Technical guidelines for assessing fisheries sector claims

With special reference to small-scale operations lacking evidence of earnings

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International Oil Pollution Compensation Funds

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INTRODUCTION TO THE GUIDELINES

Experience from many oil spills has shown that fisheries sector enterprises often have little or no evidence as to their normal earning levels against which to assess claims for compensation. This problem occurs in many countries, but it is most pronounced in developing nations, especially in the case of small-scale fisheries sector operations.

The aim of the IOPC Funds and P&I insurers is to ensure that all victims of oil pollution damage are fairly and promptly compensated. However, achieving this aim has proved difficult, due to a lack of evidence to support claims for compensation. It is recognised that there are a number of common methods that can be applied in the case of oil spills, to assess appropriate levels of compensation.

These guidelines describe the likely types of impact on various fisheries sector operations, and provide information and methods for estimating losses. The guidelines cover the more common mechanisms of loss, but not market damage issues, which are complex and, by definition, require routinely collected market data, pre- and post-impact.

Compensation is only available in respect of claims that fulfil specific criteria. These guidelines are designed to assist experts in the assessment of claims in the fisheries sector, with special reference to small-scale operations lacking evidence of earnings. They do not address legal issues in detail and should not be seen as an authoritative interpretation of the relevant international conventions.

Who are the guidelines aimed at?

The guidelines are intended primarily as a tool within the Funds Secretariat for those who may be involved in assessment and settlement of claims for compensation from fishery sector operations. However their range of content, from general descriptive sections, to detail on collecting data and fishing sector business models, means that they could also be useful to non-specialist personnel in P&I Clubs, local claims offices, and to advisers to claimants.

Activities at risk

An oil spill has the potential to disrupt a range of economic activities in the marine environment. These guidelines cover fisheries *sector* activities, i.e. not just fishing, but also aquaculture and associated businesses.

Fishing includes all forms of capture of marine organisms, from simple hand gathering through to industrial scale trawling.

Aquaculture covers a wide range of activities that increase the natural productivity of marine organisms. It ranges from intensive farming to extensive nurturing, and can be distinguished from wild fisheries by human intervention in the life-cycle and ownership of the farmed stock. It can take place in the sea, in estuaries, or in facilities onshore, supplied with sea-water.

Associated businesses are those which are dependent on the primary producing sub-sectors.

The most obvious is fish processing, which is taken to include transformation (e.g. gutting, smoking etc) and packing (e.g. canning), as well as sorting and grading. However, there are other businesses that can suffer losses from a pollution incident; for example, fuel and ice supply to fishing vessels.

1 INTRODUCTION TO FISHERIES SECTOR OPERATIONS

Economic and social context

In many countries, the fisheries sector is a relatively small contributor to the national economy, its importance declining as target species are exploited at, or beyond, their maximum sustainable yields. In some developing countries, however, fisheries are more significant in terms of Gross Domestic Product (GDP). For example, West African economies are recognized as being highly dependent on fisheries, with large inshore fleets targeting abundant, low-value, pelagic species for home consumption, and some high-value demersals for export.

Small-scale fisheries also provide an important role in terms of food security by exploiting a renewable and potentially sustainable source of food that provides animal protein, amino acids, fish oils and essential micro-nutrients such as calcium, iodine and certain vitamins.

The **capture fisheries sub-sector** is often characterized by low profitability, because in many small-scale fisheries, management is weak and attempts to control access largely unsuccessful. This means that, as long as fishing is generating profits, more people enter the fishery, increasing pressure on resources. Furthermore, profitability in small-scale fisheries is frequently adversely affected by the operations of large industrial vessels, competing for the same resources with greater catching power, and often with more political support.

While fishing communities are often relatively wealthy compared to farming communities, mainly because they are dealing with a relatively high-value commodity, they also remain vulnerable to sudden changes and loss of earnings.

So, while small-scale fishers may be poor and vulnerable, contributing little to food security, GDP, employment and poverty alleviation, many generate significant profits, prove resilient to crises, and make significant economic contributions, affecting to varying degrees the following groups:

- those involved directly with fishing (fishers, traders, processors, etc.);
- the dependants of those involved directly with fishing (fishing-related households and communities);
- those who buy fish for human consumption (consumers);
- those who benefit from related income and employment through multiplier effects;
- society in general and/or those who benefit indirectly as a result of national export revenues from fisheries, re-distributive taxation and other macro level mechanisms.

For **aquaculture**, the situation is rather different. While production capacity is limited to suitable sheltered water or coastal land for on-shore operations, the means of control over production capacity are generally restricted. Sites are normally leased for significant periods

(15 years is common) on a first-come, first-served, basis. There is also a relatively high capital requirement (construction costs and working capital).

The **fish processing and marketing** sub-sector is subject to the unpredictability of supply and price of raw material from capture fisheries. This weakness is becoming increasingly acute in many countries with heavy pressure on stocks. However, demand for fish products is generally rising in developing countries, through population growth, and in developed economies through increasing incomes and consumer preferences. In many cases, this increase in demand is helping to raise prices, and therefore profits, for processors and traders. In recent years, there has been a significant rise in the export of products from small-scale fisheries to markets in developed countries.

It is often the case that catching activities are male-dominated, while small-scale processing and marketing are conducted by women. Other characteristics of fish processing are described elsewhere in this manual.

2 METHODS FOR ASSESSING GLOBAL LOSSES

This section of the guidelines deals with ways to estimate overall fishery sector losses in the early stages of an incident. The aim is to be able to provide the Fund and insurers with a working estimate of likely losses from fishing or aquaculture disruption, when there is little reliable information to hand.

Section 3 of the guidelines deals with methods for assessing individual claims.

2.1 General considerations

Disruption to fishing and aquaculture

It is prudent for fishermen not to work in areas with floating oil present, as doing so would be likely to contaminate gear, vessel, and catch.

If there are reliable scientific data on water and fish flesh contamination, demonstrating that levels exceed acceptable norms, it is reasonable to accept that fishermen are unable to work in areas where water and stocks are contaminated. The area affected and the time that fishermen are unable to work should form the basis for compensation.

It is likely that different categories of vessel will have different degrees of reliance on the polluted area. Small inshore vessels are likely to be the most affected. However, larger boats may not be affected at all by the pollution, and may be able to steam through any floating oil to grounds further offshore. For aquaculture operations, it should be expected that all of those farms in the polluted area will be impacted in some way.

It is recommended that a dialogue between the Fund / insurers, through their experts, and the fishing industry, should be maintained from the early days of a spill, regarding the distribution of the pollution over time. Good communications can allow the Fund / insurers to express an opinion about the reasonableness of continuing not to fish in the light of changes to the pollution over time.

Government prohibitions

Governmental fishing and harvesting prohibitions serve to impose protective measures in a defined area for a specific period of time. Any ban should be managed on the basis of a thorough sampling and analysis programme and a reasonable interpretation of the results. It is recommended that the Fund, insurers, and their experts are involved in this process with the aim of ensuring that any bans are scientifically reasonable in terms of the area and time covered.

Disruption to processing

The situation with regards to processors and traders is not as clear-cut as for fishermen and fish farms. In many cases, the impact on the processing / trading sectors should be reasonably clear, particularly in developing countries where a lot of processing / trading takes place close to the beach or landing site.

2.2 Likely sources of information on the fisheries sector

Almost all administrations publish annual statistics. These typically include the current status and trends with regard to capture fisheries landings volumes and values by main species group (e.g. demersal, pelagic, shellfish etc.); volumes and value of aquaculture production by main species; and the numbers of registered / licensed fishermen and aquaculturists. Such data are often provided by region, which can be of particular benefit in assessing overall losses shortly after a spill. However, considerable care is needed in the interpretation of governmental statistics. Data collection systems are generally far from perfect, and experience shows that official statistics may significantly underestimate or overestimate volumes and values of landings.

The second important source of information is documentation or knowledge held by local fishing organisations. Such organisations (e.g. fishing co-operatives, associations of fishermen, fish farmers, traders etc.) are likely to be able to tell with a good degree of certainty the number of people actually fishing, or involved in fish farming, processing or marketing. Of course, obtaining reliable information from such organisations depends on contacting them immediately after a spill occurs, before they become involved in assembling claims on behalf of their members. Once this process is underway, the ability to obtain useful data is diminished.

Other sources of information could also be of benefit in estimating the numbers of claimants likely to be involved and thus the likely overall losses, and in the detailed calculation of individual losses. Examples include:

- Reports from donor-funded agency projects
- Work completed by local and international non-governmental organisations operating in the field
- Poverty profiling and national Poverty Reduction Strategy Papers
- Journal articles recently published by academics or consultants based on field-work relevant to the spill area
- Local research institutions and universities
- Living Standard Measurement Surveys as promoted by the World Bank

- Population censuses
- Household and village surveys
- Local or national fisheries experts

All such potential sources of information should be considered, to enhance the assessor's knowledge of the locality in which the spill occurs, and of the fisheries sector in that locality.

2.3 Calculations of global losses

In simplest terms the overall loss to the fishery sector from an incident can be expressed as:

$$((GP_{Fishing} + GP_{Aquaculture} + GP_{Processing}) \times T) + P,$$

where GP = gross profit of the enterprises impacted, on a daily, weekly or monthly basis,
T = the number of days, weeks or months that the activity can not reasonably take place due to the pollution,
P = property damage such as polluted gear or vessels.

It is recommended that the above formula is followed to estimate likely levels of loss, with the following guidelines and provisos.

