biofouling pathway management approach.

In this context, MPI and other decision makers should consider this document along with other information in determining proposed measures that are practical to implement and align with all applicable legislation, while ensuring the biosecurity risk is minimised to an appropriate level of protection.

The survey methods within this technical advice document were based on international best practice and expert advice to ensure that the performance data generated are fit-for-purpose and of appropriate accuracy and precision.

For all enquiries regarding international vessels arriving to New Zealand, please see MPI's biofouling webpage.

2 Introduction

The submerged areas of vessels entering New Zealand can vary from < 100 m^2 for recreational vessels to more than 15,000 m^2 for the largest commercial vessels. The most efficient approach to survey vessels is one that focusses on those areas more prone to biofouling (i.e., niche areas and select planar surfaces).

Biofouling is not evenly distributed on the submerged surfaces of a vessel and is typically encountered on niche areas. Niche areas are those areas that may be more susceptible to biofouling attachment and growth due to different hydrodynamic forces, susceptibility to coating system wear or damage, or being inadequately or not painted. These areas include, but are not limited to, sea chests, bow thrusters, propeller shafts, inlet gratings, and dry-dock support strips. Despite accounting for a relatively small proportion of the submerged surfaces of vessels, the higher likelihood for niche areas to be fouled means that they pose a biosecurity risk to New Zealand's marine resources.

While the planar surfaces of a vessel's hull are less likely to be fouled than niche areas, the occurrence of biofouling on these surfaces may be exacerbated by:

- vessel type and speed (e.g., slow moving vessels or barges are prone to fouling);
- vessel operational profile (e.g., long idle periods, operation in areas of high fouling pressure);
- lower hydrodynamic drag (e.g., stern areas); and
- higher hydrodynamic drag or collisions (e.g., bow areas).

This document contains the following technical advice:

- protocols for a standardised approach for in-water biofouling surveys of submerged and topside surfaces of vessels;
- attributes for the approval of suitably qualified vessel surveyors and companies;
- descriptions of the number, type and labelling of digital photographic or videographic images; and
- a list of inclusions for reporting by vessel surveyors including a survey form and summary templates.

3 Objectives of a vessel biofouling survey

The objective of an in-water vessel survey is to provide physical evidence for decision makers to verify a vessel's hull cleanliness in the context of New Zealand's domestic biofouling pathway management approach. Verification of compliance is accomplished by independent survey and reporting of the biofouling levels on a vessel's submerged and topside surfaces that are prone to biofouling by a suitably qualified vessel surveyor (Appendix 1).

The intention of the survey is not to estimate the abundance of individual species on the vessel (e.g., biomass, or numbers of individuals), rather it provides an estimate of the biofouling extent.

The Level of Fouling (LoF) index is used to quantify the extent of biofouling observed (Appendix ; Appendix). Identification of key biofouling types and broad taxonomic groups can assist the allocation of LoF (Appendix). Determinations of viability can also inform decisions on biofouling risk, for example, after cleaning or treatment has been conducted or desiccation of fouling en route to recipient destinations within New Zealand (Appendix 5).

An approved surveyor should be independent from the vessel owner/operator/company when undertaking a vessel biofouling survey.

4 Survey procedure

All surveys should be carried out in the presence, and under the direction of an approved provider with experience in undertaking biofouling surveys of the submerged surfaces of vessels (i.e., an approved vessel surveyor (see Section 5)).

The surveyor should complete the vessel survey form and summary templates (see Section 8) which shall be sent to the decision maker.

The survey procedure includes:

- obtaining copies of the vessel's General Arrangement (GA), Docking Plan (i.e., placement of dry-docking blocks) and internal seawater system schematics to enable the formation of a survey plan that identifies all submerged areas to be surveyed;
- in-water or in-dock survey of the vessel's typically submerged surfaces;
- survey of the vessel's internal niche areas (e.g., sea chests, pipework, bilge spaces, anchor cable lockers and strainers);
- survey of vessel topsides and any immersible equipment; and
- survey of the Chief Engineer's Log (to identify reported blockages, reduced seawater pressure or elevated cooling temperatures that imply biofouling build up).

The in-water survey may include, but is not limited to:

- the vessel surveyor undertaking a physical survey using underwater breathing apparatus;
- the vessel surveyor remotely directing divers to undertake the survey using live audio and visual communications; or
- the vessel surveyor directing remotely operated vehicle (ROV).

The survey should make all reasonable attempts to access and survey all submerged and relevant topside areas as thoroughly and safely as possible. A rationale should to be provided for those areas that could not be surveyed.

To enable accurate assessment, verification and for future reference, video or digital still photographs should be included for all areas surveyed regardless of the presence of biofouling (including internal and external niche areas) (Section 6). This includes determinations of viability (Appendix 5).

To minimise delays and ensure the survey is undertaken in an efficient and safe manner, the approved surveyor shall request the Vessel Master to prepare the vessel (e.g., all bilge spaces, strainer boxes, anchor cable lockers) and immersible equipment (e.g., anchors, anchor chains, ROVs) prior to the survey.

The surveyor should engage the chief engineer, or other appropriate staff, to assist the development of the survey plan.

In-water surveys should occur where water clarity is at its highest and currents are minimised.

5 Approval of suitably qualified vessel surveyors

Vessel surveyor approvals can be given to organisations. In this case, individuals within that organisation will be assessed according to the criteria below and should be present at all times during the conduct of a vessel survey.

The application approval should contain the name, address, contact details (including phone number(s) and email address(es)), relevant qualifications and practical experience of the individual, or in the case of an organisation of its employees, contractors or members, and two independent referees as to relevant professional expertise.

Key criteria for consideration of vessel surveyor approval:

1) Professional experience
    a. Experience, skills and attributes should include some of the following: commercial or scientific diving, conducting or directing in-water vessel biofouling surveys, remote operated vehicle operation, in-water photography/videography, marine biological research, ecological consulting, biosecurity, or taxonomy.
2) Professional outputs
    a. Provision of examples of previous vessel surveys undertaken.
3) Understanding of New Zealand's survey requirements
    a. Familiarity with New Zealand's vessel biofouling survey requirements, the assignment of the LoF index on the basis of the amount and diversity of biofouling present, and the identification of key biofouling types and broad taxonomic groups.
4) Professional achievement and commitment
    a. Employment history and commitments to professional accountability, quality assurance and quality control systems, staff training (as applicable), adherence to occupational health and safety, and professional memberships.

Any organisation requesting approval should submit their operating manual for evaluation. This manual should provide the approving organisation with the relevant information to make a decision as to their ability to conduct and report an in-water survey in accordance with this document.

Approval of a surveyor may be suspended or cancelled in situations where the approving organisation is not satisfied of that surveyor's competency. A surveyor can reapply for approval.

6 Digital images and video communications

6.1 GENERAL

Videographic and digital photographic images should be used to verify LoF ranks and organism viability following a survey.

Images of fouled areas need to be clear to enable broad organism identifications and assessment of LoF of the area and organism viability. To ensure the images taken are of sufficient detail, the following guidance is provided:

- a distance of approximately 30 cm from the vessel surface;
    - a distance rod can ensure a constant distance;
- lower distances can be used in sampling locations with poor visibility; and
- larger distances can be used to show the extent of fouling over large areas.

High quality clear photographs of all predetermined equipment or locations should be obtained regardless of the presence of biofouling.

The CCTV of the entire survey, including diver to surface communications, should be recorded onto an external drive or DVD. This should be supplied to the decision maker.

A minimum of 3 digital images should be provided to the decision maker from each survey location (i.e., 3 digital images for each allocation of LoF - where the LoF changes). That is, the minimum number of digital images is three for the location surveyed if the LoF is the same across the area of

that location. However, further digital images are to be provided if the LoF is variable across the area surveyed (i.e., 3 digital images are to be taken for each change of LoF).

Determinations of viability should be recorded videographically with a minimum of 3 digital images also provided for each determination of viability. These should be supplied to the decision maker.

6.2 VIDEO COMMUNICATIONS

Divers should be connected to high quality closed circuit television (CCTV) and reliable communications equipment at all times. This system should allow the viewer to identify fouling to broad taxonomic groups (e.g., macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms; Appendix 4). Communications equipment should allow continuous two way diver/surface communication throughout the survey.

The CCTV camera should be stabilised (e.g., hat mounted) and diver should be capable of taking high quality still colour photographs of all predetermined survey areas (i.e., hull areas, external and internal niche areas).

6.3 DIGITAL IMAGES

At least two digital underwater cameras should be on-site for each survey with appropriate housings, strobes or lights, and replacement batteries and chargers.

Digital cameras should be capable of obtaining high quality colour digital images underwater in poor lighting and poor water clarity (e.g., at least 4-5 mega pixel (2,560 x 1,920) images). Images should allow the viewer to identify fouling to broad taxonomic groups (e.g., macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms; Appendix 4).

Digital cameras should be capable of "date stamping" photographs (i.e., correct date and time should be incorporated within photographs). The photographs should include indexing to enable determination of where and when each image was recorded so that they may be cross-matched with the video images submitted.

Each image should be labelled to identify the image's location during the survey.

7 Survey design

7.1 SURVEY OF WIND-AND-WATERLINE AND HULL AREAS

Biofouling on planar submerged surfaces typically occurs on:

1) Wind-and-waterline
    a. The antifouling coating is often damaged during berthing operations or by striking floating debris or compromised due to turbulent water movement, paint degradation from wet-to-dry cycles or UV degradation of the biocide.
2) Bow area
    a. Prone to antifouling paint wear and collision damage.
3) Stern area
    a. Reduced hydrodynamic drag.

The wind-and-waterline areas should be surveyed by a series of horizontal transects of both port and starboard sides of the vessel.

The bow and stern areas should be surveyed by vertical transects of both port and starboard sides of the vessel.

7.2 HORIZONTAL WIND-AND-WATERLINE TRANSECTS

For the horizontal wind-and-waterline transects, the diver surveys the hull from the waterline to approximately 4 m below along the entire length of both sides of the vessel (Figure 1).

Four horizontal transects, 1 m wide, should be made on each side covering:

- the waterline;
- 1 m below the waterline;

- 2 m below the waterline; and
- 3 m below the waterline.

The waterline transect is divided into three parts, for example:
- waterline (stern);
- waterline (amidships); and
- waterline (bow).

