

Implementation of oil spill impact mitigation measures in fisheries and mariculture.*Nicky Cariglia**ITOPF, 1 Oliver's Yard, London, EC1Y 1HQ***ABSTRACT**

Response actions and mitigation measures, undertaken at the time of a spill specifically to protect seafood resources can ultimately influence the duration, magnitude and extent of impacts. Understanding if and why particular measures were successful (or not) in minimising or eliminating damages to a particular fishery or mariculture installation is important for the seafood sector to use, either in planning, or when faced with making a choice as to what measures may be best to protect their resource. This paper reviews small-scale (in terms of volume spilled) cases in which ITOPF has been involved from around the world where fisheries or mariculture were an important concern and where measures were implemented specifically to mitigate damage. By evaluating whether any trends, or criteria exist under which certain measures or actions are likely to be successful or unsuccessful, contingency plans can be adapted to provide more practical, tailored guidance. Furthermore, policy and research objectives could be directed towards damage prevention rather than the quantification, assessment and remediation of impacts.

INTRODUCTION

Globally, people dependent on fisheries and mariculture production for their livelihoods and as a source of protein can suffer significant disruption during and in the aftermath of an oil spill. Most current estimates suggest that the number of people dependent on capture fisheries and mariculture stands at 56.6 million (FAO, 2016). The high reliance on seafood production, which up to 2010 was the fastest growing agricultural sector (in terms of

employment) in the world means that the International Maritime Organisation (IMO) has for many years understood the importance of equitable and sustainable management through both working groups and binding instruments relating to maritime law (e.g. FAO/IMO ad-hoc working group on illegal, unreported and unregulated fishing and related matters, UNCLOS). As regards liability from oil spills, the international liability and compensation regime (1992 CLC and Fund Conventions, 2001 Bunkers Convention) stipulates that compensation be made available for those involved in the fisheries and mariculture sectors who suffer pure and consequential economic losses as a result of oil spills. Having these provisions set out in international law ensures consistency and fairness in the financial compensation provided to those negatively affected, as well as ensuring standards are in place for the world's financial security markets to understand what their potential obligations may be. The global, erratic and transboundary nature of global shipping makes the need for an international standard especially important so that financial guarantors, operators and potential claimants can plan for or respond to an emergency situation more effectively.

For these reasons, the topic of seafood harvest closures following oil spills has received much attention in oil spill related discourse. In the immediate aftermath of an oil spill, the primary goal of the seafood sector is to safeguard human health and this is the main reason closures are imposed and implemented on both fisheries and mariculture. Closures can be either self-imposed by those engaged in the seafood sector or formally enforced by the authorities. A secondary goal may be to minimise the risk of causing damage, further damage or loss to property such as fishing gear, vessels and farm facilities. Usually, in the immediate aftermath of an incident, these measures are implemented on a precautionary basis. As such, due to the emergency and dynamic nature of such situations, decisions will, in the first instance, be based on visual observations (i.e. presence or absence of oil within an area). As the situation develops further, these closures will need to be informed by data in order to

ensure the minimum possible disruption to those affected. In almost all cases, the implementation of fishing and harvesting closures, result in a net financial burden to businesses and individuals. Even where the actions taken or the disruption caused fall within the scope of the international liability and compensation regime, and are compensable, the necessary administrative and bureaucratic procedures inherent to all types of claims means that considerable time can pass before those affected receive compensation. The most favourable outcome, therefore would be to mitigate, as far as is possible, the disruption and economic losses experienced. The international regimes that address liability and compensation from ship source pollution lay out an international standard for the criteria under which compensation is available for economic losses to the fisheries and mariculture sectors. Because a standard exists, as far as possible, the means by which claims are evaluated are consistent and fair. In order to help ensure a consistent approach to the management of the seafood sector, the need for the development of standard guidelines for the management of fishing and harvest closures in the aftermath of an oil spill has long been recognised (Moller *et al.* 1999). Although guidelines for standardised sampling and analysis for taint and contamination of seafood have been in place for some time (e.g. developed by CEFAS in the UK and EPA in the US), standardised guidance on the process by which individuals or authorities consider the necessity of whether to implement a fishing or harvesting ban in the first place has not until recently been available. In April 2016, the International Oil Pollution Compensation (IOPC) Fund Secretariat formally adopted best practice guidelines developed to aid Member States to manage fishing and harvest closures in a standardised manner. The guidelines were published in September 2016¹ and set out a logical process for authorities to consider when determining the level of intervention in the