1. Fishing vessels should be counted in the polluted area.
2. GP for an average of the vessel types impacted should be estimated, if possible, by comparison with descriptions of fishing activities and/or through rapid survey of a few vessel owners, and/or information readily available in the country.
3. If it is not possible to quickly assess GP in the catching sector, gross income (weight of catch x price) per unit time should be used as a safer estimate (i.e. overestimate) of global losses.
4. The capacity or area of farms which have been polluted should be quantified.
5. The rapid survey and descriptions of aquaculture processes, together with models, may provide indications and benchmarks for estimating lost aquaculture GP from the spill.
6. The volume of seafood normally produced per unit time should be assessed for the fishing and aquaculture industries together, using the methods mentioned above.
7. A working estimate of the proportion of catch processed by enterprises located immediately adjacent to the polluted coast should be made. An assessment of the gross profit per tonne of seafood processed should also be made using benchmarks provided, and/or through rapid survey of a few processors, and/or information readily available in the country.
8. Estimates of the duration of fisheries interruption are, of course, difficult to make in the immediate aftermath of a spill. It is unlikely that the whole of the polluted zone will be equally impacted, and some areas may recover faster than others. This could be taken into consideration when estimating global losses.
9. If static gear loss or pollution is indicated as an issue early in the spill, it is safest to make an overestimate of the gear that may be at sea and at risk. This is probably best achieved through interviews with a combination of affected fishermen, unaffected fishermen and governmental fisheries officers. A rapid survey of gear manufacturers

should provide indicative unit costs for gear, to be used in making a global estimate for lost gear.

10. If fishing vessels and farms need significant cleaning, local marine surveyors should be asked to assist in assessing reasonable costs per metre of vessel length, or unit costs for aquaculture equipment. These unit costs should then be applied to the fleet and farm count data to arrive at a global cleaning cost.
11. Estimates of global fishery losses shortly post-spill will be inherently inaccurate, though should still be of assistance to the Fund and insurers in the early stages.

Much of the information gathered in the early stages will be useful for assessing the detail of individual claims at a later stage and should obviously be retained. Also, communications links should have developed in the early stages between the Fund staff and its experts on one hand, and key players in the fishing industry and governmental departments on the other. It is recommended that this should be maintained as smoothly as possible through the transition into detailed claims handling.

2.4 Earnings

As would be expected, the range of total earnings in absolute terms, and per day, in various costs and earnings models, such as those prepared by the Food and Agriculture Organisation (FAO), is large, given the wide range of fishing operations profiled, and differences in technological sophistication, vessel size, fishing methods, and the regions covered.

The calculation of cash loss within an artisanal fishery is often difficult. Commonly, a large proportion, or in some cases all of the catch, is taken for domestic consumption.

The wide range of earnings displayed in costs and earnings models does not enable any general conclusions to be drawn about earnings, except that earnings generally increase in a country as vessel and/or crew size increases. This is to be expected given the higher fixed costs, and the need for larger earnings to generate sufficient crew earnings. Nevertheless, data may reveal that earnings can be significantly different for vessels of similar sizes, and greater for smaller vessels than larger ones in a particular country. However, it can usually be expected that, in any particular country, when both vessel and crew size increase at the same time, total earnings will increase.

What is perhaps of more interest is the level of earnings per crew per calendar day. Data reveal that figures within any one country are remarkably consistent across different types of fishing operation, and this is also true, but to a lesser extent, across regions. It is especially useful if earnings by fishermen in a comparable area not affected by the oil spill can be easily assessed.

2.5 Variable costs

As with earnings, absolute levels of variable costs can vary greatly, even between vessels of similar sizes in the same country. But it is generally true for any one country that when both vessel and crew size increase, variable costs also increase. No clear differences or patterns emerge from the data on average variable costs as a percentage of earnings, but the data suggest that as a rough rule of thumb, variable costs are on the order of 60-70% of total earnings.

A large proportion of the fishing equipment, and even the fishing vessel, may be made by the fishermen from locally-sourced natural materials, and therefore the major cost would be labour time. The proportion of variable costs attributable to crew earnings does show some clear patterns across the regions, if not across different fishing operations within each region, with Africa showing the greatest costs, followed by Asia, the Middle East, and then the Americas. This is probably due to similar costs of the factors of production within each region. For example, in Africa, where labour is plentiful and relatively cheap, labour costs constitute a higher proportion of total costs, than in other regions where labour may be relatively expensive compared to capital inputs.

2.6 Fixed costs

Average fixed costs for the models in each region are remarkably consistent, at around 20% of total earnings. This is not to say that significant differences do not occur between different fishing operations, but it serves as a useful rule of thumb to be used in claims. As already mentioned, these fixed costs are made up of depreciation, insurance, interest charges, maintenance costs for vessels and engines, but not for gear, and other non-variable general expenses.

Within fixed cost items, the data reveal that vessel maintenance and repair costs tends to decline as a percentage of total costs as fishing operations become more unsophisticated. Depreciation and interest payments are generally less for less-developed countries, as less capital is involved.

2.7 Profit and value-added

As expected, given the above statements about the range of costs and earnings across different fishing operations, few clear patterns emerge from the data on average profit levels in absolute terms. For example, there are no clear trends that absolute profits levels, or profits as a percentage of earnings, increase with vessel size. Profit levels vary enormously across the different operations. However, almost all models show small-scale marine capture fishing to be an economically viable activity, generating sufficient funds for re-investment in addition to generating income and employment.

For the purpose of claims assessment, the ability of profit levels to change rapidly must always be borne in mind. This is especially so, given that many fisheries around the world are either fully- or over-exploited. This clearly raises questions about the extent to which data collected on historical profit and value-added can be used to project the actual profits following an incident. The claims assessor must be especially careful to consider whether a decline in profits and value-added are due to an incident, or to other external factors such as resource availability, fuel price rises etc.

2.8 Investment costs

The models presented in the next section show total investment costs broken down into items for hulls, engines, deck equipment, fishing gear, and other investment costs, and as with data on costs and earnings, it is hoped that data might be useful as a benchmark in future claims situations relating to damage or loss of gear. Hull costs appear to display some consistencies for vessels of similar sizes in the same country, with investment costs increasing as vessel size increases. This, of course, is to be expected, given that small-scale fishing vessels are usually made of either wood or glass-fibre, and that the same construction materials are often used for vessels engaged in different fishing operations.

The proportion of investment costs attributed to hulls, engines, gear, etc., depends very much on the type of fishing operation, and this must be acknowledged in any assessment of claims. For example, a beach seine operation will have low hull costs and low, or non-existent, engine investment costs, but potentially large gear investment costs. Likewise, a fishing operation using pots may have gear investment costs that vary considerably from one that is gillnetting.

3 DETAILED ASSESSMENT OF CLAIMS

This section of the guidelines deals with the assessment of individual claims. Templates of business models are then presented, followed by a discussion of their application in assessing business disruption, suggestions for assessing the key variables in the models in the absence of reliable data, and some worked examples.

3.1 First screening

3.1.1 Admissibility

Given that the amount of compensation in any one spill is limited, the Fund has a responsibility to ensure that those receiving compensation are those that have a genuine dependence on the impacted coastline for fishing, aquaculture, or processing (or other economic activities).

The range of people who may be encountered, purporting to be in the fisheries sector and suffering losses after a spill, include:

1. fishermen, fish farmers or processors who are dependent on the polluted area and are operating legally,
2. as category 1, but whose normal activity is, in some way, outside the law,
3. fishing vessel crew, or employees of fish farms or processors,
4. fishermen, fish farmers or fish processors without dependence on the polluted area,
5. individuals who are not in the fishing industry at all.

While local claims offices in large incidents have many advantages, they perhaps have greater potential to attract spurious claims than the Fund or shipowner direct. These offices are therefore where the most effort is likely to be needed to establish claimants' credentials.

3.1.2 Adherence to relevant legislation

This is an area which has caused considerable problems for the Fund in the past, and is most likely to be encountered in spills in developing countries, where evidence of the legal standing of fishermen and their activities is lacking.

The Funds' policy is to reject claims for compensation for alleged loss of catches which exceed quotas laid down by the competent authorities. The Funds also maintain a general policy of not accepting claims from commercial fishermen who carry out their activities in breach of licensing requirements laid down in, or based on, national legislation.

Licensing in the fisheries sector

Capture fisheries: Although fisheries legislation is weakly enforced in many developing countries, some form of licensing system usually exists. It is likely that the fisheries authorities will hold lists of licensees. The detail held for licensees may include some kind of civil identification number, domicile of the licensee and/or the home fishing port/village of the vessel. Indeed, many licence systems licence an individual to operate a particular vessel, rather than just provide the individual with a permit to fish, particularly where the purpose of the licence is to control fishing effort through fleet size.

Community approach: In other situations, the number of fishermen may be too great to interview on an individual basis. Also, if licensing is disregarded, there may be more people claiming to be vessel skippers than boats in use at any one landing place. In either case, for claims handling generally, it is recommended that the assessment process is undertaken at a community level.

Government approach: Where there is a large incident, and many communities and individual fishing operations impacted, it is likely that the government will take a significant role in the compensation process. In many cases, governments have submitted claims on behalf of their fishing industries. While there are many drawbacks to such an approach, this may be the only practical way of dealing with possibly many thousands of individual claims. Claims assessment techniques would be similar to those described at a community level, but on a wider scale. However, it would be for the government to allocate compensation and by inference take a view on whether unlicensed fishermen, or even non-fishermen, were eligible for compensation.