Each of these transect parts is to be further separated into 1 m^2 quadrats and allocated a separate LoF (e.g., a 20 m transect would have 20 separate LoF ranks – however, if the LoF allocated is the minimum number of images recorded is 3). The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3). The reporting template should be modified to accommodate each quadrat where LoF ranks are allocated (Section 8). In low-visibility environments multiple dives along each transect may be required to achieve the survey area.

For each transect surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each transect (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.3 VERTICAL BOW TRANSECTS

Vertical transects should be conducted on both sides of the vessel at the bow (Figure 2).

The diver should slowly descend down the vertical transect from the waterline to the deepest part of the hull. The width of observation should be approximately 1 m.

Each transect is to be separated into 1 m^2 quadrats and allocated a separate LoF. The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3). The reporting template should be modified to accommodate each quadrat where LoF ranks are allocated (Section 8). In low-visibility environments multiple dives along each transect may be required to achieve the survey area.

A minimum of 3 digital images should be taken for each transect (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.4 VERTICAL STERN TRANSECTS

Vertical transects should be conducted on both sides of the vessel at the stern. Transects are best positioned approximately 5 m from the stern, where the hull curves inwards (Figure 2).

The diver should slowly descend down the vertical transect from the waterline to the deepest part of the hull. The width of observation should be approximately 1 m.

Each transect is to be separated into 1 m^2 quadrats and allocated a separate LoF. The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3). The reporting template should be modified to accommodate each quadrat where LoF ranks are allocated (Section 8). In low-visibility environments multiple dives along each transect may be required to achieve the survey area.

For each transect surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each transect (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.5 TRANSOM TRANSECTS

During the transom transect the diver surveys the hull from the waterline to approximately 4 m below along the entire length of the transom (as applicable) (Figure 3).

Four horizontal transects, 1 m wide, should be made covering (as applicable):

- the waterline;
- 1 m below the waterline;
- 2 m below the waterline; and
- 3 m below the waterline.

Each transom transect is divided into three parts, for example:
- waterline (port);
- waterline (mid); and
- waterline (starboard).

Each of these transect parts is to be further separated into 1 m^2 quadrats and allocated a separate LoF. The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3). The reporting template should be modified to accommodate each quadrat where LoF ranks are allocated (Section 8). In low-visibility environments multiple dives along a transect may be required to achieve the survey area.

For each transect surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each transect (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.6 SURVEY OF NICHE AREAS

Vessel niche areas are more prone to biofouling compared to the hull planar surfaces. The number and type of niche areas varies from vessel to vessel, highlighting the importance of sourcing the vessel General Arrangement, Docking Plan and internal seawater system schematics prior to survey. This will enable preparation of a plan that identifies all of the specific niche areas to be targeted for survey.

Each niche area present on a vessel should be surveyed and allocated with a LoF rank:
- niche areas ≤ 1 m^2 are to be allocated a single LoF rank; and
- niche areas > 1 m^2 are to be allocated a separate LoF ranks for each 1 m^2 quadrat.

The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3).

For each niche area surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each niche area (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

The most common niche areas on the submerged surfaces of vessels are (Figure 4):
- rudder and rudder shaft/recess [RS];
- propeller and propeller shaft* [PS];
- anodes* (often several along a hull) [AN];
- dry-docking support strips (areas along keel bottom on which the vessel rests while in dry-dock thus lack antifouling paint) [DDSS];
- sea chest gratings* [GR];
- sea chests and internal pipework* [SC];
- openings on intake or outflow pipes* [OP];
- bilge keel* [BK];
- bow thrusters* [BT]; and
- areas of paint damage* [PD].

The abbreviations in brackets may be used for labelling digital images.

Niche areas marked by an asterisk (*) are likely to be present on both sides of a vessel, in such cases all identified niche areas should be surveyed and LoF recorded. A rationale should to be provided for those niche areas that could not be surveyed.

Some vessels have more than one of a particular type of niche area, for example, many vessels have multiple sea chests and gratings (usually 2-8 depending on vessel size) and dry-docking support strips (potentially > 10). On vessels where more than one of a particular type of niche area is present, all niche areas should be surveyed. The reporting template should be modified to accommodate these areas (Section 8).

7.6.1 Sea chests and internal pipework

Internal seawater systems vary from vessel to vessel, some of which are difficult to access. The vessel survey should include all accessible internal seawater systems and include a record of those systems not surveyed and rationale as to why (for example, lack of time, gate values seized). Sea strainers can be used to access internal seawater systems, the layout and number of which is also vessel dependent. Therefore, a survey plan should be established based on vessel schematics and following engagement of the vessel's chief engineer.

The survey should include all accessible sea strainers and include sea strainer housings, lids and associated pipework. Sea strainers and housings should be surveyed as the lids are removed and systems should be drained to enable unrestricted access to associated pipework. Specific equipment (e.g., pipe inspection camera) should be used to assist access for allocation and recording of LoF for internal pipework.

Internal seawater systems and associated equipment that should be considered for survey include, but are not limited to:

- ballast water systems;
- fire-fighting (main and emergency) systems;
- engine cooling (main, auxiliary and/or generators);
- drinking water (desalination/reverse osmosis) and
- air conditioning and chiller units
- hydraulic cooling and heating systems (e.g. ROVs, diving systems, thrusters); and
- deck servicing systems.

For in-water surveys:
Each of the above areas on a vessel should be surveyed and be allocated with a LoF rank:

- niche areas ≤ 1 m^2 are to be allocated a single LoF rank; and
- niche areas > 1 m^2 are to be allocated a separate LoF ranks for each 1 m^2 quadrat.

The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3).

For each niche area surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each internal niche area (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

For on-vessel surveys:
Each of the above areas on a vessel should be surveyed and be allocated with a LoF rank:

- niche areas ≤ 2 m^2 are to be allocated a single LoF rank; and
- niche areas > 2 m^2 are to be allocated a separate LoF ranks for each 2 m^2 quadrat.

The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3).

For each niche area surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each internal niche area (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.6.2 Ballast water tank surveys (as possible/applicable)

The surveyor should obtain schematic diagrams and engage the vessel's chief engineer to identify all ballast tanks and their access points. The survey plan for ballast tanks should take into account their

accessibility, size, shape, position and number. The vessel survey should include all accessible ballast water tanks or include a record of those tanks not surveyed and a rationale as to why.

Each part of each ballast tank is to be separated into 2 m^2 quadrats and allocated a separate LoF. The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3). The reporting template should be modified to accommodate the inclusion of each area where LoF ranks are allocated (Section 8).

For each ballast tank surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each internal niche area (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

7.6.3 Opportunistic observations

Biofouling encountered outside of the designated hull and wind-and-waterline transects and surveys of identified niche areas should be allocated a LoF rank over a 1 m^2 area with the appropriate recording of images (see Section 6). The reporting template should be modified to accommodate these areas (Section 8).

7.6.4 Topside surveys

Topside surveys should include surfaces (including equipment) above the waterline that have the potential to be exposed to the marine environment. Topside surveys are likely to be unique for each vessel and may include, but are not limited to, the following surfaces:

- anchors, anchor chains, chain lockers, cables, winches, sheave rooms;
- mooring lines, fenders, floats and buoys;
- safety equipment (e.g., life rings, rafts and boats);
- diving equipment and ROVs;
- acoustic positioning equipment; and
- miscellaneous equipment for project vessels (e.g., drills, dredges, piping, environmental monitoring equipment).

Some vessels have more than one of a particular immersible equipment type that may be exposed to the marine environment, for example, many vessels have more than one anchor. On vessels where more than one of a particular immersible equipment type is present, all equipment should be surveyed. The reporting template should be modified to accommodate the inclusion of each of these areas (Section 8).

Each piece of immersible equipment on a vessel should be surveyed and be allocated with a LoF rank:

- equipment ≤ 2 m^2 are to be allocated a single LoF rank; and
- equipment > 2 m^2 are to be allocated a separate LoF ranks for each 2 m^2 quadrat.

The LoF rank should be allocated on the basis of the amount and diversity of the biofouling encountered (Appendix 2; Appendix 3).

For each separate surface or piece of immersible equipment surveyed, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the overall LoF.

A minimum of 3 digital images should be taken for each topside surface assessed (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

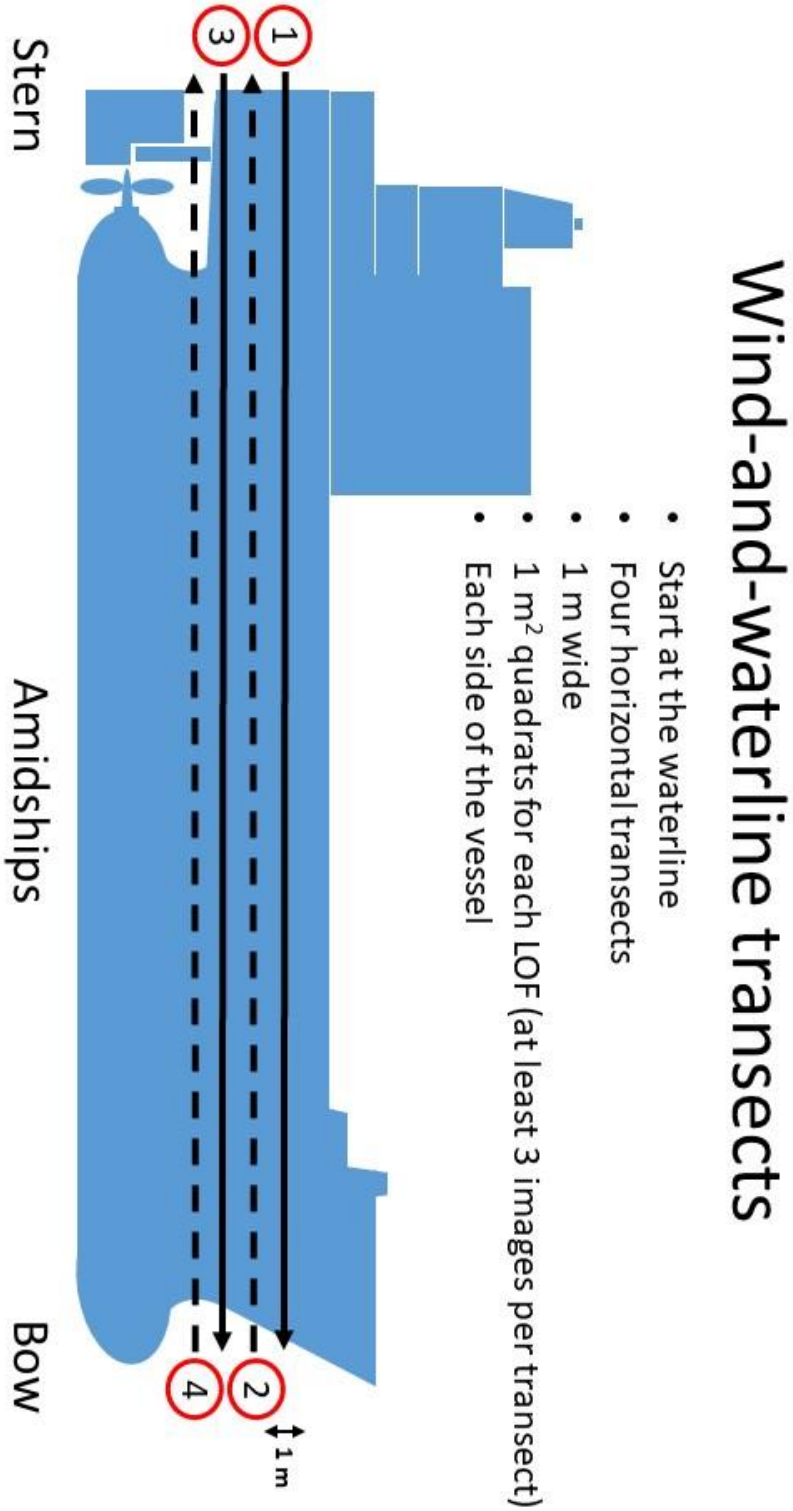


Figure 1: Biofouling survey of hull areas using wind-and-waterline transects.

