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Viewpoint

Challenges associated with pre-border management of biofouling on oil rigs

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ABSTRACT

The potential for oil rigs to transport diverse, reef-like communities around the globe makes them high risk vectors for the inadvertent spread of non-indigenous species (NIS). This paper describes two case studies where a suite of pre-border management approaches was applied to semi-submersible drilling rigs. In the first case study, a drilling rig was defouled in-water prior to departure from New Zealand to Australia. Risk mitigation measures were successful in reducing biosecurity risks to the recipient region, but they resulted in the unintentional introduction of the non-indigenous brown mussel (*Perna perna*) to New Zealand when the rig was defouled in-water by divers. In the second case study, lessons learned from this high-profile incursion resulted in a more structured approach to pre-border management, and this serves as a useful template for future rig transfers.

1. Introduction

Recent studies highlight the need to improve pre-border management of biofouling risks associated with large structures from the oil and gas industry. In particular, a common theme emerging from biofouling surveys undertaken on oil rigs is the presence of advanced reef-like communities having a large biomass (Wanless et al., 2009; Yeo et al., 2010). This is in contrast to the much lower levels of fouling encountered on other vessel types (Coutts and Taylor, 2004; Davidson et al., 2009). Furthermore, given the much lower hydrodynamic forces (and associated indirect effects such as reduced feeding) experienced at the speed at which rigs are towed (c. 5 knots) compared with a merchant vessel travelling at >20 knots (Coutts et al., 2010; Yeo et al., 2010), fouling survivorship is likely to be higher than on a faster moving vessel.

There are an estimated six submersible drilling rigs, 186 semi-submersible drilling rigs, 451 jack-up drilling rigs, 163 floating-production-storage-offloading (FPSO) structures, and 94 drill barges or ships in operation worldwide (Yeo et al., 2010, and references therein). While such structures only account for a small proportion of international vector traffic, their ability to accumulate high levels of fouling biomass and diversity is of concern. While there are only a few documented examples where fouling on such structures has lead to the incursion of NIS into the recipient environment (e.g. Ferreira, 2003), there are numerous examples where NIS have been found on a rig and hence have the potential to be transported to a non-native recipient region (Benech, 1978; Foster and Willan, 1979; Ferreira et al., 2006; Galil, 2008; Yeo et al., 2010).

There is a broad range of pre-border management options available for reducing risks posed by potential vectors of NIS, including: (1) pre-departure inspections for NIS, (2) risk profiling to identify high risk vectors, (3) the development of border standards for biofouling extent and vector hygiene (e.g. time since last dry-docking), and (4) biofouling treatment or removal to mitigate unacceptable risks. Each of these pre-border management options has its own limitations and challenges when applied to rigs, mainly due to their large size and associated issues with fouling removal and treatment if NIS are discovered. In this paper, two case studies are used to highlight these challenges, and provide a framework for future rig transfers between bioregions that can equally be applied to a range of vessel types arriving at the border. The first case study details a decision to defoul a rig in-water to mitigate biosecurity risk before transport to Australia but which led to the incursion of a potential pest to New Zealand waters. As a result of this incident a subsequent proposal to transport a rig from Australia to New Zealand resulted in the implementation of a systematic risk-based approach to mitigate biosecurity threats that has become the standard for rigs entering New Zealand territorial waters (the second case study).

2. Case study 1: pre-border management resulting in an incursion

2.1. Rig inspection while in source region

In 2004, a semi-submersible drilling (Rig A) arrived in New Zealand from South Africa, where it had been dry-docked and completely defouled. Over the next 3 years, the rig drilled at offshore locations at several locations along the New Zealand coast

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and in Bass Strait, Australia. In November 2008, the Department of Sustainability and Environment (Victoria, Australia) requested that the rig be inspected for target NIS prior to departing New Zealand for Portland (Australia). The target NIS list comprised *Perna canaliculus* (green-lipped mussel), *Undaria pinnatifida* (Asian kelp), *Didemnum vexillum* (colonial ascidian), *Asterias amurensis* (Northern Pacific sea star), *Maoricolpus roseus* (New Zealand screw shell), *Grateloupia turuturu* (red alga) and *Charybdis japonica* (Asian paddle crab).

On 28 November 2007, the rig was inspected for target NIS by divers and with the aid of a remotely operated vehicle (ROV) while it was moored off the west coast of the North Island, New Zealand (Fig. 1). The inspection was undertaken while the rig was de-ballasted, therefore only the two $9 \times 11 \times 100$ m (height $\times$ width $\times$ length) pontoons were submerged. Considerable fouling (c. 150 mm thick) was observed on the rig pontoons, with a total of 23 species identified from samples collected haphazardly by divers from representative areas of the structure (Table 1). This is by no means an exhaustive list of taxa on the structure, but nonetheless provides a good indication of the dominant taxa present. Fouling biomass was dominated by the mussels *Mytilus galloprovincialis* and *P. canaliculus*, but a diverse assemblage of other taxa was also present, including ascidians, bryozoans, colonial anemones, tubeworms, barnacles and crabs (Fig. 2). Approximately one-third of species identified were non-indigenous to New Zealand, including five taxa that had not been previously described in New Zealand waters (Table 1).