Aquaculture: The situation with first screening of aquaculture claimants should be more straightforward compared to capture fisheries, since there are fewer operators risking time and capital to produce a crop in specific areas of sea. This is more conducive to effective licensing regimes.

Processing: Whether first screening is required depends upon legislation in place, and the degree to which it is observed. Fish processing operations are unlikely to be subject to specialised licences and permissions that apply to the common resource aspects of fisheries and aquaculture: a basic permit to operate a business is more likely. If the policy is to be flexible toward 'unlicensed' claimants, similar research techniques as described for unlicensed operations in other sub-sectors should apply.

Other fisheries sector legislation

Capture fisheries: In addition to a basic licence, there are several other common management regulations found in small-scale fisheries, notably minimum size of fish/shellfish that can be landed, minimum net mesh sizes, zoning of fishing areas by vessel size or gear type, closed seasons and closed areas.

In many developing countries, such management measures are weakly enforced and there are short-term economic incentives to disregard them. In any compensation situation, it is usual not to admit claims for loss of income that is derived from potentially illegal activity. However in many instances in small-scale fisheries, applying a rigid policy to illegal fishing would cause severe hardship in the industry. A policy of flexibility towards claimants in these situations may be considered appropriate.

Aquaculture: As with fisheries, apart from a licence, there is often further legislation relating to the way in which farms operate. These are mainly aimed at minimising impact on the environment, spread of disease and conflicts with other coastal zone users. Regulations may cover species allowed for farming, capture of juvenile seedstock, stocking densities, size and location of farms (if not covered by the basic licence), discharge of waste, disease status of the stock or farming area, and use of theraputants.

Processing: There is a very wide variety of legislation in place around the world affecting the way in which fish processors operate, much of it aimed at protecting consumers and employees. In some countries there is very little, while in others it is burdensome, particularly where product is exported to North America or countries in the European Union. In common with other sub-sectors, regulations can be weakly enforced or ignored, though less so where export is involved.

3.1.3 Dependence on the polluted zone

Fishing: The degree of dependency of a fishing operation in a polluted area is difficult to establish even when normal business records are available, and the problem is not confined to developing countries.

In the first screening process, the aim is to differentiate between claimants who have at least partial dependence on the polluted area, and those who have none at all. The assessment procedures for this initial differentiation are much the same as those for establishing the degree of dependence of a partially dependent fishing operation, and so both will be discussed here.

As mentioned previously, there should be reliable information available about the distribution of pollution, or agreement on a zone in which fishing is prohibited. The degree of dependence is essentially the degree of overlap of normal fishing operations in the non-fishing area, though the economic effect is not necessarily directly proportional.

In any large incident it is likely to quickly become clear that several fishing communities are 100% dependent on the polluted zone. In smaller incidents, or in those communities near the boundaries of the polluted area, it is necessary to establish the home bases and fishing areas of the claimants.

Aquaculture: It goes without saying that this issue is far simpler with aquaculture than capture fisheries. A farm in the sea, or the source of water in the case of ponds and pump-ashore farms, is either polluted or not: there is no question of partial dependence, so this is a critical test in first screening. Adequate data should be available from overflights and other assessments of the pollution zone.

The only situation where partial reliance may become an issue is if some part of the life cycle is carried out in one area and another in a different location. For example, seedstock may be sourced from the wild or from hatcheries in the polluted are, and grown on elsewhere. In such situations, independent assessment of the dependence of uncontaminated farms on the polluted zone will be necessary. Totally unaffected farms, governmental aquaculture organisations, universities and buyers of the crop are all possible sources of such information.

Processing: The degree of dependence on the polluted zone is one of the criteria that the Fund applies to processors. It is normally measured in terms of the percentage or raw material (volume or value) that is traditionally sourced from the polluted area. In a small-scale processing industry where there is minimal record keeping, this could be difficult to establish.

As mentioned above, the situation should be very clear where small-scale processors are immediately adjacent to landing areas in the polluted zone. Research effort is therefore likely to be needed for operators outside the polluted area who claim that they buy from within it.

3.1.4 Crew or employees

The Fund and P&I Club practice is to pay owners or skippers of vessels without deducting crew earnings, leaving it to the skippers concerned to settle with their crew as they normally would. Payments have similarly been made to the owners of fish farming or processing businesses.

In many situations, particularly in developing countries, it could be very difficult to establish the status of someone claiming to be a crew member or similar employee, as no licence is required to be a crew member in many countries.

The Fund and P&I Clubs make their position widely known at an early stage through meetings etc. with the fishing industry in the initial assessment period. Any direct claims from crew or employees would be declined in the first instance and the procedure explained to them. Similarly, fishing vessel owners/skippers would be requested to sign an undertaking to settle with their employees in the normal way. In spite of such arrangements, claims may be brought directly by crew or employees, although it is recommended that a single approach to crew and employees is taken.

3.2 Business models and their application

3.2.1 Fishing

A financial model of a fishing business

The financial model shown in Table 1 overleaf illustrates the main characteristics of a fishing business and the kinds of information needed to complete an assessment of commercial losses resulting from business interruption. The following paragraphs explain the terms used in the model and introduce some of the means of estimating the key variables. In modelling a business for the purpose of estimating interruption losses, we are concerned above all with quantifying **losses** in gross revenue (catches the vessel was prevented from making) and **savings** in direct costs (fuel and supplies not consumed).

Total annual revenue (**d**) is presented here in terms of *mean daily catch* (**a**), *mean price* (**b**), and *number of fishing days* (**c**). In practice, determining these variables can be a complex process, requiring investigation of the seasonality of both landings and prices. Catches are usually expressed by fishers as catch per landing, or catch per fishing day, and it is therefore necessary to multiply up to obtain an annual revenue estimate. Note that in small-scale fisheries, a

Table 1 – A simple fishing business model

SALES		
Mean catch per fishing day	a	
Mean price	b	
Number of fishing days / year	c	
Total annual revenue	***d***	$= (a \times b \times c)$
FIXED COSTS		
Depreciation	e	
Interest	f	
Vessel repairs and maintenance	g	
Other	h	
Fixed costs ex depreciation	*i*	$= (f + g + h)$
Total fixed costs	***j***	$= (e + f + g + h)$
VARIABLE COSTS (ex labour)		
Fishing gear repair / replacement	k	
Trip costs		
Fuel and lubricants	l	
Ice	m	
Bait	n	
Food and provisions	o	
Marketing costs	p	
Other	q	
Total trip costs	*r*	$= (l + m + n + o + p + q)$
Total variable costs	***s***	$= (k + r)$
LABOUR COSTS		
Share costs, OR	t_1	= (d - r) / 2
Crew salary	t_2	
PROFIT	***u***	$= d - (i + s + t)$
Interruption losses per calendar day	***v***	$= (d - s) / 365$

'landing' is often equivalent to a fishing day – but not always. In some fisheries, trips of several days are normal, in others, the vessel may land two or more times in one day.

Fixed costs (**j**) are those costs that are incurred regularly, regardless of the amount of fishing effort or the amount and value of catch landed, i.e.:

- *depreciation* of the fishing vessel, engines and machinery, vehicles and other assets (**e**);
- *interest* payable on loans (**f**);
- *vessel repairs and maintenance* (**g**);
- and various *others*, which might include insurance (**h**).

It might be considered more correct to classify vessel repairs and maintenance as a variable cost, dependent on vessel activity. However, periods of lay-up or inactivity do not usually result in a reduction in hull or engine maintenance costs, hence they are treated as fixed costs. Although important in a financial or economic analysis, fixed costs are not of concern to the assessment of fishery losses, since by definition they will not change as a result of the oil spill.

Variable costs (**s**) are those that are related, directly or indirectly, to vessel activity, and will cease during periods of lay-up. They represent savings during fishery interruption, and are important inputs to the loss assessment. In the model they are divided into

- *fishing gear repair and replacement* (**k**), which is normally the responsibility of the vessel owner, and
- *trip costs* (**r**), which are normally shared between the owner and the crew in the calculation of the crew share (see below). Trip costs include all of the immediate direct costs of production and sale, including:
    - *fuel and lubricants* (**l**),
    - *ice* (**m**),
    - *bait* (**n**),
    - *food and provisions* (**o**),
    - and *marketing costs, when appropriate* (**p**).

Most of these items may be quantified through interviews with claimants, with some cross-referencing between claimants or with non-claimant fishermen from equivalent fishing areas. Unit prices for fuel and ice are fairly standard within a given geographical area, and easily verified. Fuel consumption may be learned through the interview survey, and may be cross-checked by reference to standard specific fuel consumption data for the type of engine, intensity of use (degree of load) and daily running pattern.

Labour costs (**t**) are structured in many different ways, and it will be necessary to determine the system in use in the assessment area. Worldwide, the most common arrangement is the share system, in which the crew and the vessel owner take equal shares of the catch value after trip costs have been deducted ($\mathbf{t}_1$). There are many variations on this theme, and the crew share may be more or less than 50%. Complications may arise where there is an additional share for the owners of the gear, which may include crew members as well as the vessel owner. Simpler, but less common is the payment of fixed salaries to the crew ($\mathbf{t}_2$), with or without an incentive bonus. None of these details affect the overall quantum of interruption loss, but they do have a bearing on how compensation is to be distributed, and the structuring of labour costs should be investigated as a matter of course.

The *annual profit* of the enterprise (**u**) is the gross revenue (**d**), less all fixed costs, except depreciation (**i**), all variable costs (**s**) and labour costs (**t**).

