

UK Overseas Territories Marine Biosecurity Toolkit: Hull Fouling Assessment Guidance



1. Introduction

The growth and accumulation of aquatic plants and animals (biofouling) on vessels can transport organisms beyond the limits of natural dispersal, leading to the spread of invasive non-native species (INNS). Some of the most widespread marine INNS, which have caused serious ecological, economic, and human health impacts, are considered to have been transported by fouled commercial and recreational vessels.

All vessels have some degree of biofouling, even if the hulls have been recently cleaned or anti-fouled. The amount of biofouling depends on many factors such as:

- the type, age and condition of the vessel's anti-fouling coating and how effectively any hull cleaning was undertaken;
- the way in which the vessel is used - for example, top and average speeds, time underway compared with time moored or anchored and where the craft is normally kept (on land, in a marina or on an estuarine mooring);
- places visited and the local environmental factors such as water temperature, salinity and the amount of particulate matter in the water;
- design and construction of the vessel, particularly areas that are more susceptible to biofouling (such as rudders, propellers and propeller shafts and intake and discharge points).

The most cost effective and efficient means for managing biosecurity is to focus on prevention. It is therefore important to regularly assess the degree of biofouling on visiting vessels to help reduce the risk of introducing marine INNS into your waters.

This brief guidance document provides a simple tool which you can use to easily assess the degree of biofouling on visiting vessels, enabling the identification of high-risk vessels as soon as they arrive in your waters.

2. Methods

In order to determine the level of risk from vessels visiting your ports and harbours, the following information should be collected from the vessels' captain / owner at the earliest opportunity:

Vessel name and type	Boats with slower transiting speeds such as sailing boats are likely to have more biofouling present than powerboats or fishing boats and so may pose a higher biosecurity risk. Recreational boats also pose a higher risk as they tend to have long lay-up periods, are not restricted to ports / harbours and there can be less economic incentive for frequent maintenance.
Point of origin and ports / locations visited on route	This gives an indication of whether the vessel has visited ports / locations with a history of species invasions and with similar environmental conditions which might allow INNS to establish in your port or harbour. Vessels which have travelled from / through an area with extensive sea ice may pose a lower risk due to the scouring effect of ice removing attached INNS.
Duration of stay at each location (either in a port / harbour or at anchor)	The longer boats are in the water, the more likely they are to have biofouling present, therefore increasing the biosecurity risk.

Date of departure from last port of call	Long trips with a substantial amount of time in the open ocean may reduce the likelihood of survival of fouling organisms or increase the probability of dislodgement and therefore pose a lower biosecurity risk.
Date of last hull inspection and hull clean	This gives an indication of the likely degree of biofouling - a vessel that has very recently received comprehensive cleaning will mostly be free of biofouling.
Date of last antifouling paint renewal	This gives an indication of the likely degree of biofouling - vessels that have very recently received a new coating of antifouling paint will mostly be free of biofouling.

It is recommended that initially, visual inspections are carried out on all vessels where possible, to improve local knowledge of the level of risk of marine INNS being introduced through hull fouling. Studies have, however, shown that the age of antifouling paint on a vessel's hull is the best predictor of biofouling extent and the likely presence of INNS. Therefore, **vessels that can evidence that their most recent antifouling paint renewal or comprehensive hull clean occurred within 4 weeks prior to the time they arrive in port could be exempt from inspection.** These vessels are likely to be either free of biofouling or, any organisms present are unlikely to have attained sexual maturity. Such vessels should present appropriate documentation of their recent antifouling paint renewal.

In situations where high volume of visiting vessels occur and where it may not be possible to inspect all vessels, the information obtained from the vessels' captain / owner could be used to identify vessels which may pose a higher biosecurity risk. Vessels that are only visiting the Territory for a short stay (1 to 3 days) are unlikely to pose a high risk as the likelihood of any species establishing in the Territory's waters is small. In contrast, studies have found that boats that engaged in less sailing activity, spent a long time in their most recent port of call and had antifouling paint that was more than 9 to 12 months old would be more likely to have biofouling present. These vessels should therefore always be inspected.

Once the above information has been obtained from the vessels' captain / owner, a rapid visual inspection should then be carried out. Biofouling on hulls tends to occur close to the waterline where antifouling paint is often damaged during berthing operations or by striking debris while sailing, as well as in the stern area where hydrodynamic drag is reduced. The inspection should therefore be conducted from a boat or the wharf of all of the visible submerged areas along the entire waterline, paying particular attention to the stern / rudder area.