¹ The guidelines can be downloaded at:

http://www.iopcfunds.org/uploads/tx_iopcpubs/WEB_IOPC_Fisheries_Restrictions_28pp_ENGLISH.pdf

fisheries and mariculture sectors following an oil spill (Figure 1). An important element is that States now identify the specific mechanism and processes by which the guidelines might be implemented in their jurisdiction.

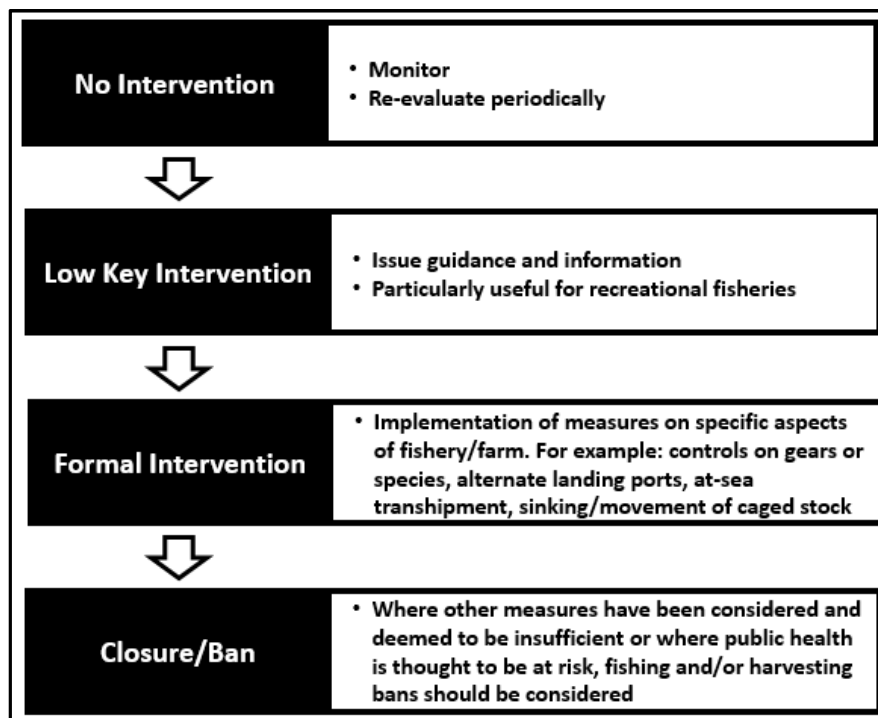


Figure 1 Guidance for governments on logical process for considering the implementation of emergency management measures on fisheries and mariculture during a spill. Modified from IOPC¹.

The guidelines recognise the importance of implementing harvest closures for two reasons (harvest has been used to relate to both wild capture fishing and mariculture): 1. to safeguard human health and safety and; 2. as a precautionary measure in the early stages of an incident, where the potential to pose a risk to health and safety *and/or* significant economic disruption is unknown. However, they also emphasise that other, lower level intervention restrictions could, with appropriate planning and foresight, be implemented, avoiding the need to fully cease harvesting. Due to the absence of specific knowledge on preparedness and capability of oil spills by authorities managing fisheries, and vice versa for those managing the response to an oil spill, blanket fishing and harvest closures have frequently been implemented in previous spills. This has occurred even when resources were

not at risk from oil but on the basis that there had been a spill in the general area. Another frequent challenge when harvest closures have been implemented is the reopening of a given fishery or mariculture operation. In many cases, closures have remained in place, even where a threat or impact no longer exists. In part, this can be explained by the lack of standardised criteria by which the risks to the seafood sector are determined (Mauseth and Challenger, 2001). Where seafood has not been contaminated or tainted by oil, it would be far less disruptive to attempt to continue fishing and harvest activities under a more rigorous management regime rather than prolong a full closure. While, such measures may still result in economic losses, they may reduce the level of financial loss caused by waiting for compensation to be paid, and the uncertainty associated with closures that may have been imposed without consideration of the reopening criteria.