The most important value derived from the business model is the net *daily loss from interruption* (**v**). This is the annual gross revenue, less annual variable costs, divided by 365. In fisheries of a clearly seasonal nature, and where there is sufficient information on seasonal variation, the model should be set up with values equivalent to the season in which the interruption occurred rather than with annual average values. Note that this calculation provides the loss per *calendar day*, not per *fishing day.* Failure to distinguish between the two is a frequent source of error in fishery interruption claims.

Field surveys: objectives and techniques

It is rare to encounter a fishery for which no documentary records exist, even though small-scale artisanal fishers rarely keep records of their own incomes or costs. Government fisheries departments usually make estimates of monthly and annual production; the larger markets may record retail prices, and fishery cooperatives or associations may also keep their own records of landings and/or sales. One of three principal objectives of a field survey is to fill in the gaps where data are missing, and provide a check on the reliability of such records as do exist. The second is to record the facts of the oil spill incident and its impact on fishing operations in as much detail as possible. The final objective is to develop, within a fairly short time period, an understanding of the local fishing industry – to the extent that will enable the assessor to respond to the diversity of compensation claims that will undoubtedly arise.

Timing of the assessment

The best time to study and assess the workings of a fishery after an oil spill occurs is as soon as possible afterwards. It may take several days before the government acts to impose a ban on fishing, or before fishers' organisations call a voluntary suspension, especially where the fishery is a subsistence or artisanal one. During this period, many fishermen will be going to sea in an attempt to retrieve set gear (e.g. nets, lines or traps), and they may haul the gear through the oil slick, contaminating it so badly in the process that it may be useless for further fishing. It is very difficult at this stage to obtain useful objective interviews, but the value of first-hand observation during the immediate post-spill period cannot be overstated. Overall, the immediate post-spill period should be seen as a time for establishing a **detailed record** of events and forming a **preliminary assessment** of the likely level of losses.

After the initial chaos has subsided –a matter of weeks to months, depending on circumstances – it will be possible to undertake a more comprehensive interview survey that will lead to a **detailed assessment** of losses. During this passage of time, two changes are likely to have taken place within the fishing communities. Firstly, the initial shock will have subsided to some extent, although there may be severe hardship where daily earnings translate directly into daily subsistence. Secondly, the issue of compensation will have been raised – by government agencies, fishermen's organisations, or by the P&I Club's local agent.

On occasion, the assessor is called in long after the oil spill has taken place – perhaps even years later. This has obvious disadvantages, in that it takes quite a lot more work to piece together a credible picture of events, but there are advantages also. Official estimates of the fishery may be available, which will enable the incident to be viewed in a wider spatial and temporal context[1]. These are usually published a couple of years in arrears, and current estimates are rarely available at the time of the incident. It may also be the case that the fishing communities affected by the spill have weathered the hardships of the period, and are now able to look back more objectively on past events.

Interviewing fishermen

It is normal practice for the Fund / insurer to issue a claims form to each fishing vessel

[1] *Official statistics must always be treated with caution, but they can at times be very useful.*

operator intending to make a claim. These forms, which differ according to the type of fishery, ask various questions to enable the assessor to understand the claimant's business. However, experience has shown that claims forms are no substitute for face-to-face interviews with claimants, once the forms have been completed.

Ideally, the assessor will interview individual fishermen on or at their vessels, or at the harbour or landing beach. In that way, the fisherman can show the assessor his vessel and fishing gear, and can answer questions about them. It can sometimes be helpful to hold interviews with small groups of fishermen– they can remind each other of details that one or other has forgotten.

An in-depth interview can take 45 to 90 minutes. The information that derives from an extended interview often proves invaluable later, when discussions on claims may be carried out in locations remote from the incident. The time needed for individual interviews declines as the assessor acquires more understanding of the fishery and begins to focus on key issues.

The purpose of interviewing fishermen is to determine the nature of their fishing operations, to attempt to quantify the variables listed in the business model and to find out how the oil spill affected their businesses. The last may well be the simplest to answer, especially if the fishery has been officially or unofficially closed. In these cases there has simply been a cessation of fishing for a fairly well defined period. The most difficult variables to pin down are catch volume and value.

Catch volume and composition

The most productive approach is to try to build up a picture of a 'normal' fishing year, with questions initially focusing on fishing methods, fishing grounds, and the species caught. The fisherman would be asked about the seasonality of his fishing. He may use different gear at different seasons, or, even where the same gear is used throughout the year, the catch may vary in size or composition. Follow-up questions will usually enable the assessor to estimate the likely levels of landing through the year, as well as seasonal variations in catch composition and value.

Catch units

Fishers are unlikely to quote catches in kilograms. It is necessary to quantify the local units. It is also possible to estimate weights by measuring the volume of containers.

Catch value

The exploration of landed prices should begin with questions about how the catch is The exploration of landed prices should begin with questions about how the catch is marketed. This may include auction markets at the quayside, or another central location, direct sales to merchants, processors or the public, or sales to informal, small-scale, traders. The last of these is the most common in artisanal fisheries. The interview should then be directed towards the prices paid for all species of major importance in the catch, and should aim to capture seasonality and trends. Some interviews should be conducted with other links in the marketing chain, in order to verify landed prices and to explore the possibility that distributors may also have suffered losses through a reduction in supply.

Domestic consumption

It is normal for the crews of fishing vessels to retain a proportion of the catch, most commonly low value species, for (a) domestic consumption, or (b) local sale within the fishing community. It is not necessary to know the level of domestic consumption in order to calculate interruption losses, but it is useful to quantify this variable in order to estimate the total volume of fish entering the local market, which may sometimes provide a valuable method of cross-checking production estimates.

Fishing days

Correctly estimating the number of days that a fisher actually goes to sea is as important as estimating catch volume or catch value in the calculation of annual revenue or daily loss. Activity is slightly less difficult to determine than the landed catch (at least there is an upper limit to the number of days in a year), but it is worth trying to obtain an accurate estimate of this variable. Once weather conditions, engine breakdowns, gear repairs, social, religious, or traditional commitments are taken into account, it is usually reduced to between 10 and 15 fishing days per month, or 120-180 fishing days per year.

Observations of landings

Witnessing fishing boats landing their catch is recommended, especially if a large number of vessels land in the same place at around the same time. This affords the opportunity to see at first hand how much fish and what types are brought ashore from individual vessels, and how much variation there is between vessels. It may also provide an opportunity to see how sales are conducted, to verify prices, and make arrangements for subsequent meetings with fish traders. It is worthwhile repeating this exercise – on several occasions, if time permits – to develop a more reliable picture than is afforded by a single visit. If the fishery remains closed during the field survey, it will not be possible to see the affected fleet in action, but it may in this case be useful to observe landings from similar fisheries in nearby locations that remain in operation.

Interviews with other sectors of the fishing industry

Initial interviews with fishers will lead to an overall picture of the local fishing industry, and will indicate other sectors within it that should be followed up during the field survey. Particularly important here will be fish traders and fish market officials, but ice suppliers, fishing gear dealers or manufacturers, and fuel suppliers should also be contacted. Every opportunity should be taken (a) to verify key variables in the fishing business model, and (b) to consolidate a broad understanding of how the industry operates.

Surveying non-polluted areas

A rapid survey of areas where fisheries broadly similar to those affected by the oil spill are carried out, from nearby but unpolluted coastline, can provide a simple cross-check on some of the basic variables in the fisheries business model from information provided by respondents who are not motivated by an interest in compensation. Even a small number of interviews with key people – e.g., respected, knowledgeable fishermen – can provide helpful corroboration (or otherwise) of information provided by potential claimants. If sufficiently detailed fishery statistics are available, it will be possible later to verify the comparability of the two areas by calculating the mean annual or monthly catch per vessel over the same time period.

Non-polluted fisheries close to the area of impact may themselves be affected indirectly, through the displacement of fishing units from a closure zone. This may in part mitigate the losses of fishers normally based in the area of the spill, but may also result in a localised depression of catch rates, in response to the increase in fishing effort, thereby reducing the profitability of the resident fleet. In this event, the area of secondary impact should also be surveyed in reasonable detail, and losses assessed accordingly.

Other indicators

There are a number of other indicators and sources of information that can usefully be considered when assessing the likely levels of lost earnings, and which can provide a cross-check for the claims assessor on the quantum of losses that might be calculated on the basis of surveys of fishermen affected by the oil spill.

Most small-scale fisheries operate in developing countries where labour is both cheap and plentiful. It is therefore often, but not always the case, that fishing earnings are roughly comparable with those in the agricultural sector, and wages in the agricultural sector can be examined at the time of the assessment of fisheries losses, to determine whether the estimates of crew share or wages in the financial model constructed by the assessor, are at least of a similar magnitude. It may be possible to access government employment and earnings surveys conducted in previous years, to assess the ratio of wages/earnings per fishermen, with those of workers in other sectors. Quick surveys can then be used to identify current wages in other sectors, and whether there might be any reasons to suppose that the ratio between fisheries and other sector wages has changed.

Broader considerations

The fish capture sub-sector is never going to be entirely static. There will be many influences and underlying trends. Some of these may be significant enough to incorporate into the business model when assessing the losses arising out of the spill. While researching the overall operation of the fishery and individual claims, the assessor should be attuned to possible trends and changes, and follow up whatever comes to light.

The most obvious trend to look out for concerns the fish stocks and their management. Some stocks, particularly short life-cycle pelagics can vary significantly from year to year according to the success of recruitment of juveniles into the fishable stock. A spill may occur just as the fishing of a good year class is beginning or ending. However, as discussed elsewhere, fisheries are generally in a state of full or over-exploitation, and any upward trend in the state of a stock is unlikely to last for long.