The level of biofouling on each vessel inspected should be scored using the scale shown in Table 1 below. This scoring system is based on a standard sampling protocol developed for international yacht arrivals to New Zealand and later applied to assess fouling across a range of international vessel types. It provides a quick and effective method of assessing hull fouling that considers both the area covered and the number of different species which are fouling. During a vessel inspection, one score should be allocated to the entire visible submerged area. Descriptions of the level of fouling (number of species / percent cover of fouling) for each score are shown in Table 1. A score of 0 to 2 would be given for no to light biofouling ($\leq 5\%$ cover) with fouling consisting of small patches of just one type of algae or animal. A score of 3 to 5 would be given for considerable to heavy biofouling ($>5\%$ cover) consisting of different species of algae or animal.

Examples

A hull which had 5 % of its visible submerged surfaces covered with biofouling consisting of biofilm and small patches of green algae only would be given a score of 2.




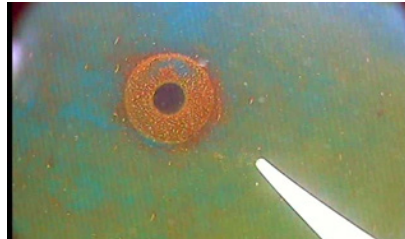
A hull which had 25% of its visible submerged surfaces covered with lots of biofouling consisting of green and red algae as well as barnacles would be given a score of 4.




If there are many different species found on a vessel but the percentage cover is low, then the vessel should be classified according to the percentage cover and given a lower score. For example, a hull which had 5 % cover of biofouling (consistent with a score of 2) but that comprised of algae and barnacles (consistent with a score of 3), should be allocated a score of 2.

All information should be entered into the datasheet provided in Appendix 1. Where possible, representative digital photos should be taken of the biofouling organisms present to provide a permanent record. If potential INNS are found during the inspection, then samples should be taken if it is safe and practical to do so; please see the sampling guidance within this Biosecurity Toolkit (Document C) for further information.

It should be noted that scoring hulls based on surface observations alone may not be a true indication of the extent of fouling on deeper, submerged surfaces and may result in an underestimation of biofouling levels. High surface fouling will, however, generally be consistent that a vessel is heavily fouled overall. Therefore, surface-based observations can justifiably be used to identify vessels that present a higher biosecurity risk from potential marine INNS.

Table 1: Level of fouling (LOF) scale based on existing categories and rank descriptions. All photos are used with permission from Oriana Brine, The Ministry for Primary Industries, New Zealand.

Level of fouling (LOF) assessment guide				
Score	Description of fouling	Visual estimate of biofouling cover	Descriptive photo	Suggested actions
0	No visible fouling. Hull entirely clean.	Nil		<ul style="list-style-type: none"> The extent of hull fouling is acceptable and poses a negligible biosecurity threat. No action is required.
1	Slime ¹ fouling only. Submerged hull areas partially or entirely covered in biofilm ² , but absence of any plants or animals other than goose barnacles	Nil		
2	Light fouling. Hull covered in biofilm and 1-2 very small patches of one type of algae or animal. Green algal growth should be no more than 50 mm in length; red and brown algal growth should be no more than 4 mm in length. Animals (e.g. barnacles or tubeworms) should occur as isolated individuals or small clusters of animals that appear to be the same species.	1-5 % of visible submerged surfaces	 	<ul style="list-style-type: none"> Vessels are considered borderline. The vessel captain / owner should be advised of the need to clean the hull in the near future or before returning to the Territory (if appropriate). On no account should the vessel be allowed to clean the hull while in the water.

Level of fouling (LOF) assessment guide				
Score	Description of fouling	Visual estimate of biofouling cover	Descriptive photo	Action
3	Considerable fouling. Presence of biofilm, and fouling still patchy, but clearly visible and comprised of either one or more types of algae and/or animal	6 - 15 % of visible submerged surfaces		<ul style="list-style-type: none"> The extent of hull fouling is unacceptable and poses a biosecurity threat. If the port / harbour has the appropriate facilities, then the vessel should be removed from the water to a dry dock or haul-out facility and the hull should be cleaned to remove all biofouling. On no account should the vessel be allowed to clean the hull while in the water. If haul-out facilities do not exist, then the vessel captain / owner should be made aware of the INNS risk and advised of the need to clean the hull at the next port of call and before returning to the Territory (if appropriate) In all cases, it is important that any records of known marine INNS, or unidentified plants and animals of concern are reported as soon as possible.
4	Extensive fouling. Presence of biofilm and abundant fouling assemblages consisting of more than one type of algae or animal	16 - 40 % of visible submerged surfaces		
5	Very heavy fouling. Many different types of algae and / or animal covering most of visible hull surfaces	41 - 100 % of visible submerged surfaces		