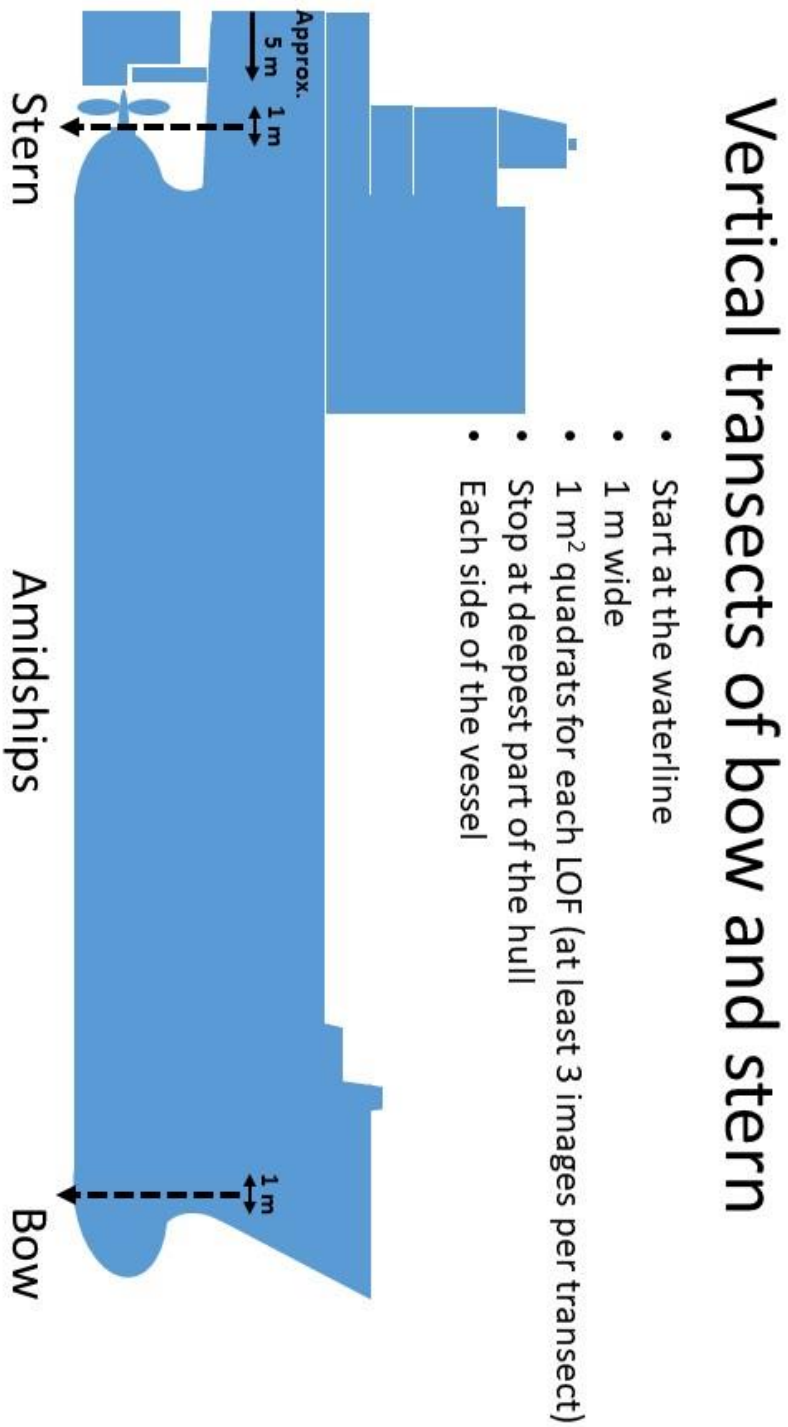


Figure 2: Biofouling survey of hull areas using vertical bow and stern transects.

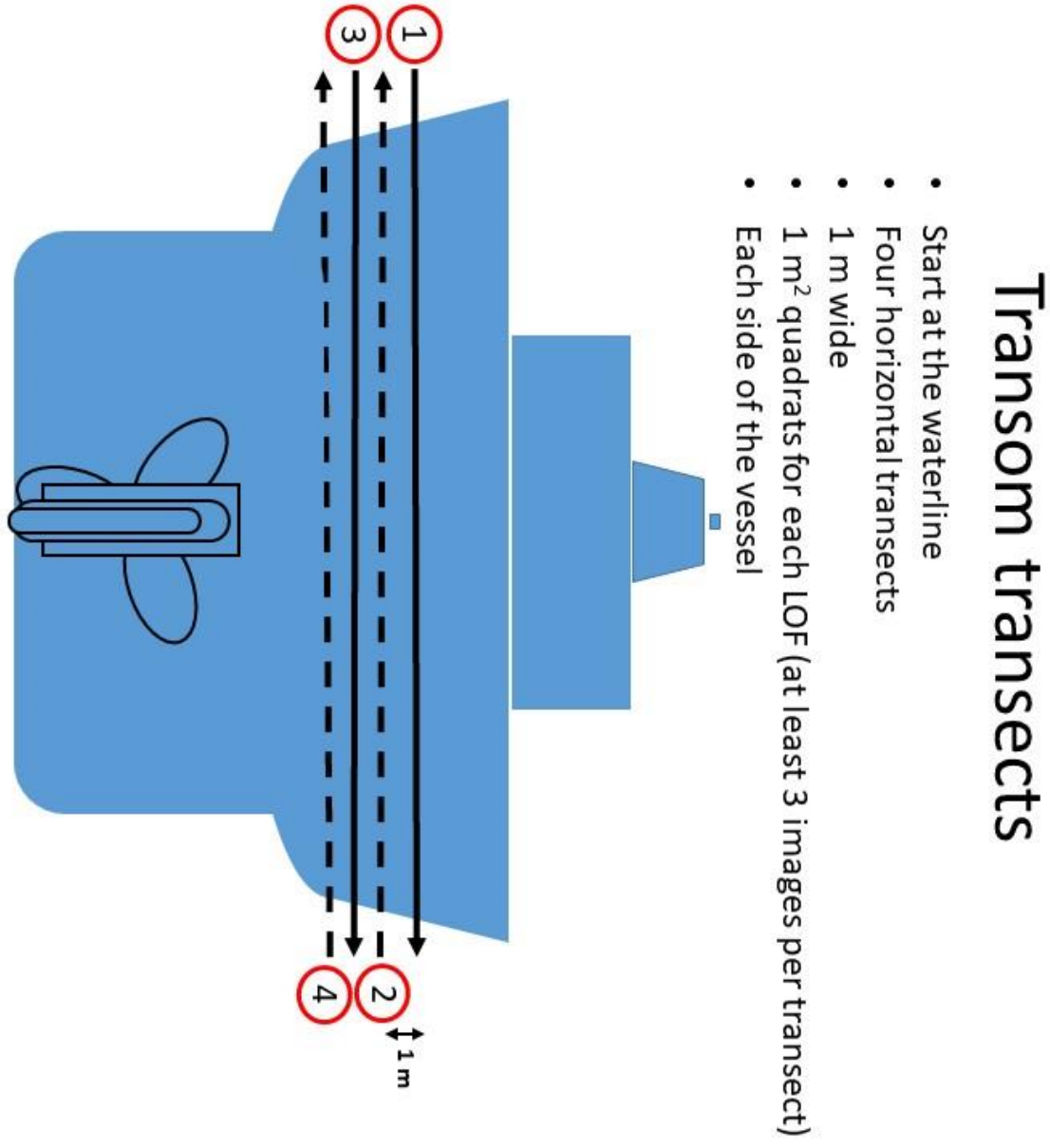


Figure 3: Biofouling survey of hull areas using transom transects.