Another factor that may drive fishing opportunity in the absence of the spill is regulation aimed at managing the stock. Management measures have been discussed earlier, but the assessor should be aware that regulatory change may have impacted the fishing area during the period of interruption.

Fishing technology does not usually change in quantum leaps in inshore fisheries, but so-called 'technology creep' can increase the catching capacity of the fleet over time. Such changes include new or improved boat, net, or trap design and materials, more powerful engines and hauling gear, better navigation, and improved fish preservation/handling. Any one of these may be significant enough to include in the assessment. Input costs are also prone to change. The main risk of sudden change is through currency movements or perhaps shortages affecting the price and availability of fuel, nets, and engine spares.

Likewise, markets are also rarely static. Prices paid to fishermen will vary with seasonal influences of supply and demand, alternative foodstuffs, and other behavioural aspects of consumers. Occasionally, a new market is found for a previously under-valued species, and this may lead to a short term boom in activity, and temporarily transform the fleet. Sales price and methods can also be changed by regulations, for example relating to unhygienic markets or processors. Imports, currency fluctuations and anything disrupting normal distribution around the country (transport difficulties, strikes, war/unrest, severe weather), will also have an influence.

Whole fishery modelling

In calculating the economic impacts of an oil spill on a local fishing industry, it is normal practice to identify all components of the industry, from the supply of inputs (e.g., fuel, ice, vessels, gear), to the various catching operations, marketing, processing, and distribution, and then to assess the extent to which each has suffered losses. Where there are large numbers of very similar operations – particularly in small-scale fishing – a representative business model may be constructed as in Table 1 above as a basis for assessing the losses of the entire group. The losses of larger or more unique components of the industry (e.g., a single ice plant) will be assessed individually.

The information collected by the assessor is often sufficient to allow estimated values (catches, revenues, levels of activity) to be cross-checked by two or more independent lines of calculation. For instance:

- Fish entering the marketing and distribution system should equal landings less domestic consumption. If the distribution network is simple (e.g., all fish sold at a single central market), then market records (if available) may provide a valuable check on fishery output. It follows from this that the amount or proportion of the catch retained by fishing crews should be quantified, wherever possible.
- Fuel sales to the fishing fleet are an excellent guide to fleet activity, and vary according to fleet size (which may alter significantly through the year), weather conditions, and seasonal management measures (e.g., close seasons). Fuel sales data may be very helpful in confirming the effectiveness and duration of a fishery closure, and can also be used to confirm levels of 'normal' vessel activity if the fishery is fairly homogeneous.

In the quest for information that might be of value in the assessment process, numerical data of any kind are always extremely welcome. But the fact that someone has taken the trouble to keep records does not necessarily mean they are accurate. Some 'hard' data are harder than others, for example:

- Fuel sales are almost always recorded reliably, as they are subject to periodic audit. But these data are only useful if the fuel supply is dedicated to the fishing fleet. This may sometimes be the case, but fisheries using outboard motors are usually supplied from automotive fuel stations, and even fishing port diesel tanks may supply transport or other non-fishing vessels.

- Some fish markets maintain records, and they are more likely to do so if they charge a commission or standing fee based on sales volume. Where this is the case, there is usually a sizeable proportion of 'back-door' sales.
- Market price records can be extremely useful, although in artisanal fisheries, first-sale markets are unusual. Retail markets are common, however, and retail price data are useful for showing seasonal and long-term trends and species differentials. One should be cautious about translating short-term trends in retail price. A drop in demand always feeds back quickly into a reduction in first-sale price, but short-term increases rarely benefit the producers. A series of interviews along the distribution chain may be used to relate retail to first-sale prices.
- Ice plants usually record sales, and records may give a rough guide to catch volume. In very hot countries, ice plants (even in fish docks) also supply other domestic and trade consumers (e.g. cold drinks sellers), and it will be necessary to estimate the split between fishing and non-fishing sales.
- Government fish landings statistics should always be treated with great caution. They almost always underestimate the volume of fish landed, although price data (when available) is generally more reliable. Before using them, it is essential to find out how the raw data were collected and processed. It is sometimes possible to track down the individual data recorders for the area of interest, and/or to examine the original unprocessed data. These records may provide very valuable insights into individual landings from the fishery under investigation.

It is particularly important to reconcile the sum of the assessed fishery outputs (annual catches of major species or species groups) with what is known from other sources about the local or even the national fishery production. What may appear reasonable at the individual level can often appear unreasonable when multiplied up across the entire fleet. The most reliable sources of information on fishery production may be special studies (for instance, those conducted within the context of a donor-financed fishery research project), and these should always be consulted where available. If government statistics are the basis of the evaluation, a view should be taken on their reliability, remembering that while claims and assessments may overestimate the total catch, government statistics more often underestimate it.

Fishing gear claims

In addition to the loss of income occasioned by an enforced or voluntary interruption to fishing immediately after an oil spill, there are often claims for loss of or damage to fishing gear. Physical loss and damage raise slightly different issues in assessment, and are here treated separately.

(a) Lost gear

The principal causes of physical loss are almost always linked to the fishermen's prevention from going to sea, either by the imposition and enforcement of a ban on all fishing activity, or by physical obstructions, such as a defensive boom stationed across a harbour entrance.

A common factor in all cases of gear loss is that there is no evidence that the loss actually occurred: the most that an individual fisher can do is to establish that he had once owned the gear he claims to have lost. For this reason, gear loss claims are always difficult to assess. The following questions provide a starting point for investigations of this type:

- Does the quantity of gear claimed to have been lost make sense at (a) the individual, and (b) the fleet, levels? The assessor should know the amounts of gear normally used by individual vessels, and can therefore estimate the total quantity within the fishery. Some individual vessel owners might genuinely lose all the gear they had set, but it should be considered unusual for more than a small proportion of the total gear deployed to have been lost.
- Is there a plausible explanation for the loss? It is difficult to lose gear that is set close inshore in areas of little tide and no shipping, but gear set offshore in deep-water shipping lanes and strong tides must be considered at significant risk of loss, unless attended regularly.
- Is there any secondary or circumstantial evidence that might confirm the claim of loss? If the assessment is carried out after the fishery has returned to normality, heavy gear losses should be reflected in abnormally high post-spill sales by gear suppliers.

(b) Damaged gear
The predominant cause of damage to fishing gear is contamination by oil, although other types of damage may result from an enforced lack of attendance.

Fishermen whose gear is contaminated by oil will usually retain it and seek help from local authorities. Where fisheries or government agencies determine that the gear should be written off, it is normal practice to survey and record losses before destroying it, ideally through a joint survey attended by the claimant, government agency representative, and the Fund/ insurer's expert. Sometimes, however, this is not done, and claims are presented in respect of gear damaged and subsequently destroyed without the maintenance of records, or the presentation of any other kind of evidence. Such claims should always be treated with circumspection, since the claimants have, apparently knowingly, destroyed the evidence of their losses. The general style of the investigation should follow the lines suggested for physical loss claims above (quantity and secondary evidence), but it should also be born in mind that:

- Genuine attended gear claims (beach seines, trawls) are rare, since the fisherman usually has ample opportunity to remove the gear from the source of risk.
- Where the claim is for total loss resulting from contamination, the geographical distribution of claims should match the observed distribution and movement of the oil spill.

Example – artisanal fishery interruption losses in southern Africa

The following case study of oil spill assessments illustrates some of the approaches described above, and gives an idea of the range of difficulties encountered when documentary evidence is lacking. It also demonstrates the need for a flexible approach in such cases, with the assessor ready to consider new arguments and new evidence (albeit often circumstantial) as they are produced. The model-making approach is essentially the use of scientific methods to bridge gaps in factual knowledge – and, as in all good science, one must be prepared to scrap the model if better information comes to hand.

The spill resulted in the ingress of crude oil into a large bay that supported a vigorous artisanal fishery carried out by means of gillnets, handlines, and beach- and open-water seines, as well as a small trawl fishery, targeting shrimp. The spill caused extensive damage to artisanal fishing gear, and prompted a government closure of both the artisanal and inshore trawl fisheries, for periods of one to six weeks, according to the area and the fishery.

A rapid field survey of the fishing industry was carried out six months after the spill, on behalf of the vessel's insurers, principally in order to resolve a number of issues related to fishing gear damage. Since it appeared likely that the government would also submit a claim for economic losses, the survey was designed to include a preliminary investigation of the structure of fishing fleet, the size, composition and unit values of catches, levels of fishing activity, and the fish trade. A number of fish landings were observed, markets were visited, parts of the fleet counted during a period of stormy weather, and a small number of in-depth interviews conducted in different parts of the impacted area. The short time allocated for the initial survey precluded visits to non-polluted areas, or any attempt to count the entire fleet, which was scattered across numerous beach landing sites.

Almost no formal records existed in relation to the artisanal fishery. The most recent census of fishermen and fishing gear had been conducted six years before the spill, and the routine collection of landings data on a sample survey basis had ceased at about this time. No records were available from local retail markets, although a state-owned fishing company handled a proportion of the artisanal catch, and did record prices paid to fishermen by grade of fish. An artisanal clam fishery, mainly supplying an export market and handled by a single company, was very well documented, although it represented only a small fraction of the total value of landings. Reasonably good records were available from the trawler companies.