The responsibility for identifying appropriate and achievable measures falls not only to individuals, but also to regulatory/fisheries authorities as well as those managing the response. As summarised by Figure 1, these measures would fall under the low level intervention and formal intervention categories. In the case of wild capture fisheries, the measures are essentially extensions of traditional fisheries management tools that regulate stock sustainability, markets and public safety, developed over more than a hundred years. For mariculture, these measures have evolved to respond to water quality issues, and as such, apply also to the threat of oil spills. Their implementation following an oil spill may be most successful where there is strong institutional capability for fisheries management. Moller *et al.* (1999) and Wadsworth *et al.* (1999) have previously elaborated on mitigation measures and restrictions available for fisheries and mariculture impact mitigation, which are summarised in Table 1.

While ship source oil spills have in recent years been characterised by relatively small scale incidents in terms of volumes spilled, experience highlights that clean-up and water

quality requirements are becoming increasingly stringent. This trend is complicated by the tendency for associated issues to be managed on a local or regional level, with sometimes only remote oversight from central government. This can result in a lack of both oil spill and fisheries specific expertise on site, with a consequence being that fishing and harvest closures can be imposed by local authorities or individuals as an instinctive reaction, without first receiving appropriate support or guidance. In light of this, recent and documented examples of proactive mitigation measures that fall short of full closures that are applied to wild capture fisheries and mariculture to prevent economic loss are rare. Even where central authorities become involved in an incident, participation of fisheries and mariculture management authorities' into the pollution preparedness process before an incident is rare. This means that when an incident does occur, area specific mitigation measures have rarely been considered. The purpose of this paper is to expand on previous papers relating to fisheries and mariculture mitigations measures (Moller *et al.* 1999 and Wadsworth *et al.* 1999), with an emphasis on ITOPF's experience where management measures, outside of full harvest closures have been successfully implemented in the aftermath of a spill. For the purposes of this paper, mitigation measures are defined as measures whose purpose is either to avoid contamination or minimise economic disruption. Based on these observations, recommendations are made for how such interventions could be more proactively planned for prior to an oil spill.

Table 1 A summary of mitigation measures that fall short of full closures, as identified by Moller et al. (1999) and Wadsworth et al. (1999).

Wild capture fisheries	Mariculture
Temporal/spatial restrictions	Towing of anchored cages
Gear/species restrictions and alternatives	Transfer/sinking of stock

Exceptional changes in quotas	Feeding suspension
	Early/late harvest

METHOD

ITOPF's internal incidents database was queried for cases from 2004-2014, where the terms "fisheries" and "mariculture" were cited in incident summaries. The ten year period was selected as an arbitrary cut-off point for ease of data management.

The IOPC Fund's decisions database was also interrogated for examples of where preventive loss measures other than closures were implemented and where compensation was paid as they were deemed to be admissible. These were not constrained by date range.

Technical literature was consulted for examples of measures that relate to general fisheries management or management of fisheries and mariculture in the event of other disruptive events (such as terrestrial pollution, toxic algal blooms, bacterial epidemics), but that might be relevant and applied in the event of an oil spill..

DISCUSSION

Based on the ship source pollution cases that ITOPF has attended, the two most frequently encountered approaches are no intervention or a full closure/ban. Of 201 oil and HNS (hazardous noxious substances) spills attended between 2004 and 2014, perceived or actual fisheries and mariculture issues were encountered in 54. Of these, in 29 cases, fisheries and mariculture were reported within the area to be a concern and either:

- No known intervention took place by the authorities or those employed in the fisheries and mariculture sectors, or;

- As the spill evolved, it became clear that fisheries and mariculture resources would not be affected by oil.