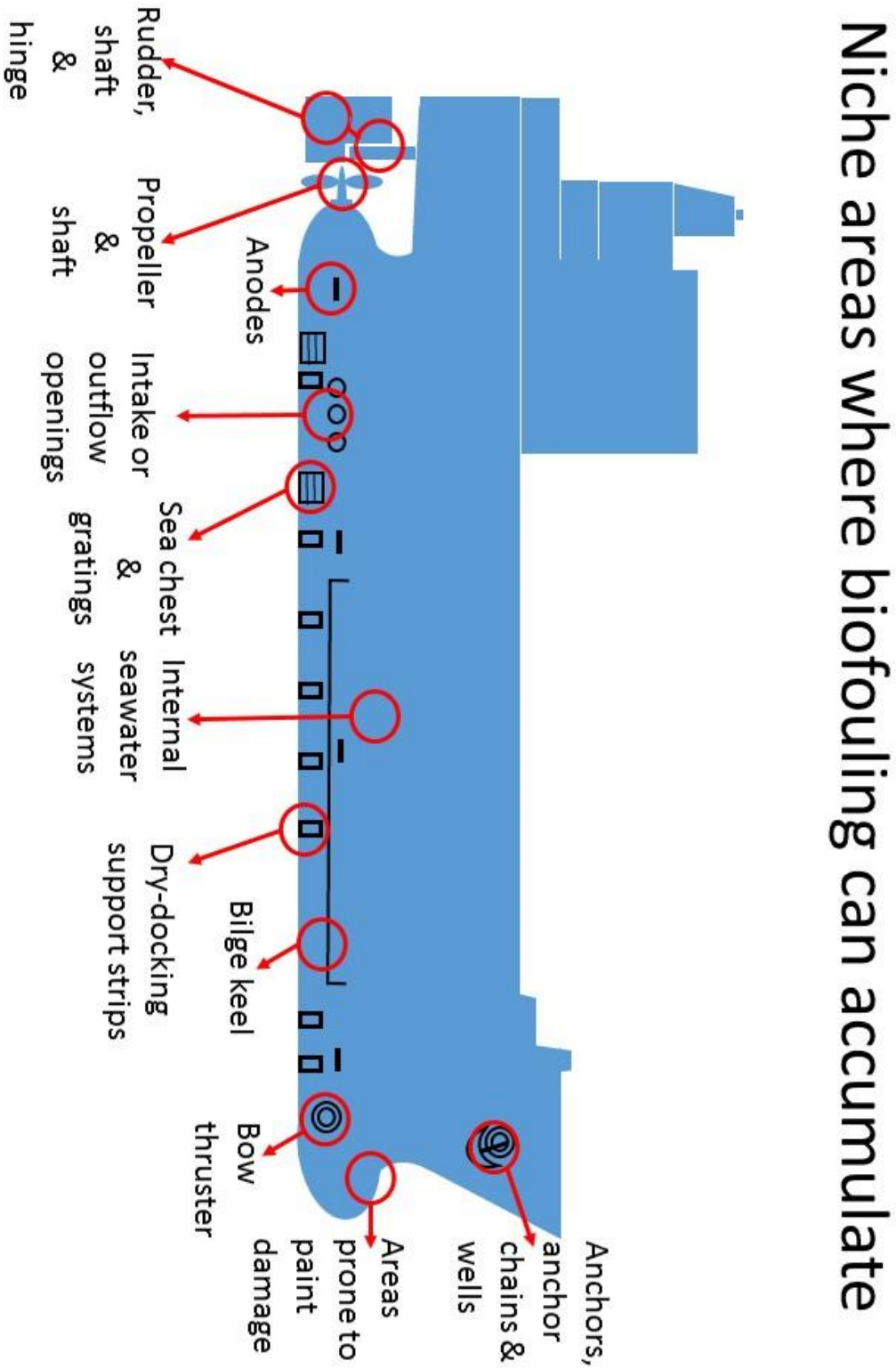


Figure 4: Typical niche areas found on a vessel.

8 Reporting templates for biofouling surveys

This section contains reporting inclusions and templates that vessel surveyors should complete and submit to the decision maker prior to movement of the vessel. The objective of the templates is to facilitate the submission of comprehensive, standardised and usable reports.

8.1 INITIAL REPORTING

The following documentation should be supplied to the decision maker *within 24 hours* following completion of the in-water survey.

8.1.1 Summary

The summary provides an overview of the biofouling survey. This should include a brief background of the vessel, a concise summary of the survey activities undertaken and a summary of the key findings. The following vessel particulars should be included:

1) Vessel name;
2) Length overall (LOA);
3) Beam; and
4) Draft.

The summary should be written to be stand alone and not be longer than 2 pages.

8.1.2 Survey details and methods

Inspection details and methods should include:

1) Personnel and equipment used;
2) Physical conditions, weather conditions and visibility; and
3) General Arrangement, Docking Plan and internal seawater system schematics with key survey areas identified for hull, wind-and-waterline and niches.

This section should highlight where there were parts of the vessel that could not be surveyed, along with the reasons why they could not be surveyed (as appropriate).

The methods section should also be used to explain any limitations of the survey.

8.1.3 Results

The results section consists of:

1) *Completed* vessel checklist and survey form (see template below); and
2) *Completed* immersible equipment checklist and survey form (see template below).

Images for each allocated LoF should be supplied to the decision maker (e.g., appropriately arranged, filed and labelled on an external drive, DVD, file share service, etc.).

8.1.4 Appendices

The appendices are to provide documentation and evidence to support the survey results. This information may include, but is not limited to:

- images (to allow independent assessment, all original images are to be provided to the decision maker in an appropriate format, including easy to access filing and labelling); and
- CCTV recordings from diving or ROV surveys should be provided to the decision maker (e.g., DVD, external drive or file share service).

8.2 ADDITIONAL REPORTING

The following documentation should be supplied to the decision maker within 10 working days following completion of the in-water survey.

8.2.1 Background

The background provides the specific details that assist future vessel risk profiling, including:

Vessel particulars

1) Name;
2) Owner/manager;

3) Port of registry;
4) Flag;
5) IMO number;
6) Class;
7) Year built;
8) Fuel capacity;
9) Length overall (LOA);
10) Beam;
11) Draft;
12) Gross tonnage;
13) Number of sea chests;
14) Total propulsion;
15) Azimuth thruster; and
16) Service speed.

Maintenance and travel history

1) Date of last antifouling paint renewal;
2) Antifouling coating system(s)
    a. Antifouling certificates and descriptions of use (e.g., dry film thickness, expected service life);
3) Marine growth prevention system(s)
    a. Is system currently operational?
    b. System type (e.g., chlorine, anode, etc.);
    c. Does system treat all internal systems of the vessel?
    d. Frequency and concentration of dose; and
    e. Last dose applied (date);
4) Date of last in-water maintenance (i.e., biofouling removal or treatment) of external submerged surfaces;
5) Date of last in-water maintenance (i.e., biofouling removal or treatment) of internal surfaces;
6) Date and location of last in-water survey, brief description of results and maintenance undertaken, including copies of:
    a. Previous survey report; and
    b. Previous maintenance activity report (e.g., biofouling removed or treated);
7) List of countries visited since last dry-dock or maintenance activity and location;
8) Period(s) of idleness (> 10 days) since last dry-dock or maintenance activity and location.

8.2.2 Results

This section includes the results from all aspects of the survey and provides the rationale to support them. This section may be broken up into relevant sub-sections that include specific descriptions of all locations surveyed and LoF ranks allocated (i.e., each sub-section should include details and rationale of each LoF allocated and be accompanied or have direct reference to the high quality images from which each assessment was made).

Information presented in the results tables should be cross referenced to specific photographs presented in the Appendix or to those provided to the decision maker. In circumstances where niche areas, such as anodes, are surveyed the number surveyed or not surveyed should be specified. Results can be summarised in tables (see templates below).

8.2.3 Appendices

The appendices are to provide documentation and evidence to support the survey conclusions. This information should be in addition to what was submitted with the *Initial Report*.

9 Acknowledgements

The document is based on the inspection guidance within the Department of Conservation Regional Coastal Plan Kermadec and Subantarctic Islands (Appendix 4 is based on Floerl *et al.* 2010[1]) and Woodside Energy Ltd Invasive Marine Species Energy Plan (Woodside 2014[2]). The document was improved following expert review from within MPI (Abraham Growcott, Tracey Bates, Malindi Gammon, Katie Lubarsky, Kathy Walls) as well as from the Australian (Sonia Gorgula), Western Australian (Dr Justin McDonald), Californian (Chris Scianni) and Hawaiian (Jules Kuo) Governments. The authors specifically wish to thank Dr Ashley Coutts (Biofouling Solutions Pty Ltd) for his expert technical input.

[1] Floerl O, Wilkens S, Inglis G (2010). Development of a template for vessel hull inspections and assessment of biosecurity risks to the Kermadec and sub-Antarctic Islands Regions. NIWA Report No. CHC2010-086.
[2] Woodside Energy Limited (2014). Contractor information pack for the management of invasive marine species. Version 2.

10 Appendix 1

Checklists and templates

VESSEL CHECKLIST AND SURVEY FORM		
Ref:	Lead surveyor: Personnel involved:	Survey location: Name of anchorage or Latitude and Longitude (if offshore)
Date:	Vessel number:	Vessel type:
Date of last docking:	Survey type: In-water	
Date of last AFC application:	Voyage history verified:	
Date of last hull clean:	Expected New Zealand itinerary:	

Item	Area	Description (to be completed for every specified area within each designated transect or niche area)	Surveyed (Yes; No or N/A)	LoF	Viability (Yes/No)	Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)
1	Hull surface	Vertical stern transect port (*n* = 1, 2, 3, etc.)*****				*******Due to the size and number of many of the listed areas, it is likely that many LoF ranks will be allocated (see Section 6; Section 7). This is particularly so for areas that are split into quadrats. In such instances, additional numbered rows are to be added to the template to accommodate each LoF allocation, for example:* *Vertical stern transect port 1, quadrat 1,* *Vertical stern transect port 1, quadrat 2,* *Vertical stern transect port 1, quadrat 3, etc.* *Vertical stern transect port 2, quadrat 1,* *Vertical stern transect port 2, quadrat 2,* *Vertical stern transect port 2, quadrat 3, etc.* *Vertical stern transect port 3, quadrat 1,* *Vertical stern transect port 3, quadrat 2,* *Vertical stern transect port 3, quadrat 3, etc.* *Dry-docking support strip 1* *Dry-docking support strip 2* *Dry-docking support strip 3, etc.* *Sea chest grating 1* *Sea chest grating 2* *Sea chest grating 3, etc.* ***"Blanket" LoF allocations may be made but only across defined surveyed areas where there is no change in LoF.***