Four years after the spill, the government submitted a claim for industry losses sustained as a result of the fishery closure. This analysis considers only that part of the claim that relates to the artisanal fishery, since the trawler claims were presented individually, and supported by satisfactory documentary evidence of loss. Given the long delay between the event and the claim, and the dearth of hard information on the fishery, it can only be considered extremely fortunate that a field survey – albeit brief – had been undertaken reasonably soon after the spill.

The claim was very clearly ordered, presenting a breakdown of the fishery by gear type, gear number and location; catch composition for each gear type and unit value by fish category; and the period of interruption, by location. In response to the claim, an assessment of loss was prepared by an independent advisor to the insurer, on the basis of the initial field survey, and a limited number of published papers on fisheries in the area.

Table 2 overleaf presents a simplified breakdown of the claim as compiled by the government and the assessment carried out on behalf of the insurer.

Table 2 – Artisanal fishery interruption losses in Southern Africa

	Claim	Assessment	Notes
Number of fishing units	1 479	1 479	(1)
Mean catch, kgs / unit / day	58	62	(2)
Mean price, US$ / kg	1.81	0.97	(3)
Mean catch value, US$ / unit / day	105	60	(4)
Activity, days / year	365	169	(5)
Mean period of interruption, days	16.9	7.6	(6)
Total days lost	25 061	11 264	(7)
Value of lost catch, US$M	2.149	0.600	(8)
Fuel savings, US$M	-	0.103	(9)
Total assessed loss, US$M	**2.149**	**0.497**	

Notes:

(1) Published information on the size of the fishery was six years out of date, but fleet counts performed by the assessor at several beaches in the year of the spill were in tolerably close agreement with the government's submission, and the number of fishing units was not disputed.

(2) There was surprisingly close agreement between the mean catch per fishing day claimed and that projected from the field survey, although within those estimates, the catch composition differed markedly. The claim assumed a much higher proportion of high-value shrimp within the total catch than was observed in practice, or could be supported by reports on the declining shrimp fishery.

(3) Base prices were the same in the claim and the assessment, and the difference in mean price here is related solely to differences in catch composition. The claim assumed a much higher proportion of shrimp in the catch of seine netters than was evident from either the field survey or published literature on the decline of shrimp stocks in this area. This resulted in a similar difference in the estimated mean daily catch values (4), accounting for 41% of the total difference between the claim and the assessment.

(5) Although the claim nowhere stated that fishermen fished for 365 days / year, the assumption was made that a 14 day closure meant 14 lost fishing days. (A similar approach was taken with the trawler claims, where it was assumed that a vessel that normally fished for three days / week would have fished every day during the closure period.) The field survey estimated activity at 180 days / year in the boat-based fisheries, while clam gatherers fished for 90 days / year. This error in the claim, one that is found very often in model-based group claims, accounted for 53% of the difference between the claim and the assessment. It translated directly into the estimate of fishing days lost as a result of the closure (6).

(7) Differences in mean daily catch value and lost fishing days are compounded in these estimates of the total value of lost production, the claimed loss being 3.6 times the assessed loss.

(8) The assessor estimated from field visits and interviews that approximately 40% of the artisanal fleet (414 boats) were powered by outboard motors. The total fuel savings during the fishery closure were calculated using contemporary fuel and oil prices,

assuming a 50:1 petrol / oil mix and three hours full speed running per fishing day. No fuel savings were taken into account in the claim, this factor contributing a final 6% of the difference between claim and assessment.

That the claim had exaggerated the level of fishing activity was further confirmed by close examination of the clam fishery where 80% of production was exported through a single company, which maintained detailed records. Production in this fishery was overestimated four-fold in the claim, through erroneous assumptions on the level of activity of individual fishermen. The assessment provided an adequate basis for settling a revised claim without recourse to further field investigation.

This example demonstrates:

- the value of good field work, even if long after the incident and necessarily brief;
- two errors common in fishery interruption claims: assuming that every day is a fishing day, and neglecting to account for costs saved; and
- the value of making use of any well-documented part of the fishery (in this case the clam fishery) as an indicator of the reliability of the claimant's methodology.

3.2.2 Aquaculture

The economic impact of a spill on an aquaculture operation is potentially more complex than that for fishing. A spill is likely to cause some disruption to a long-term production process rather than merely a temporary cessation of a short-term regular activity, as is the case for fishing.

The nature of the disruption will depend upon the type of production system, and the stage in the production cycle at which the impact occurs. Assessment of the economic impact will require a basic understanding not only of an aquaculture business model, but also the consequences of the impact on the farming process of the actions that a farmer might reasonably take. Gathering information on both of these topics will require particular care where there are no reliable historic records to which to refer. Set out in Table 3 overleaf is a standard business model for an aquaculture operation followed by an explanation of the production concepts and the functioning of the model.

Aquaculture models are usually described on a crop basis, i.e., considering all the input and outputs of one batch of production. Less commonly, they can be generated on an annual basis if cropping is continuous, or if there are multiple crops in any year. For the sake of simplicity, only a single crop model will be considered here.

The model involves a combination of external cost factors over which the farmer has little control, particularly market price and cost of inputs, and biological factors, such as growth and stocking density, over which he attempts to exert control to maximum economic efficiency. The model considers fish as the unit of production, but this could be shellfish or seaweed.

Production concept

The constraint on output volumes and hence overall profits of most aquaculture systems The constraint on output volumes, and hence overall profits of most aquaculture systems, is the capacity of the farm (A), and the maximum stocking density (D_2). Capacity (A) is dictated

Table 3 – Aquaculture business model

SALES		
Number of fish	N_2	$= (N_1 \times S)$
Weight of fish	W_2	$= (W_1 \times G)$
Average price at sale	P	
Total crop value	*V*	$= (N_2 \times W_2 \times P)$
BIOLOGICAL FACTORS		
Capacity of farm	A	cubic metres of cages / number of ropes etc
Number of crops / year	N_c	
Numbers stocked	N_1	
Weight at stocking	W_1	
Growth	G	
Survival	S	
Stocking density start	D_1	$= (N_1 \times W_1) / A$
Stocking density at harvest	D_2	$= (N_2 \times W_2) / A$
VARIABLE COSTS		
Price of juveniles	a	
Cost of juveniles	b	$= (a \times N_1)$
Price of feed	c	
Food conversion ratio	d	weight feed / weight fish
Feed volume	e	$= (N_2 \times W_2 - N_1 \times W_1) / d$
Feed cost	f	$= (c \times e)$
Labour cost	g	
Transport	h	
Consumables	I	
Processing / selling cost	j	
Total variable costs per crop	*k*	$= (b + f + g + h + i + j)$
FIXED COSTS		
Rent	l	
Repairs and maintenance	m	
Depreciation	n	
Interest	p	
Total fixed cost per crop	*q*	$= (l + m + n + p) / N_c$
Total crop cost	*r*	$= (q + k)$
GROSS PROFIT	s	$= (V - k)$
NET PROFIT	t	$= (V - r)$

by licensing and environmental constraints, or the capital available to the farmer to install the farming equipment. Safe levels of maximum harvest density (D_2) are constrained by the biological characteristics of the species and site, and possibly also licence limits. At the extreme, maximum profitability could be achieved through keeping all facilities with capacity (A) at maximum density (D_2), constantly replacing harvested fish with new stock.

However, the seasonal availability of most juvenile forms in aquaculture, and the cost and risks associated with frequent handling of part-grown stock, mean that farms are managed differently, and (D_2) is only reached occasionally. The most common production schedule is the 'all in – all out' batch throughput where maximum density is reached just pre-harvest. Harvesting of, for example, caged fish, can last several months, so harvesting and growth of the remaining stock are in balance, maintaining the density at the most efficient level (D_2) for some time. Alternatively, different parts of a farm can have stock of different ages. Stock placed at high density can be reared to D_2 well before normal individual market weight (W_2) is reached. The stock is then divided and some placed into facilities just vacated by harvesting. A further variation, for example prawn in hatcheries, where the stock are ready to sell in as little as 20 days, and new eggs are constantly hatching, is for a new tank in a facility of, say, 15 tanks to be stocked every day or two, so that harvesting becomes almost continuous.

Model operation

The model shown follows the same logical sequence as that for fishing, but considers a crop or batch rather than a fishing year.

Before considering the main financial variables, it is worth considering the underlying biological variables, as they will be critical to the assessment of loss. At the start of the production cycle, when selecting the number of juveniles (N_1), the farmer will use his best estimates of likely growth (G) and survival (S), to achieve the maximum safe density (D_2) just before harvest.

In terms of absolute weight, the growth follows a classic 'S-shaped' curve with small increases when the animals are small, then greater increases as it grows, followed by a slowing of growth as the animal matures and ages. Normally, farmers harvest before the slowing of growth, to keep the productivity of the system as high as possible. In relative terms, however, growth is fastest at the earlier stages when the animals are small. The time needed to double in weight can be as little as 20 days in young fish, for example, whereas it may increase to 100 days or more, later in the process.

Mortality of farmed stock throughout the production process is inevitable. In many production systems, particularly shellfish, natural mortality is very high and an accepted feature of the production process. In fish culture, the aim is, of course, to minimise mortality, though again it is accepted in some situations, particularly early in the process, when younger fish are more vulnerable. Disease loss is probably the biggest uncertainty, although mortality can also occur through storm losses, algal blooms, jellyfish blooms, non-oil pollution and so on.

All of these factors have to be taken into account to estimate the final number (N_2) and final weight (W_2) of animals available for harvest. Care is needed over applying price (P), as this can vary with season, the individual weight of the stock, and other market factors.