Table 1
Taxa sampled from Rig A and their present biosecurity status in New Zealand (*first record of this species in New Zealand).

Taxa	Description	Biosecurity status in New Zealand
Anthopleura aureoradiata	Anemone	Indeterminate
Aulacomya atra	Bivalve	Alien*
Austrobalanus imperator	Barnacle	Alien
Austromegabalanus cylindricus	Barnacle	Alien*
Balanus trigonus	Barnacle	Indigenous
Bugula flabellata	Arborescent bryozoan	Alien
Cnemidocarpa bicornuta	Solitary ascidian	Indigenous
Cnemidocarpa nisiotis	Solitary ascidian	Indigenous
Cnemidocarpa stolonifera	Solitary ascidian	Alien*
Corynactis sp.	Colonial anemone	Indeterminate
Dicathais orbita	Whelk	Indigenous
Galeolaria hystrix	Tubeworm	Indigenous
Herdmania momus	Solitary ascidian	Alien
Lumbrineridae	Polychaete	Indeterminate
Megabalanus coccopoma	Barnacle	Alien
Microcosmus sp.	Solitary ascidian	Indeterminate
Monanchora clathrata	Sponge	Alien
Mycale toxifera	Sponge	Alien*
Mytilus sp.	Bivalve	Indeterminate
Notomegabalanus decorus	Barnacle	Indigenous
Perna canaliculus	Bivalve	Indigenous
Perna perna	Bivalve	Alien*
Plagusia chabrus	Crab	Indigenous
Pyura spinosissima	Solitary ascidian	Indigenous
Sabellidae	Polychaete	Indeterminate
Schizoporella errata	Arborescent bryozoan	Cryptogenic
Scruparia ambigua	Arborescent bryozoan	Cryptogenic
Serpulidae	Polychaete	Indeterminate
Unidentified hydroids	Hydroids	Indeterminate
Unidentified sponges	Sponge	Indeterminate

2.2. Risk mitigation

Following the discovery of *P. canaliculus*, the rig was towed at low speed (c. 5 knots) to Tasman Bay (Fig. 1) where it was defouled

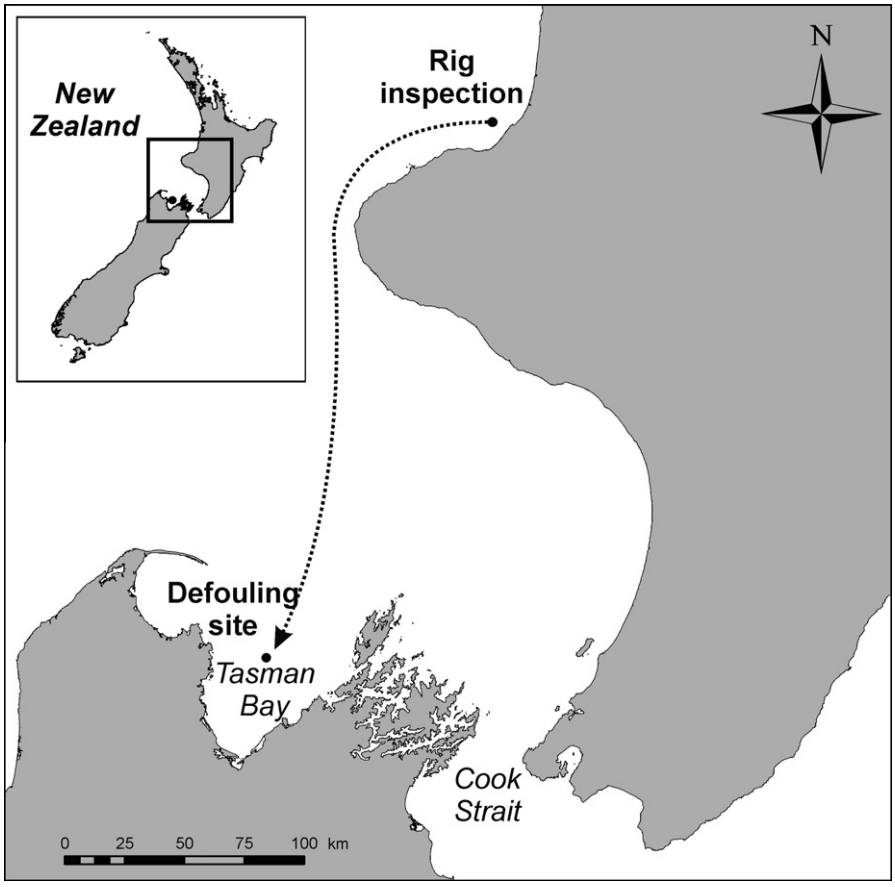

Fig. 1. Rig A was inspected off the New Zealand coast (38° S, 174° E) for a list of target taxa which are non-indigenous to Australia. Upon the discovery of New Zealand green-lipped mussels (*Perna canaliculus*), it was towed to Tasman Bay (41° S, 173° E) where it was defouled in-water by divers.