Item	Area	Description (to be completed for every specified area within each designated transect or niche area)	Surveyed (Yes; No or N/A)	LoF	Viability (Yes/No)	Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)
		Vertical stern transect port 1 (Overall), 2 (Overall), 3 (Overall), etc.**	Mode	Range	Yes/No	***** For each transect or niche area surveyed, where changes in LoF are recorded, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the Overall LoF (See* Appendix 2*).*** *In such instances, additional rows with Mode are to be added to the template to accommodate each LoF mode and range allocation.* *For example:* *Vertical stern transect port 1* (Mode LoF: XX; Range XX – YY; Viability Y/N). *Vertical stern transect port 2* (Mode LoF: XX; Range XX – YY; Viability Y/N). *Vertical stern transect port 3* (Mode LoF: XX; Range XX – YY; Viability Y/N), etc. *Dry-docking support strip 1* (Mode LoF: XX; Range XX – YY; Viability Y/N). *Dry-docking support strip 2* (Mode LoF: XX; Range XX – YY; Viability Y/N). *Dry-docking support strip 3* (Mode LoF: XX; Range XX – YY; Viability Y/N), etc. *Sea chest grating 1* (Mode LoF: XX; Range XX – YY; Viability Y/N). *Sea chest grating 2* (Mode LoF: XX; Range XX – YY; Viability Y/N) *Sea chest grating 3* (Mode LoF: XX; Range XX – YY; Viability Y/N), etc.
		Vertical stern transect starboard				
		Waterline port (bow)				
		Waterline port (amidships)				
		Waterline port (stern)				
		Waterline port 1 m (bow)				
		Waterline port 1 m (amidships)				
		Waterline port 1 m (stern)				
		Waterline port 2 m (bow)				
		Waterline port 2 m (amidships)				
		Waterline port 2 m (stern)				
		Waterline port 3 m (bow)				
		Waterline port 3 m (amidships)				
		Waterline port 3 m (stern)				
		Waterline starboard (bow)				
		Waterline starboard (amidships)				
		Waterline starboard (stern)				

Item	Area	Description (to be completed for every specified area within each designated transect or niche area)	Surveyed (Yes; No or N/A)	LoF	Viability (Yes/No)	Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)
		Waterline starboard 1 m (bow)				
		Waterline starboard 1 m (amidships)				
		Waterline starboard 1 m (stern)				
		Waterline starboard 2 m (bow)				
		Waterline starboard 2 m (amidships)				
		Waterline starboard 2 m (stern)				
		Waterline starboard 3 m (bow)				
		Waterline starboard 3 m (amidships)				
		Waterline starboard 3 m (stern)				
		Bow area (inc. bulbous bow) port				
		Bow area (inc. bulbous bow) starboard				
		Transom waterline (port)				
		Transom waterline (mid)				
		Transom waterline (starboard)				
		Transom waterline 1 m (port)				
		Transom waterline 1 m (mid)				
		Transom waterline 1 m (starboard)				
		Transom waterline 2 m (port)				
		Transom waterline 2 m (mid)				
		Transom waterline 2 m (starboard)				
		Transom waterline 3 m (port)				
		Transom waterline 3 m (mid)				
		Transom waterline 3 m (starboard)				
		Dry-docking support strips				
		Opportunistic observation				
2	Keel, bilge keels, and skeg	Keel				
		Bilge keels				
		Skegs				
3	Seawater inlets, sea chests and outlets	Starboard inlet/sea chest and gratings				
		Starboard outlets				
		Port inlet/sea chest and gratings				
		Port outlets				
4	Sacrificial anodes/	Starboard anodes/impressed current blocks				

Item	Area	Description (to be completed for every specified area within each designated transect or niche area)	Surveyed (Yes; No or N/A)	LoF	Viability (Yes/No)	Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)
	impressed current blocks/ earthing plates	Port anodes/impressed current blocks				
		Propellers/steering gear anodes/impressed current blocks				
		Earthing plates				
5	Sounder and speed log	Echo sounder transducers				
		Speed log fairings				
6	Propulsion units	A-bracket/rope guard/azimuth housing				
		Propeller shaft/azimuth centre				
		Propeller blades				
		Propeller boss(s)				
		Bow/stern thrusters				
7	Rudder, rudder stock, post	Rudder				
		Rudder stock				
		Rudder post				
8	Anchoring	Anchors, chains and lockers (inc. free of sediment)				
9	Internal seawater systems and bilge spaces	Strainer(s) and pipework for starboard engine cooling				
		Strainer(s) and pipework for port engine cooling				
		Strainer(s) and pipework for auxiliary/generators				
		Strainer(s) and pipework for fire main				
		Strainer(s) and pipework for deck services				
		Date of last pipework flushing/chemical treatment				
		Date of last bilge space clean up				
	Additional niche areas identified					

OUTCOME OF VESSEL SURVEY

Based on the observations made by the vessel surveyor (NAME) _____, the vessel (NAME) _____ has been surveyed according to the decision maker agreed survey procedure.

Areas of concern viable fouling include (as applicable):

Completed by:_____ of _____

Signature:_____ Date ____/___/_____

Vessel representative/delegate:_____

TOPSIDES AND IMMERSIBLE EQUIPMENT SURVEY FORM					
Ref:	Lead surveyor:	Survey location:			
Date:	Vessel number:	Vessel type:			
Item	**Description (to be completed for every specified area within each designated transect or niche area)**	**Surveyed (Yes; No or N/A)**	**LoF**	**Viability (Yes/No)**	**Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)**
1					
1*	Overall	Mode	Range	Yes/No	***For each surface area or piece of immersible equipment surveyed, where changes in LoF are recorded, the mode of the LoF (i.e., the most frequent ranking) and the LoF range (i.e., highest and lowest ranking) is to be used to report the Overall LoF (See* Appendix 2*).*** *In such instances, additional rows with Mode are to be added to the template to accommodate each LoF mode and range allocation.* *For example:* *1* (Mode LoF: XX; Range XX – YY; Viability Y/N). *2* (Mode LoF: XX; Range XX - YY; Viability Y/N). *3* (Mode LoF: XX; Range XX - YY; Viability Y/N), etc.
2					
3					
4					
5					
6					
7					
8					

The topsides and immersible equipment of vessel (NAME)_____, has been surveyed according to the decision maker agreed survey procedure.
Areas of concern fouling include (as applicable):

Completed by:_____ of _____

Signature:_____ Date ____/___/_____

Vessel representative/delegate:_____

11 Appendix 2

Criteria for allocating level of fouling (LoF) ranks

The Level of Fouling (LoF) scale was developed by NIWA as an effective and efficient method for quantifying the extent and diversity of biofouling on vessel hulls (Floerl *et al.,* 2005, *Environmental Management* 35(6): 765-778). It has since been used in a variety of MPI commissioned research projects and underpins the vessel hull survey procedures developed by NIWA for the Department of Conservation (Floerl *et al.,* 2010, NIWA Report No. CHC2010-086). More recently, an updated LoF guidance document was prepared by Davidson *et al.* (2019)[3].

LoF ranks range from 0 to 5 and the various ranks along with example images are provided below.
It is important to note that macrofouling organisms (e.g., barnacles, tubeworms, bivalves, macroalgae, etc.) are *absent* from areas described as LoF 0 (i.e., entirely free of biofouling) or LoF 1 (i.e., slime layer only). **Therefore, the lowest LoF rank that can be allocated to an area where there is a single barnacle, bivalve or other macrofouling organism, is a LoF 2.**

Surveyors should be able to allocate LoF ranks confidently and consistently, with minimal variation among observations and observers.

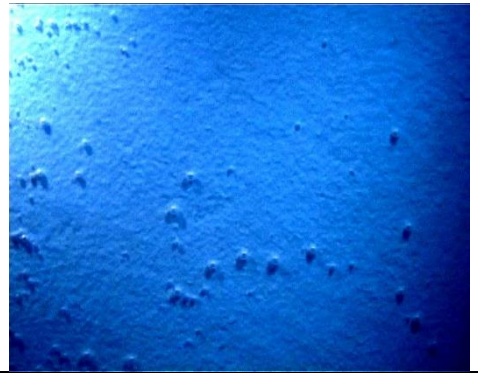
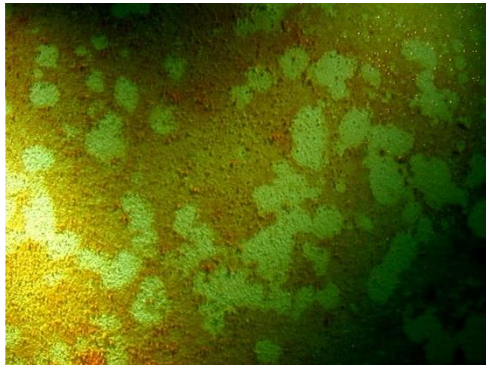
During an in-water vessel survey, a LoF rank is allocated for each area (≤ 1 m^2) within the hull transect or niche area under survey. For example, for a propeller where the total surface area is estimated to be ≤ 1 m^2, the LoF rank is allocated for the entire structure, including the blades, boss and shaft. Where the surface area of the propeller is > 1 m^2, separate LoF ranks are allocated for each 1 m^2 area. Similarly, each 1 m^2 area along a transect is to be given a separate LoF rank. Above water surveys (i.e., on-vessel or topsides surveys) a LoF rank is allocated for each area (≤ 2 m^2) under survey.

For each transect and niche area surveyed, the **Mode of the LoF** (i.e., the most frequent ranking) and the **LoF range** (i.e., the highest and lowest ranking) is to be used to report the **Overall LoF** of that area. It is *inappropriate* to use the **Mean** (e.g., average) and **Standard Deviation** to report the results derived from ordinal data. For cases where the survey data is multimodal (i.e., more than one mode), report each of the modes for Overall LoF and the LoF range. For cases where there is no mode, report the highest LoF for Overall LoF and the LoF range.

A minimum of 3 digital images should be taken for each surveyed area (i.e., a minimum of 3 images should be taken for each allocation of LoF - where the LoF changes; see Section 6).

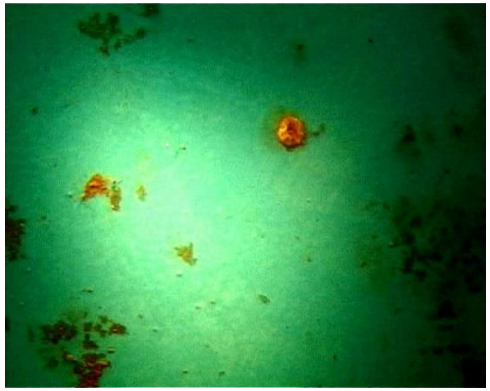
It is advised that vessel surveyors should be trained in the use of the LoF rank scale.

[3] Davidson I, Floerl O, Fletcher L, Cahill P (2019). Level of Fouling rank scale - an updated guideline. Prepared for Auckland Council, Auckland, New Zealand. 14 pp.

LoF rank	Criteria
0	No visible fouling. Hull entirely clean, no biofilm (slime) on any visible submerged parts of the hull.  
1	Hull partially or completely covered in slime fouling (biofilm). Absence of any macrofouling.  

2 Light fouling. 1 – 5 % of visible surface covered by very patchy macrofouling or filamentous algae. Remaining area often covered in slime. Examples below show presence vs. absence of fouling in two adjacent areas of a hull (low LoF overall).