As with the fishing model, variable costs are those incurred through actually producing the output, rather than items which have to be paid whether the farm is in production or not. It is debatable whether labour should be considered as a fixed or variable cost. In many small-scale enterprises in developing countries, labour is hired for specific tasks in the production process, with just the farmer and his family attending to routine husbandry. However, in medium- and larger-scale shrimp operations, labour is often employed on fixed-wages. Whether labour costs are deducted in the assessment process will therefore need to be addressed on a case-by-case basis.

Care is needed in understanding the interaction between processing and selling costs (j), and the selling price (P), as the exact point of sale can vary. Sometimes it is pond-side or cage-side, sometimes the farmer may process the fish himself before selling, and sometimes he may also transport the product to a distant market at his own expense, or hire an agent to do so. Often, small-scale producers use collective sales methods. Co-operatives may organise processing and marketing on behalf of their members, (and in some instances, purchase inputs), but will charge a fee to cover the costs of their administration.

As with the fishing model, fixed costs should generally not come into the assessment process and are shown for guidance. Occasionally, rent for the use of the site may be linked to output volume or value, and so may need to be considered for deduction. Normal repairs and maintenance, for example to pond structures, or floating longlines or cages, are likely to continue in spite of disruption related to a spill, as the normal wearing processes will continue whether the facilities are stocked or not. If any fish farming equipment becomes oiled to the extent it cannot be economically cleaned, and capital replacement costs are met, then allowance should be made for age. Interest is also partly variable, as some of it may be related to working capital for stock and feed, rather than just capital items.

Mechanisms of impact

In the immediate aftermath of a spill where there is large-scale impact on aquaculture, and calls for immediate compensation, undertakings should be avoided about the principle of assessment of loss, until it is possible to consider the particular impact on the normal business model the spill has caused. Before consideration of compensation, it is important to assess whether any significant impact has actually occurred. Oiling may be light and brief, and damage to stock or equipment may be negligible.

The influences of these impacts on normal production and the business model are discussed below, according to the stage in production.

Stocking period

If farm facilities and/or the waters they depend on are significantly oiled, it is generally considered reasonable not to carry out normal introduction of stock. Juvenile fish and shellfish are more vulnerable to pollution than mature individuals, and the extra stresses associated with handling at stocking will exaggerate this. They are likely to become contaminated.

Some juvenile forms in aquaculture are only available on a seasonal basis. If the oiling is severe, and the facilities can not be cleaned to an acceptable condition before the opportunity to stock is lost, then it is probably reasonable to consider the crop as entirely lost. There are pragmatic solutions that may be sought with the farmers in certain situations, but these require detailed discussions outside the scope of these guidelines. Complete loss of the crop requires a calculation of lost gross profit (s), as shown in the model.

If supply of juveniles is not time-critical, then their introduction can be delayed until the farm is cleaned and oil levels have returned to levels considered safe for the introduction of stock, normally local background levels. Delay has two possible effects on the business:

a) Impacting next crop – if the delay between intended time of stocking and actual stocking is significant, the harvest may be pushed back past the intended date of stocking of the next crop, or possibly may result in inadequate fallow, repair, or maintenance time, which may also effectively disrupt the following crop. Depending on the likely magnitude of continuing disruption, it may be best to agree to the harvesting of the delayed crop at a smaller size, at the time originally intended. Final weight (W_2) will be smaller through reduced opportunity for growth (G), slightly larger through reduced mortality (N_2), but give an overall reduced crop weight and value (V). Note that the unit price (P) can be lower at a reduced weight (W_2). Offset against this will be reduced variable costs, notably feed (f), labour (g), and possibly consumables (i).

b) No impact to next crop – if a delay occurs, but the stock can be grown through to the normal harvest size without interference to the next crop, then the loss is reduced. Compensation should be restricted to any adjustment in gross profit resulting from the delay, for example seasonal factors that may change the market price, together with an allowance for additional interest to have working capital outstanding longer. Contribution to fixed costs should not be paid, as, although the farm is idle and unproductive during the delay, the next empty or fallow period will be shorter.

Pond farms may be able to stock as normal, provided there is confidence that the oil will be clear of the inlet canals etc., by the time water exchange is needed. For pump-ashore facilities, they may be able to draw uncontaminated water below the surface layer, and so not disrupt stocking

Growing period

It is generally accepted that if farming facilities become significantly oiled, the immediate response should be to do nothing to the stock. Fish should not be fed or disturbed, to reduce contact with the oil and stress, while shellfish in suspended culture should not be lifted through the surface layer. As mentioned earlier, seawater-fed ponds and pump-ashore facilities face a difficult dilemma between continuing to draw water, which may be contaminated, and not drawing water, thereby risking stress and mortality.

There are a range of potential impacts on the farm businesses through a spill in the growing period.

a) Feeding interruption. With caged fish, feeding may be suspended for a few days or weeks, depending on the nature of the spill. For the sake of simplicity, it can be assumed that the fish will not lose weight, unless the feeding interruption is long, and the effect on the growth curve will be such that the delay in achieving harvest weight (W_2) will be the same as the aggregate feeding interruption. Differing temperature regimes in the growth phase caused by the delay may disrupt this assumption somewhat.

The impact of feeding interruption will be similar to delayed stocking, the critical question being whether the delay will disrupt the next crop. If it will, then harvesting at a reduced weight (W_2) is likely to be the least damaging option. Compensation calculations should then be along the lines described in section a) in the discussion of the delay in stocking, above. Note that growth characteristics mean that a small difference in weight due to lack of feeding, say of 10 g in younger fish, can translate into a much greater difference, say 50 g, later in the growth cycle. If there is no likely impact on the next crop, then the compensation should be restricted to adjustments in sales value (V), through seasonal factors impacting price (P), and extra costs of servicing the farm for the extended growing period, notably labour (g), consumables (i), fuel (h), particularly if workboats are involved, and interest (p).

b) Stock contamination. Cultured bivalves and, to a lesser extent, fish, are at risk from contamination of their tissues through intake of dispersed oil or soluble components. This is measured by chemical analysis and taint. Measurement by both is outside the scope of these guidelines, save to say the assessors should organise access to competent laboratories for undertaking these tests, should independent data prove necessary.

Over time, the contamination will be lost through natural depuration. The problems for the farmers and the assessors will be the extent to which they will be clear by normal harvest time. Three possible outcomes are:

- Depuration is complete by normal harvest,
- Depuration can be achieved through delayed harvest,
- Depuration only likely to be achieved through delayed harvest to the point of disrupting the following crop.

For the first outcome, there is no impact on the business related to the contamination. For the second, the impact and assessment necessary will be as described for the stocking delay which does not impact the following crop.

For the third outcome, the situation is more serious. The options are to either delay or cancel the new crop, or to destroy the contaminated stock. Pragmatic decisions will be needed, based on contamination evidence and clearance time predictions. From a biological point of view, it is not particularly desirable to have old fish or shellfish on a site past their normal harvest weight (W_2). Older animals grow more slowly, convert food less efficiently, may take on undesirable characteristics of maturity, and may be victims or a source of disease pathogens. From an economic point of view, the balance is between payment for destruction of part-grown stock, or, if retained and the next crop lost, the gross profit (s) of that crop. If older animals are retained, there will probably be further losses associated with the biological problems described.

If the contaminated stock is destroyed, compensation should be calculated on the basis of the crop value (V), less variable costs between destruction and normal harvest time.

However, if the contamination was early in the growth period, there may be time to re-stock. In practice, this seems unlikely, as in such a situation there is a better chance of contamination clearing, and destruction becoming unnecessary. Stock to be destroyed should be weighed in total, and individual average weights also taken on removal from the farm. Estimates will be needed of the weight increase between the destruction weight ('W_d') and harvest weight (W_2), the normal decline in stock from normal losses between the number removed ('N_d') and normal harvest number (N2), and also the time between destruction and normal harvest. Using these, it will be possible to calculate the hypothetical finished crop (W_2 x N_2), and to apply price (P), to arrive at a crop value (V). Feed savings will be (W_2 x N_2) – (W_d x N_d) x (d) x (c). Other variable cost savings will have to be assessed on the basis of time between the date of destruction and the predicted harvest date, and estimates of their normal usage rates.

Again, there may be no contamination of stock in ponds or pump-ashore farms if care is taken over water abstraction. However, if that is not possible, then contamination, stress and mortality may occur.

c) Stress and mortality. These factors are very difficult to assess from a technical point of view, and are often highlighted by claimant farmers. It is unlikely that oiling will be such that it directly kills farmed stock. Inter-tidal shellfish farms are at highest risk through smothering of the stock. However, oiling may add a further stress on stock that are already facing a disease challenge or nutritional problem. It is exceedingly difficult to separate the role of oil from other factors in determining the state of the stocks. Pragmatic decisions are needed in light of the evidence in each case.

Inability to exchange water through contamination risk may well cause mortalities in ponds and pump-ashore facilities. The balance is complex if ponds and pump-ashore facilities become contaminated, since removing oil from them could be time-consuming and expensive. Continuing water exchange with oily water may save the crop, but also may contaminate it.

If it is accepted that the spill has elevated the normal mortality rate, the impact on the business and the assessment should be much as described for stock destroyed by contamination. Numbers actually killed, time of death, and their weight should be determined as accurately as possible, and the formula applied as described. Variable cost savings may be reduced if there is partial mortality. Labour (g) to service the farm and consumables (i) are only likely to be modest. Feed costs (f) should be pro-rated according to the ratio survivors : mortalities.