In 20 cases, a formal or voluntary fishing or harvesting closure was known to have been implemented. In only five incidents are alternative restrictions known to have been applied, either on a voluntary or official basis². It should be noted that in none of the examples cases described below were fish tissue samples found to be contaminated by oil attributable to the spill or beyond national seafood safety standards. Mitigation measures were implemented on purely a precautionary basis or because of the unquantified presence of oil within a fishing area.

1. Wild capture fisheries

Tools for managing wild capture fisheries to avoid stock depletion have evolved over a period of more than 100 years. Although many of these same tools can be used to mitigate the economic impacts of oil spills (see Table 1), an absence of area specific planning and processes mean that documented examples of these being applied are rare. This section reports three cases where these were applied. In two of the examples reported below (Japan and Argentina), coastal fisheries are characterised by strong governance and organisation at a local level.

1.1. *Alternative fishing gear/target species*

Small scale fisheries that operate in coastal waters tend to be less specialised than offshore fleets, and are therefore more adaptable in the gears they use and species they target. In Japan, all fishing activities are regulated by Fisheries Cooperative Associations (FCAs). FCAs will usually have one or more fishing ports exclusively used by their members and

² These data are for indicative purposes only and represent instances where fisheries and mariculture issues were known to have existed or where mitigation measures were known to have been implemented.

fishing gears are stored on site. In 2007, a general cargo ship grounded ashore on northern Honshu Island, Japan between Fukushima and Miyagi Prefectures. Ultimately, shoreline oiling was limited, with patches of oil sheen restricted to the vicinity of the vessel.

Seafood markets in Japan are extremely sensitive to perceptions of a decline in quality and standard of products. Seafood caught and harvested in Japan is frequently subject to value-added effects based on the location of capture and harvest. Therefore, publicity of an oil spill affecting a particular Prefecture may result in wholesalers withdrawing demand for a particular product, irrespective of whether oil has actually affected the product in question. At the time of the incident, the fishery for *kounago* (sand eel) was open and the vessels belonging to fisheries cooperatives from both Prefectures were in the process of targeting this species, the highest densities of which were reported to accumulate on the border between the Prefectures, in the vicinity of the casualty. Although the fishery was not considered to be at risk from contamination, wholesalers from both the local and Tokyo markets cancelled orders for the remainder of the season. In an effort to mitigate their loss, the heads of the fishing cooperatives encouraged the fishers to switch to other, less valuable target species (i.e. flatfish and squid). For some vessels (those travelling further from their home ports to target *kounago*), the reduced catch value was partially offset by considerable savings in terms of fuel consumption and time at sea. Given the multi-species nature of fisheries in Japan, the majority of fishing vessels are, or can be, equipped with the multiple gears necessary to enable a change in target species. In this case, whilst the alternative target species of cod and squid were less valuable than the *kounago* at that time of year, the majority of fishers were able to continue working, resulting in a reduction in overall economic losses than would otherwise have been the case.

1.2 *Spatial restrictions/alternatives*

Shore-based fishers and gleaners are frequently those most impacted when an oil spill affects the coastline. Shore-based fishers, or those utilising non-mechanised vessels, are also often amongst the poorest. Options for targeting other areas when oil spills affect their normal fishing grounds can be limited, although opportunities may still be available.

In 2007, crude oil was spilled in Chubut Province, Patagonia, Argentina. The shoreline within a 6 km bay was affected by oil for several months following the incident. Within the bay, two of the most common fishing activities were shore-based; shellfish gleaning and octopus hunting. To avoid the collection of contaminated seafood for several months, the local municipality arranged for *marisqueros* (gleaners) and *pulperos* (octopus fishers) to be driven to beaches 20-50 km to the north of the affected bay. Because these areas were unpopulated and unexploited, fishers reported a greater catch per unit effort (CPUE) during this period. Given that transport was provided by the municipality, there were no additional costs incurred by the fishers.