3 Considerable fouling. Macrofouling clearly visible (usually > 1 species) but still patchy. 6 – 15 % of visible hull surface covered by macrofouling or filamentous algae. Remaining area often covered in slime.

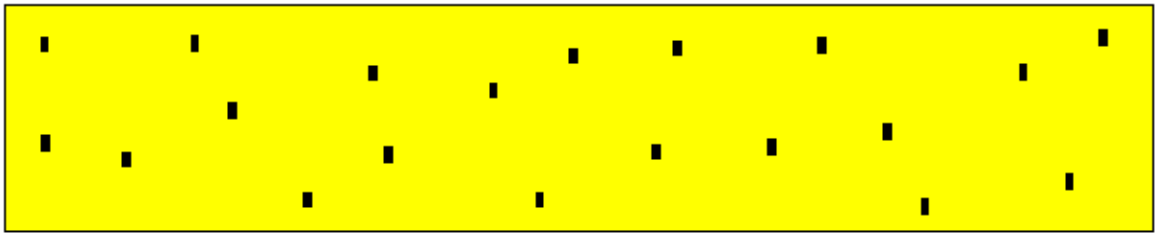


4 Extensive fouling. 16 – 40 % of visible hull surface covered by macrofouling or filamentous algae. Remaining area often covered in slime.

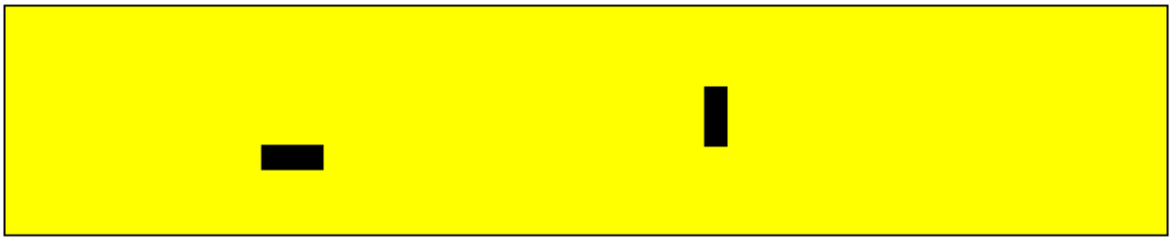
5 Very heavy fouling. 41 – 100 % of visible hull surface covered by macrofouling or filamentous algae. Remaining area often covered in slime.

12 Appendix 3

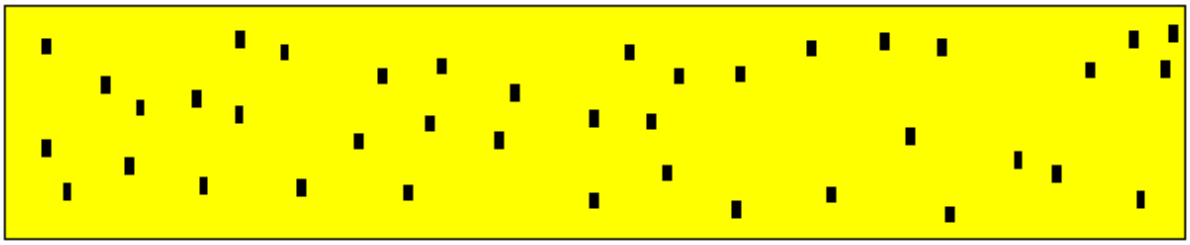
Fouling extent diagrams



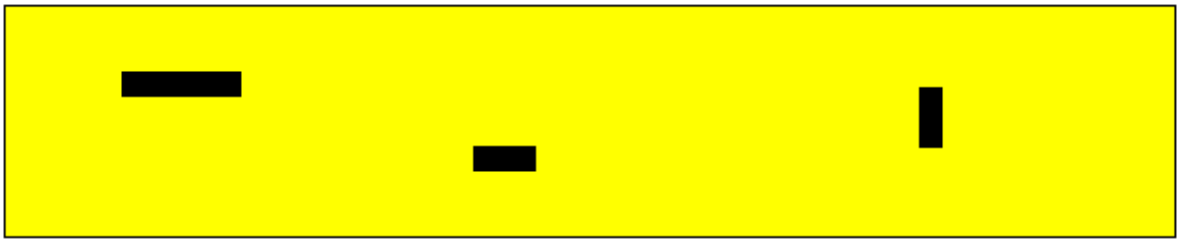
Fouling extent diagram – 1 % scattered fouling.



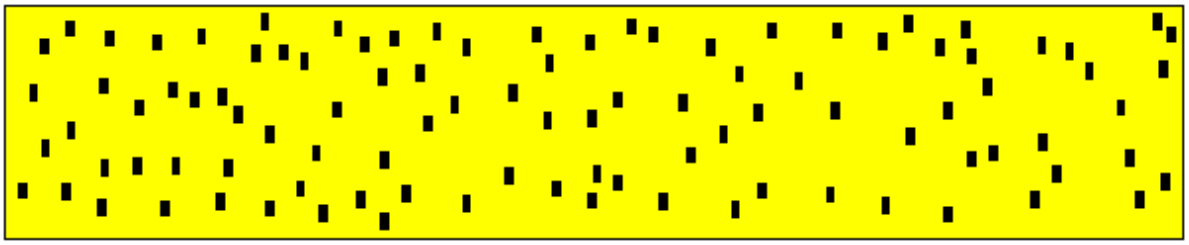
Fouling extent diagram – 1 % localised fouling.



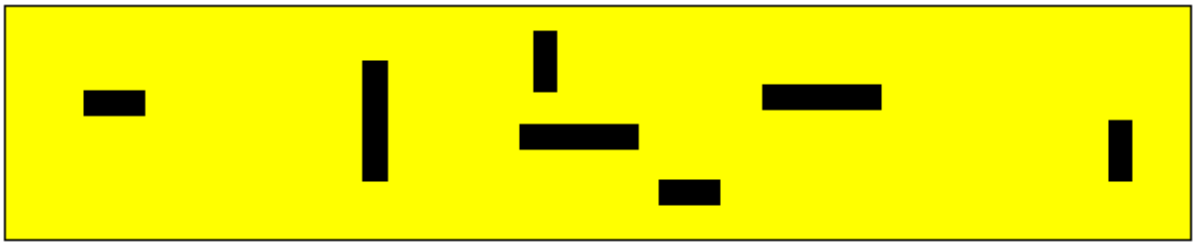
Fouling extent diagram – 2 % scattered fouling.



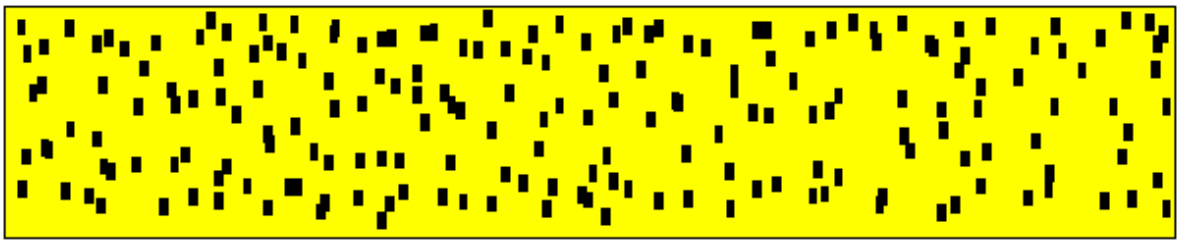
Fouling extent diagram – 2 % localised fouling.



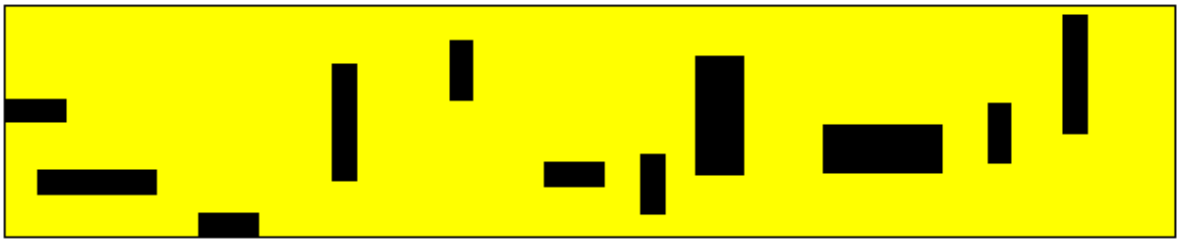
Fouling extent diagram – 5 % scattered fouling.



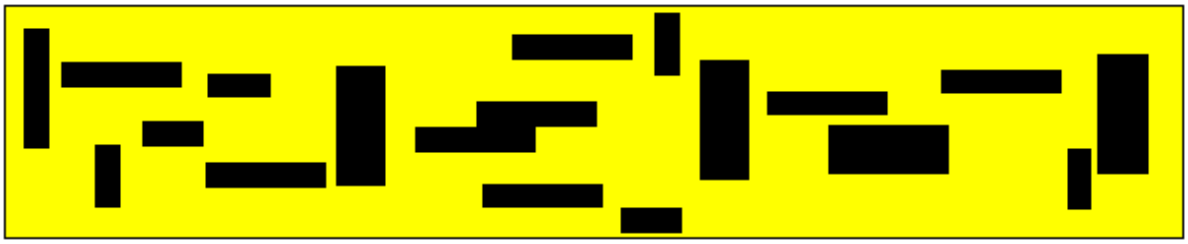
Fouling extent diagram – 5 % localised fouling.



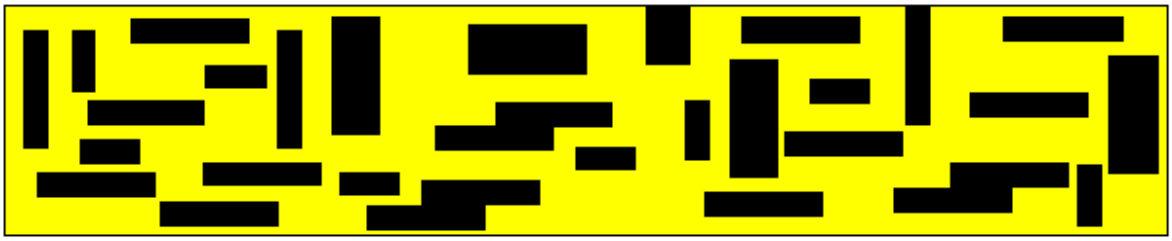
Fouling extent diagram – 10 % scattered fouling.