¹ Slime: covering of microalgae and other particles that has a grey / green tinge, can vary in thickness but appears slimy and is easily removed with light pressure.

² Biofilm: thin layer of bacteria, microalgae, detritus and other particulates.

3. Awareness-raising

It is recommended that in all cases, awareness-raising activities are undertaken to try to ensure that vessels visiting the Territory arrive with a clean hull. A quick analysis of the main points of origin of visiting vessels should be conducted to enable targeting of messages via social media, in yachting magazines or on marina websites in these countries. For commercial vessels, awareness-raising materials would be targeted more effectively at the shipping line companies and agents responsible for chartering vessels. Information could also be made available on your port / harbour website as part of the information for visiting vessels, and leaflets could also be given out to those vessels given a score of 2 or above. These materials should all explain the range of best practice options available for the prevention and mitigation of hull fouling for different vessel types highlighting the importance of:

- regularly checking and cleaning vessels, especially areas that are most prone to biofouling (e.g. around the rudder, propeller and water intake pipes) as well as all equipment and gear that may get wet
- flushing internal seawater systems regularly with freshwater or an approved treatment
- thoroughly cleaning vessels before sailing to a new location — preferably in a dry dock, haul-out facility or on a slipway
- applying a suitable antifouling coating that is appropriate to the vessel operational profile and maintaining a regular cleaning and maintenance schedule in accordance with the manufacturer's instructions

Want to know more about the science behind hull fouling assessments?

Please see these scientific papers for more details on the methods described in this guidance:

Brine O, Hunt L and Costello MJ (2013). Marine biofouling on recreational boats on swing mooring and berths. *Management of Biological Invasions* 4: 327-341.

Floerl O, Inglis GJ and Hayden BJ (2005). A risk-based predictive tool to prevent accidental introductions of nonindigenous marine species. *Environmental Management* 35: 765-778.

Floerl O, Wilkens S and Inglis G (2010). Development of a template for vessel hull inspections and assessment of biosecurity risks to the Kermadec and sub-Antarctic Islands regions. National Institute of Water & Atmospheric research Limited, Christchurch, New Zealand.

Galil BS, McKenzie C, Bailey S, Campbell M, Davidson I, Drake L, Hewitt C, Occhipinti-Ambrogi A and Piola R (2019). ICES Viewpoint background document: Evaluating and mitigating introduction of marine non-native species via vessel bio-fouling. ICES Ad Hoc Report 2019.

Georgiades E and D Kluza (2014). Science underpinning the thresholds proposed in the CRMS: biofouling on vessels arriving to New Zealand. New Zealand Ministry for Primary Industries Technical Paper 2014/22. Ministry for Primary Industries, Wellington, New Zealand.

Murray CC, Therriault TW and Pakhomov E (2013). What lies beneath? An evaluation of rapid assessment tools for management of hull fouling. *Environmental management* 52: 374-384.

APPENDIX 1: Hull fouling datasheet

Date of inspection	
Name of vessel	
Type of vessel	
Port of origin (i.e. start of voyage)	
Ports / locations visited in last 28 days and duration of stay at each location	
Date of departure from last port of call	
Date of last hull clean	
Date of last application of anti-fouling	
Level of fouling observed (using guidance for reference)	
Photograph taken? (Y/N)	
Action taken (if applicable)	

Actions post-assessment:

- Vessels scoring 0 or 1: **Acceptable** – No action required.
- Vessels scoring 2: **Borderline** – Vessel advised to clean the hull soon, or before returning to the Territory.
- Vessels scoring 3, 4 or 5: **Unacceptable** – Depends on the territory. The vessel should either haul-out and clean the hull if facilities are available. If no facilities are available the hull should be cleaned at the next port of call before returning to the territory. **Vessel should not be allowed to clean the hull whilst in the water.** Follow up is required to ensure compliance (if ordered to clean the hull).