A similar example involving set and mobile traps occurred during a spill in the Philippines. Following a spill of heavy fuel oil (HFO) in Cebu in 2013, the lagoon used usually by local fishers became a natural collection point for bulk oil. Fishers were able to retrieve these traps at high tide and redeploy them in an unaffected location. This measure however, required the fishers to walk greater distances within the lagoon, which due to the mud and limestone platforms could be challenging and slow. Others chose not to replace or move their traps and were unable to exploit the traps for several months whilst clean-up operations were underway and oil continued to be flushed from the mangroves.

Where fishing activities are less heavily regulated, and fisheries are largely managed on a local level, opportunities to exploit alternative fisheries grounds may be relatively straightforward. In countries where fisheries are heavily managed and regulated, the options to find alternative fishing grounds may require formal intervention on behalf of the fisheries

regulators to ensure that during this period, the legal basis for fishing on alternative fishing grounds exists.

2 Mariculture

The processes for the governance and management of mariculture are less well defined than for wild capture fisheries, although the rapid growth of this sector, along with associated issues on sustainability and environmental impacts has seen a rapid development of management tools.

2.1 *Towing cages*

ITOPF has not encountered recent examples of where stocked cages have been towed in response to avoid an oil spill. High value species such as salmon, seabass and seabream, Bluefin tuna and groupers are those most likely to be reared in anchored, high-density polyethylene (HDPE) cages that can be towed. As reported by Wadsworth *et al.* (1999), one of the considerations when towing fish is that the total water current the stock is subject to is not great enough to cause damage to the fish. FAO guidelines suggest a maximum overall current of 1-2 knots (Cardia and Lovatelli, 2015). Towing stocked cages is a commonplace and key process in the aquaculture of salmon and ranches Bluefin tuna. ITOPF is unaware of a case where cages were successfully towed away from the trajectory of an oil slick, however, there are a number of cases from Norway, Spain and Australia where cages have been towed away from harmful algal blooms (see: Hallegraeff, 2011).

There are a number of practical challenges associated with towing cages to avoid an oil slick. These were highlighted during a recent case in Turkey where heavy fuel oil (HFO) was spilled from a grounded vessel in Gerence Bay on the Aegean coast of Turkey in December 2016. Within the bay there are more than 10 fish farms, stocking seabream and seabass, as well as Bluefin tuna ranches. Due to a prevailing north-north-easterly wind, the spilled oil was transported away from the fish farms, which were situated to the west, north east and

southeast of the vessel. To be prepared in the event of a change in wind direction whilst the casualty was still leaking oil, the possibility of towing cages from farms that would be most vulnerable to a change in wind direction to alternative locations (i.e. behind small rocky outcrops that would protect cages from the trajectory of oil) was investigated. Two challenges that would have been difficult to overcome without prior planning were identified:

- 1. Difficulty in physically moving the cages:** stocking cages are frequently considered to be permanent fixtures with their positions often marked on maritime admiralty charts. When the cages are stocked, smaller, more mobile transfer cages are used and the fish transferred to the stocking cage *in situ*. In the event of all stock requiring rapid removal, there would be no alternative stocking cages of sufficient size/capacity in which to transfer the fish. The potential option of towing the fixed, stocking cages, was faced with the widely reported difficulty in detaching/reattaching mooring lines. Improved decoupling of fixed cages has been an area that the aquaculture community has been seeking to improve in order to facilitate towing as mitigation in response to acute disturbances such as pollution and disease (Lovatelli *et al.*, 2013).
- 2. Permitting requirements:** currently, in Turkey (as elsewhere), the transfer of fish from either a transfer cage, in the case of Bluefin tuna, or from land based hatchery facilities (seabass and seabream) is highly regulated as a contingency against both illegal fishing and to minimise the number of escapees. In Turkey, in an emergency, the immediate transfer of stock would not be possible due to the absence of an emergency transfer procedure.