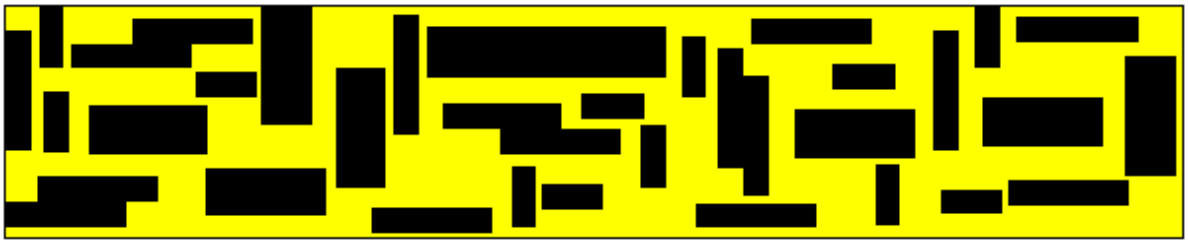
Fouling extent diagram – 10 % localised fouling.



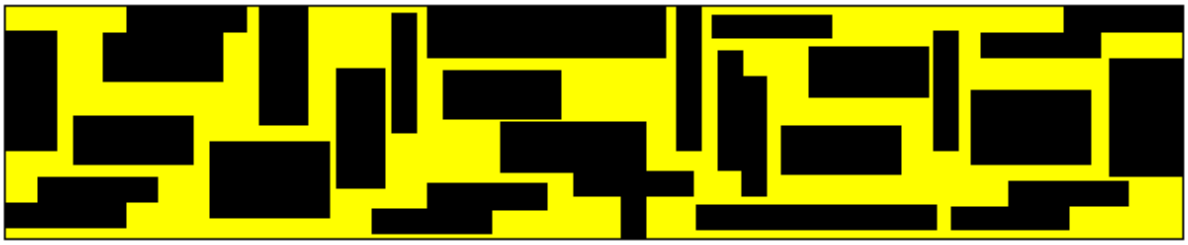
Fouling extent diagram – 20 % localised fouling.



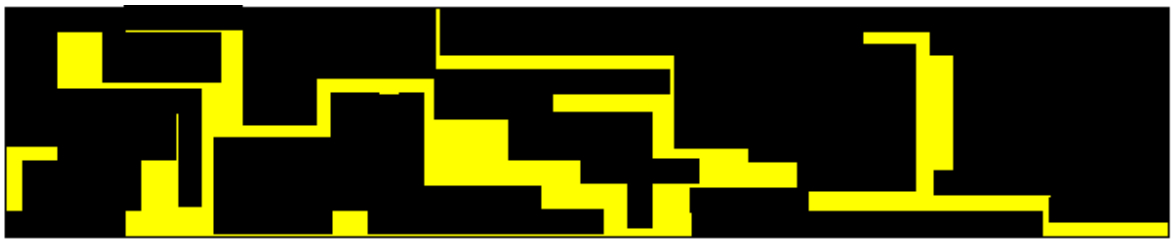
Fouling extent diagram – 30 % localised fouling.



Fouling extent diagram – 40 % localised fouling.



Fouling extent diagram – 50 % localised fouling.



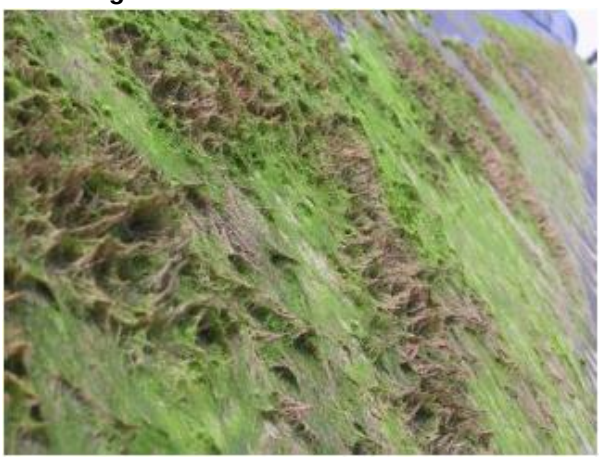
Fouling extent diagram – 75 % localised fouling.

13 Appendix 4

Examples of common biofouling taxa
Source:
Lewis J (2016). *Assessment of preventative biofouling management measures.* New Zealand Ministry for Primary Industries Technical Paper 2016/69. Ministry for Primary Industries, Wellington. 61 pp. http://mpi.govt.nz/document-vault/14530

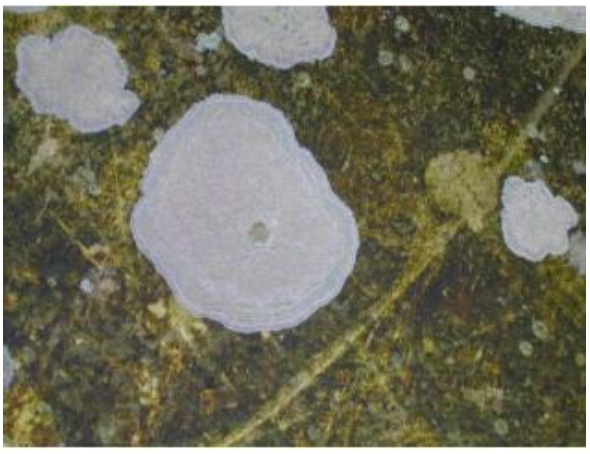
Examples of different weed types.

Green algae




Red algae


Red crustose algae

Brown algae


Examples and descriptions of animal fouling

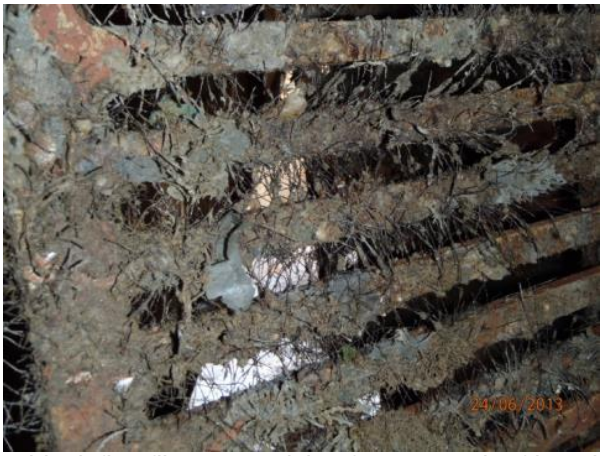
Goose barnacles


Description: Animal body with extendable feathery feeding arms, either covered by shelled plates or naked, on the end of a leathery attachment stalk.

Acorn barnacles


Description: Conical or sometimes tubular shells formed from separable plates with an outward facing opening. Many species with strongly adherent basal plates that persist after the shell has been dislodged.

Hydroids

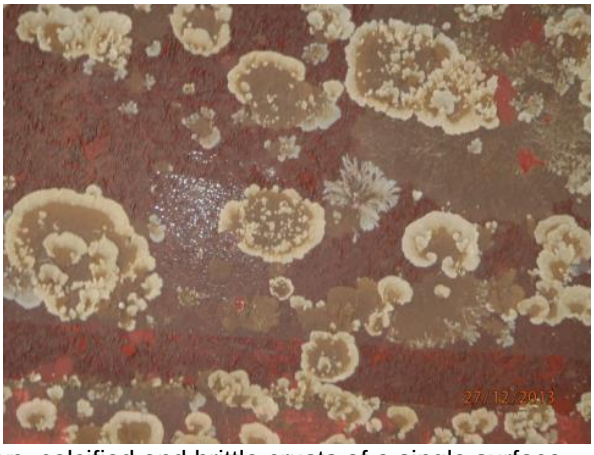



Description: Wiry, or sometimes feathery, brown or black fine filaments arising from a mesh of basal filaments growing across the surface, with branched or unbranched upright filaments bearing or terminating with minute feeding polyps.

Erect bryozoans


Description: Yellow, brown or purplish tufts of segmented, branched filaments, superficially plant-like; each minute segment contains a single zooid inside a calcified, protective case with the calcification giving the filaments a brittle texture.

Encrusting bryozoans

Description: Whitish, grey, light-brown or red-brown, calcified and brittle crusts of a single surface layer of minute, closely adjacent calcified “cells” that each contains a single zooid; most growth around the perimeter.

Tubeworms

Description: White, or sometimes brownish, calcified tubes with the lower surface cemented to the substrate and an opening at one end through which the worm extends tentacles to feed; tubes elongate and sinuate, or tightly coiled; fully adherent along the length of the tube, or the outer end extending out from the substrate when populations are dense. Uncalcified tubeworms can have grey, leathery tubes, or mucilaginous tubes consolidated with sand or silt particles.

Mussels


Description: Bivalve molluscs with the paired, similar, approximately wedge-shaped shells attached to the surface by a bundle of byssal threads (“beard”) that protrude from between the shells close to the base.

Oyster and oyster base plates


Description: Bivalve molluscs with one of the shells completely, or nearly completely, cemented to the surface and the upper shell hinged to the lower at one end. Lower, strongly adherent shell often persisting after the animal has died and the upper shell detached.

Bivalves – other


Description: Bivalve molluscs of different shapes and forms to mussels and oysters and attached by either byssal threads or leathery ligaments, or free-living between other fouling organisms.

Solitary ascidians


Description: Leathery pigmented or translucent sac-like organisms that lack any calcification and with two openings (“siphons”) at the outer end for drawing in and expelling seawater; the latter giving the common name “sea squirts”. Can grow singly or in clumps.

Colonial ascidians


Description: Encrusting colonies of zooids, each structured like a minute solitary ascidian, within a clear or pigmented mucilaginous or leathery matrix and often arranged in linear series or star-like patterns; sometimes with dense aggregations of white calcareous particles distributed uniformly through the enveloping matrix.

14 Appendix 5

Assessing viability of macrofouling organisms
Source:
Morrisey, D., Inglis, G., Tait, L., Woods, C., Lewis, J., and Georgiades, E. (2015). Procedures for evaluating in-water systems to remove or treat vessel biofouling. New Zealand Ministry for Primary Industries: Technical Paper 2015/39. 97 pp.
http://www.mpi.govt.nz/document-vault/10811

If there is reasonable doubt that the macrofouling organisms observed could be viable, the biofouling assemblage is to be classified as 'viable'.

Type of biofouling organism	Indicators for potential viability	Indicators for non-viability
Sessile taxa		
Barnacles	• Structure: all shell plates present and intact, opercular plates present. • Feeding/movement: feeding structures (cirri) protrude out of the test and perform sweeping feeding movements. Or: opercular shells closed by muscular action. Feeding or respiration currents visible.	• Structure: shell/opercular plates and/or feeding structures (cirri) broken or missing. • Feeding/movement: feeding structures visible but motionless and slack, and/or no reaction when touched. No feeding or respiration currents visible.
Bivalves	• Structure: both shells present and intact. • Feeding/movement: shells may be locked by muscular action. Shells may also be open (feeding), exposing mantle tissue and siphons (or gaps in mantle), but will close when touched (reaction). Feeding or respiration currents visible.	• Structure: one shell missing or one/both shells significantly cracked or fragmented. • Feeding/movement: shells open but no reaction to touch. No feeding or respiration currents visible.
Encrusting bryozoans	• Structure: colony/fragment contain several intact zooids, and natural colour (pigmentation). • Feeding/movement: filtering apparatus (lophophore) protrude through opening in zooid. Feeding or respiration currents visible.	• Structure: all zooids damaged/smashed, no soft tissues visible or tissues decomposing. Complete loss of pigmentation. • Feeding/movement: zooids' soft tissues and/or feeding structures may be visible but no movement or reaction to touch. No feeding or respiration currents visible.
Erect bryozoans	• Structure: colony/fragment contain several intact zooids, and natural colour (pigment). • Feeding/movement: filtering apparatus (lophophore) protrude through opening in zooid. Feeding or respiration currents visible.	• Structure: all zooids damaged/smashed, no soft tissues visible or tissues decomposing. Complete loss of pigmentation. • Feeding/movement: feeding structures may be visible but no movement or reaction to touch. No feeding or respiration currents visible.
Colonial ascidians	• Structure: Colony/fragment in reasonable 'shape', not entirely crushed, and natural colour (pigmentation). Several polyps intact. • Feeding/movement: inhalant and/or exhalant siphons open, but close when touched. Feeding or respiration currents visible.	• Structure: Shredded or crushed so that badly damaged, no soft tissues visible or tissues decomposing. No polyps visible (polyps may have 'popped out' from mechanical pressure on colony). Complete loss of pigmentation. • Feeding/movement: siphons open but no reaction to touch. No feeding or respiration currents visible.
Solitary ascidians	• Structure: test (body) intact, no holes or gashes, not crushed flat or severely deformed, and natural colour (pigmentation).	• Structure: test badly damaged, crushed or deformed. Branchial basket exposed and/or damaged, gut system protruding from test, no soft tissues

Type of biofouling organism	Indicators for potential viability	Indicators for non-viability
	• Feeding/movement: inhalant and/or exhalant siphons open, but close when touched. Or: siphons closed and resistant to opening. Feeding or respiration currents visible.	visible or tissues decomposing. Complete loss of pigmentation. • Feeding/movement: Siphons open, but no reaction to touch. No feeding or respiration currents visible.
Hydroids	• Structure: body reasonably intact, feeding polyps (often at distal ends of braches) present and natural colour (pigmentation). • Feeding/movement: feeding tentacles exposed. Feeding or respiration currents visible.	• Structure: All polyps damaged/smashed, no soft tissues visible or tissues decomposing. Complete loss of pigmentation. • Feeding/movement: feeding structures may be visible but no movement or reaction to touch. No feeding or respiration currents visible.
Tube-building polychaetes	• Structure: generally intact (body usually within tube), not crushed, no holes or gashes, and natural colour (pigmentation). Care needed, as regeneration from lesser fragmentation is possible with some taxa. • Feeding/movement: worm retracts into tube when touched, and/or feeding structures (tentacular crown) visible and moving. Feeding or respiration currents visible.	• Structure: tube missing, loss of tentacular crown, body badly crushed or lacerated, no soft tissues or tissues decomposing. Complete loss of pigmentation. • Feeding/movement: feeding structures may be visible, but no movement or reaction to touch. No feeding or respiration currents visible.
Sponges	• Structure: fragments retain natural colour, firm texture (don't fall apart). Sponges retain a "fleshy/translucent/shiny" appearance. Look for "translucent" tissue between fibres. • Feeding/movement: extremely difficult to observe. Feeding or respiration currents visible.	• Structure: colony/fragment faded and bleached, falling apart. Complete lack of pigmentation. Sponge a mass of golden fibres/hair-like structures without "translucent fleshy tissue" between the fibres, or decomposing tissues. • Feeding/movement: extremely difficult to observe. No feeding or respiration currents visible.
Macroalgae	• Structure: whole plant or fragments not crushed and natural colour (pigmentation). • Feeding/movement: n/a	• Structure: badly crushed or fragmented with complete loss of pigmentation. • Feeding/movement: n/a
Motile taxa		
Crabs	• Structure: several missing limbs no problem unless all are gone. Carapace intact. Natural colour (pigmentation). • Feeding/movement: movement or reaction to touch. Eyes/sensory organs in head region moving. Respiration currents visible.	• Structure: all, or nearly all limbs missing. Carapace significantly damaged (e.g., large holes or parts missing). Complete loss of pigmentation. • Feeding/movement: no movement or reaction to touch. No respiration currents visible.
Molluscs (gastropods, nudibranchs, chitons)	• Structure: body intact (gastropod snails: shell present), and natural colour (pigmentation). • Feeding/movement: movement or reaction to touch.	• Structure: body significantly damaged, crushed or lacerated. Complete loss of pigmentation. • Feeding/movement: no movement or reaction to touch.
Sea stars/brittle stars	• Structure: basal disc or parts of it present (can regenerate). Body (or whatever's present) has natural shape, not crushed, and natural colour (pigmentation). • Feeding/movement: movement or reaction to touch.	• Structure: arm-only without part of basal disc (can't regenerate), body significantly damaged, crushed or lacerated. Complete loss of pigmentation.

Type of biofouling organism	Indicators for potential viability	Indicators for non-viability
		• Feeding/movement: no movement or reaction to touch.
Amphipods/isopods/tanaids etc.	• Structure: exoskeleton intact. Several missing limbs no problem unless all or nearly all are gone. Natural colour (pigmentation). • Feeding/movement: visible movement/reaction, especially feeding limbs will beat if submerged and alive. Feeding or respiration currents visible.	• Structure: Exoskeleton damaged (e.g. large holes or parts missing). All or nearly all limbs or feeding structures missing. Complete loss of pigmentation. • Feeding/movement: No movement or reaction to touch. No feeding or respiration currents visible.
Errant polychaetes	• Structure: generally intact, not crushed, no holes or gashes. Care needed, as regeneration from lesser fragmentation is possible with some taxa. Natural colour (pigmentation). • Feeding/movement: movement or reaction to touch.	• Structure: body badly crushed or lacerated. Complete loss of pigmentation. • Feeding/movement: no movement or reaction to touch.

15 Appendix 6

Example of how to fill out a vessel checklist.

Item	Area	Description (to be completed for every specified area within each designated transect or niche area)	Surveyed (Yes; No or N/A)	LoF	Viability (Yes/No)	Description and biofouling taxa observed (e.g., slime, macroalgae, barnacles, bivalves, bryozoans, sea squirts, tubeworms)
1	Hull surface	Vertical stern transect Port 1, quadrat 1	Yes	2	Yes	Slime and Tubeworms (macrofouling coverage 5%)
		Vertical stern transect Port 1, quadrat 2	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 15%)
		Vertical stern transect Port 1, quadrat 3	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 15%)
		Vertical stern transect Port 1, quadrat 4	Yes	2	Yes	Slime and Tubeworms (macrofouling coverage 5%)
		Vertical stern transect Port 1, quadrat 5	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 15%)
		Vertical stern transect Port 1, quadrat 6	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 10%)
		Vertical stern transect Port 1, quadrat 7	Yes	3	Yes	Slime, Barnacles, Tubeworms, Oysters (macrofouling coverage 10%)
		Vertical stern transect Port 1, quadrat 8	Yes	2	Yes	Slime and Tubeworms (macrofouling coverage 5%)
		Vertical stern transect Port 1, quadrat 9	Yes	1	Yes	Slime (coverage 80%)
		Vertical stern transect Port 1, quadrat 10	Yes	1	Yes	Slime (coverage 60%)
		Vertical stern transect port 1 (Overall)	**Mode 3**	**Range 1 - 3**	**Yes**	**Slime, Barnacles, Tubeworms, Oysters**
2	Hull surface	Vertical stern transect Port 2, quadrats 1-5	Yes	3	No	Barnacles (macrofouling coverage 10%)
		Vertical stern transect Port 2, quadrats 6-10	Yes	2	Yes	Slime and Barnacles (macrofouling coverage 5%)
		Vertical stern transect port 1 (Overall)	**Mode 2, 3 (Equal)**	**Range 2 - 3**	**Yes**	**Slime and Barnacles**
3	Hull surface	Vertical stern transect Port 3, quadrat 1	No	-	N/A	Inaccessible due to wharf structures
		Vertical stern transect Port 3, quadrat 2	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 15%)
		Vertical stern transect Port 3, quadrat 3	Yes	1	Yes	Slime (coverage 50%)
		Vertical stern transect Port 3, quadrat 4	Yes	5	Yes	Barnacles, Tubeworms, Hydroids, (macrofouling coverage 60%)
		Vertical stern transect Port 3, quadrat 5	Yes	4	Yes	Barnacles, Tubeworms, Ascidians, Oysters, Hydroids, Goose neck barnacles (macrofouling coverage 40%)
		Vertical stern transect Port 3, quadrat 6	Yes	4	Yes	Barnacles, Tubeworms, Ascidians, Oysters, Hydroids, Goose neck barnacles (macrofouling coverage 40%)
		Vertical stern transect Port 3, quadrat 7	Yes	5	Yes	Barnacles, Tubeworms, Ascidians, Oysters, Hydroids, Goose neck barnacles (macrofouling coverage 60%)
		Vertical stern transect Port 3, quadrat 8	Yes	1	Yes	Slime (coverage 40%)
		Vertical stern transect Port 3, quadrat 9	Yes	3	Yes	Slime, Barnacles and Tubeworms (macrofouling coverage 10%)
		Vertical stern transect Port 3, quadrat 10	No	-	N/A	Inaccessible due to wharf structures
		Vertical stern transect port 1 (Overall)	**Mode 5 (Highest)**	**Range 1 - 5**	**Yes**	**Barnacles, Tubeworms, Ascidians, Oysters, Hydroids, Goose neck barnacles**