The development of simple couplings to enable detachment and reattachment of mooring/anchoring lines would greatly facilitate the physical process of towing stocking cages in the event of an emergency. A pre-approved transfer and stock movement procedure

for use in emergency situations would also facilitate the cage towing option e in the event of cages being threatened by an oil spill.

As a final point, at the spill location in Turkey, there are two prevailing weather systems in winter. Each system prevails for at least a few days at a time, and is usually accurately forecast. Locations with such stable patterns would benefit the most from consideration of cage towing as a viable contingency measure as it would allow enough time to plan for the transfer of cages.

2.2 *Feeding suspension*

Following a spill of HFO in the Bay of Tokyo in central Japan in 2014, shoreline contamination on the eastern coast of the bay resulted in significant disruption to the area's diverse fishing and mariculture activities. One of the affected installations was an experimental coho salmon farm. The farm was in its second year of operation in 2014 and was experimental in nature as coho salmon are usually farmed in the colder waters of northern Japan. Whilst sea surface temperatures in Tokyo Bay in winter are cool, they heat up significantly in summer and temperatures are more similar to the sub-tropical southern Japan than those in the north. This meteoceanic anomaly means that the grow-out period for coho salmon smolt which is traditionally 10-12 months, was approximately 6-7 months at this farm. This particular installation therefore, had a shorter grow-out season over one winter compared to traditional coho salmon farms, harvesting smaller fish in the spring. The spill occurred one month before the harvest period was scheduled to commence.

Aerial surveillance at the time, indicated oil sheen and some tarballs moving through the cages in the initial days following the spill. To attempt to mitigate contamination of stock, the farm reported that they suspended feeding for a period of 10 days. This measure resulted in no significant increase in mortality (based on a comparative time data series of only one,

from the previous year) but resulted in a minor reduction of average size at harvest (1.11kg per fish when compared to 1.18kg the previous year).

3 General strategies

The international liability and compensation regime allows for measures that, based on the best available knowledge at the time, would most likely mitigate the financial loss experienced by those involved in fisheries and mariculture. Not all interventions that aim to avoid a full closure are based on traditional fisheries management measures. This section describes two complementary, passive measures that can be successfully implemented to mitigate economic impacts.

3.1 *Marketing campaigns*

Under some circumstances, the use of marketing campaigns to maintain market confidence in the seafood products from areas affected by oil spills are considered to be an appropriate mitigation measure. Following the NAKHODKHA oil spill in Japan in 1997, the National Federation of Fishery Cooperative Associations (NFFCA) ran a publicity campaign in the primary fish markets of Tokyo, Osaka, as well as in the affected Prefecture aimed at mitigating negative effects caused by public perception (IOPC).

3.2 *Holding back supplies (non-fresh markets)/surplus/stored stock*

Where fishing and mariculture activities are conducted under the auspices of a cooperative, there may be greater resilience to a wide variety of disturbances and disruption, including those caused by oil spills. This greater resilience is not only attributable to a greater flexibility brought by the pooling of resources, but also because cooperatives may have a greater planning and management capacity. Many cooperatives involved in the production and marketing of non-fresh products (e.g. frozen, dried, canned etc.), withhold surplus yields in storage to mitigate natural, inter-annual production variability that can be called upon to maintain market supply.

In the case that occurred in the Bay of Tokyo in 2014, referred to in Section 2.2, one of the primary activities of the FCAs located on the west coast of Tokyo bay, involves the collection and drying of the furoid seaweed *Hijiki*. Following the spill, the seaweed was not affected, as the oil passed over the submerged seaweed beds at high tide, to strand on the shoreline behind. However, in an effort to mitigate negative public perception and the sensitivity of the Japanese markets to food quality standards, a number of the FCAs elected to sell surplus stock from previous years rather than freshly harvested seaweed. The harvest from the time of the spill was placed into storage for release at a later date when public scrutiny of the incident diminished to the point that it would no longer impact market demand and sales price.

CONCLUSION AND RECOMMENDATIONS

Determining the physical and economic impacts of oil spills to fisheries and mariculture impacts is becoming increasingly complex. Paradoxically, due to improvements in analytical techniques, but also driven by an increased incidence of small scale spills, accompanied by ever more stringent expectations from the public and authorities.

Since Moller *et al.* (1999) and Wadsworth *et al.* (1999), there appears to have been little effort devoted to the development of fisheries- and mariculture-specific mitigation measures during the pollution response contingency planning process (in particular, measures other than full fishing and harvest closures). From a planning and preparedness perspective, it is rare for the seafood sector to undergo detailed activity and area specific consideration during the development of area specific contingency plans.

Based on the cases described in this paper, the following practical recommendations could assist in expanding the suite of practicable and feasible mitigation measures, beyond

fishing and harvest closures to attempt to mitigate physical and economic impacts of oil spills:

- **Active engagement between local fisheries governance and central authority overseeing oil spill preparedness and response.** Of the cases the author has attended on site, and those consulted for this paper, one factor that has resulted in the greatest opportunities for the adoption of alternative measures has been where seafood sector activities are regulated by cooperatives. It is generally accepted that where fishing activity is undertaken under the auspices of a cooperative or fishers association, there is a greater degree of resilience offered by the range of gears and target fisheries available to individuals (FAO, 2012). This has been proven in the examples presented here from Japan and Argentina. Coastal fisheries are more vulnerable to oil spills than industrial, offshore fisheries but, with appropriate pre-planning, those fisheries that are organised in cooperatives have been shown to be more resilient to the effects of oil spills. Authorities responsible for developing oil spill contingency plans should aim to understand and consult with local fisheries governance when assessing the potential for the inclusion of activity specific mitigation measures.
- **Fixed facilities and fisheries cooperatives.** Owners and operators of fixed facilities should be encouraged to identify oil spill specific measures in their general contingency plans (for mitigating the risk of escapees, pollution from farms, etc.). For example, the process of site selection for commercial farms can be a highly regulated process with national guidelines in place in some States (e.g. Norway). Operators should be encouraged to identify secondary sites, where conditions would be suitable for stocked cages to be towed to in the event that the primary site is threatened by an oil spill, and could be subject to long term reoiling (i.e. near mangroves and other collection points). Where fisheries governance is characterised by cooperatives or

associations, they should be encouraged to consider and plan for relevant mitigation measures guided by the specific oil pollution risks within their area.

- **Integration of activity-specific seafood sector contingency planning into general oil spill response planning.** The process should be broadly based on best practice guidance that underpins contingency planning for oil spills. Specifically, planning should focus on:
 - Characterisation of the seafood sector within the designated plan area.
 - Identification of potentially feasible mitigation measures depending on fishery/ facility type.
 - Operational consideration of how these measures might be implemented (e.g. permitting requirements, standard operating procedures).
 - Development of criteria on thresholds that will result in fishing and harvesting closures. Crucial to this is the development of seafood safety standards, as well as emergency sampling procedures to be implemented in the event of a spill.

In researching this paper, it has become apparent that around the world, where measures besides closures or closures have been applied, they were not pre-planned, but rather implemented in reaction to an incident. In many countries, however, the ability to continue to fish or culture during an oil spill would be ultimately less detrimental to the financial status of those involved than being unable to fish or culture, and then to seek compensation at a later stage.

Along with the implementation of OPRC '90, came the need to maintain oil spill contingency plans, improved general preparedness has led to a greater capability to respond to oil spills. The FAO already recommends that at both national and local levels, emergency plans for all types of disaster should specifically address fisheries management measures. The

IOPC Fund's Management of Fisheries Closures and Restrictions Following an Oil Spill document (IOPC, 2016), therefore, is an important first step towards a more holistic approach to planning by integrating these internationally mandated goals and improving preparedness and resilience to oil spills in the seafood sector. Improved integration of fisheries and mariculture considerations into the oil spill contingency planning process is key to improving the capability to mitigate some of the impacts of oil spills on these sectors. This planning process, however, must translate into locally relevant measures that are realistic and practicable.

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