Stress of the stock is difficult to quantify. It is possible that growth (G) will be reduced and food conversion (d) will suffer. Slow growth will cause time, and so variable costs, to increase if normal harvest weight (W_2) is to be reached. Allowance for pro-rating upwards of variable costs should be made against evidence of the case. Again harvesting below (W_2) may be necessary if the next crop is not to be disrupted. Some reduction in crop value (V) should also be taken into account in addition to the variable costs.

Harvesting period

As shown in the table above, the business impacts of a spill when a farm is in the harvesting phase will be the same in principle to the growing phase. Approaches to compensation should be the same. Contamination during harvesting, rather than growing phase, will increase the potential for the next crop to be disrupted, if contaminated stocks are held to depurate, and so destruction is a more likely outcome. If the harvesting period is brief and the spill co-incident with it, there is no need to make projections of (W_2) and (N_2), nor make allowances for saved variable costs, since the compensation will equate to normal sales value (V). However if harvesting is normally spread over some months, and destruction is immediate, then some projections of the harvest pattern and both crop value (V), and saved variable costs (k) will be necessary.

Empty period

A spill coincident with aquaculture facilities being empty will obviously not produce any direct economic loss beyond cleaning. Even cleaning costs may be minimal if there is the time and potential for self-cleaning. Problems may arise if cleaning and normal maintenance cannot be completed before the next scheduled juvenile stock intake. If that is the case, then disruption calculations, as shown for the delay or cancellation in stocking, will apply.

Wider and multiple impact

The reality is often rather more complicated than described in the notes above. Impacted farms, even under the same ownership, may have different parts of their facilities at different stages of the production cycle. They may be growing more than one species. Geographically distant farms, which operate in the same way, may have been impacted at different times, and for different periods. The response to the spill by the impacted farmers may itself distort the business model. For example, a sudden rush to buy juveniles after a delay at the stocking phase may mean there are not enough at the end of a season, causing the price and availability to change. A large number of farms harvesting later than planned may distort the market price (P).

There is no easy response to these situations and these guidelines cannot cover all possible combinations that might be encountered. If more than one age-group or species is impacted, then the assessor will have to separate the various components. Other distortions will have to be investigated and included in the assessment, to the extent that they reasonably can.

Superimposed on the immediate impacts may also be a market impact. This may be one of the major issues of concern to the claimants. Market damage is a major topic in itself, and is best analysed with good data a considerable time after the event. The assessor should therefore just be sensitive to the concern, make no undertaking that it will be paid, mention that the farmer is obliged to do his best to limit such damage, and that the topic may be revisited at a later date once data are available.

Gathering data in the field

There are obviously many similarities in the approach to gathering information on the aquaculture industry with that for the fishing industry. The section on fishing (above) covers techniques in some detail, and so only those concerning aquaculture in particular will be set out here.

As with fisheries, there is a great deal to be gained from seeing the oiling of farms and farming areas at first hand in the aftermath of the spill. It enables the assessor to gain a rapid view as to the pattern of the contamination, its seriousness or otherwise, and gain credibility with claimants at a later stage by being able to speak in an informed way about the impact of the spill on their facilities. If the area of the spill and farming areas to be covered are large or spread out, then more than one person should be involved.

Time during the early stages should be spent visiting as many contaminated facilities as possible, talking about the immediate problem (rather than compensation claims) with claimants, and absorbing as much information as possible about the way the impacted businesses function in their local context. This will be necessary for making both the global assessment of the likely overall aquaculture loss following the spill, as well as gathering information useful for detailed assessment.

At the early stages, the assessor should consider which of the impacts described above will apply. However it is dangerous to draw conclusions too quickly as some key points, for example availability of juveniles, harvesting patterns, length of empty periods between crops, may need research and cross-checking, before a conclusion is drawn. Areas of difficulty or contention may need to be discussed with the Fund and P&I Club. It is thus recommended that undertakings as to methods of viewing losses should not be given until the assessor is fully confident of the situation, hence the recommendation to over-estimate the worst case scenario, and assume total stock loss in the section on assessing global impact of the spill. Major issues of principle may be best put in writing from the Fund / insurer.

This time can also be spent in identifying sources of information other than the claimants who may be useful for cross checking data and information later in the assessment process.

Sources of information

The assessor should try to quickly become attuned to the critical issues determining success of the type of operation impacted, and be prepared to acquire information from any relevant source. A good understanding of aquaculture production and economics, and an appreciation of these issues, is thus important. It will also help to gain credibility with the claimants and secondary sources. Independent sources of information are likely to be similar farms outside the area of impact, trade bodies and co-operatives, governmental organizations that regularly interact with the industry (for example, through regulation, development, support, training and extension), university researchers, marketing organizations, suppliers of equipment, feed and other significant inputs and buyers of the crop. As with claimants, these will need to be approached sensitively.

Cross-checking with secondary sources should continue as far as reasonably possible, though beyond two or three confirmations of the same point, the assessor will be wasting time and using up the good-will of the respondents.

Approach to variables

Although there is no firm distinction between the end of the early stages of spill response, and the detailed claims handling, before detailed claims assessment can start, the assessors are going to need to accumulate reliable information on biological and economic factors which form the basis of the impacted industry.

Interviews are best carried out at the farm site. During interviews, it is probably best to focus first on biological factors and to build some confidence that the assessor understands the situation, rather than commencing with direct questions on, say, prices of inputs and outputs.

Wider considerations

After interviewing a number of impacted enterprises, something of a consistent picture will hopefully emerge. Part of the assessment process is to broaden the investigations to a wider scale, to make sure that the claims made by individuals (and, indeed, the assessments) fit in to the overall understanding of the industry as a whole, either in the impacted area, or, if not disaggregated, the whole country.

At least part of this process will have been undertaken in the assessment of global losses shortly post-spill. At that stage, it is likely that at least some data will have been identified on the overall output volume, and value by species of aquaculture in the country. Centrally held data may also cover the number of farms, employment, and some of the key variables in the model, such as (D_2) or (W_2).

It is recommended that, if not already undertaken, a quick count is made of the number of impacted farms, and an assessment made of their capacity (A). Final density (D_2) should be cross-checked as rigorously as possible, to arrive at a maximum likely output per crop cycle from the impacted farms. Note that if there is more than one crop per year, notably as in the case of shrimp, it is critical to establish whether data on output, densities etc., is given on an annual or crop basis. A feeling for the range of capacities (A) of farms in the impact area should have been gained by the assessor to establish the range of plausible output volumes in assessing claims.

On the input side, the availability and cost of juveniles is unlikely to be static. Many factors can influence supply and demand, but might include new hatcheries coming on stream, natural factors such as El Niño affecting supply of wild shrimp seed, variable natural spatfall for shellfish, regulation over the harvesting of wild seed, disease problems with farmed seed, and regulations to prevent it spreading. Cultured seed, particularly fish fry, may benefit from genetic selection programmes, and show better growth characteristics or resistance to disease. Feed quality, availability, and price are also unlikely to be static. Labour costs and availability may be an issue in some situations.

Regarding operations, points to look out for include trends in disease outbreaks and their management, including governmental bans or restrictions aimed at containing them. Farms may be expanding from one year to the next. New materials or technologies might increase growth and survival, for example, aerating ponds, reducing escapees, reducing predator losses, improving feed and feeding techniques. Water quality changes unrelated to the spill may improve or worsen over the period of disruption. Temperature variations may be an influence on growth rate or stocking decisions. Regulation enforcement may be on the point of closing or restricting illegal farms, or constraining the industry in other ways.

Finally, trends in the market will also be important. There is a tendency for aquaculture industries to quickly expand to the point of over-production and softening prices. Prices move for seasonal as well as underlying factors. Co-operatives might re-structure their charges, or agents' margins may be at the point of renegotiation, at the time that the spill occurred. The assessors will need to fully understand the methods of sale and the market dynamics.

3.2.3 Processing

The economic impact of a spill on a processing business is primarily one of lack of supply of raw material. Processing businesses work on a regular throughput of raw material, and are thus closer conceptually to the fishing model than that for aquaculture, where there are different phases of the production cycle to consider.

Set out in Table 4 overleaf is a standard financial model for a processing business, followed by an explanation of the production concepts and functioning of the model.

Production concept

The production concept in a processing business is the same as in any manufacturing concern. The aim is to have the unit operating as near to maximum capacity (C_r) as possible on all working days. This dilutes fixed costs (s) to the maximum extent possible, and maximises profit (T). Variable costs are kept as low as possible on a unit weight and unit time basis.

Model operation

The model is simple and requires little explanation. It also follows those set out for fishing and aquaculture, which are explained at length.

Where at all possible, it is recommended that, in assessing claims, the raw material throughput is based on the loss of catch volume and value assessed for the vessels that supply the processor. In some processing interruption cases, all the claimants have simply assumed maximum capacity is always achieved (or exceeded) in the period of interruption, without concern as to the actual sourcing of raw material. This implies theoretical highly abundant fisheries or farming industries, which have no base in reality. It is important that the approach to processing claims also considers the wider picture of how the industry operates, as already discussed for fisheries and aquaculture: restricting processor input volumes to lost catch or farm volumes achieves this. If this approach is adopted, capacity (C_r) becomes volume of lost catch assessed for supply vessels.

Such an approach requires clarity concerning which vessels or farms supplied the claiming processors. In the absence of any purchase records this is not straightforward, but the fishermen themselves should be able to identify their customers, and they have no particular incentive to distort matters. It is fairest to assume that supplier / processor relationships that existed before the spill would be maintained through the period of interruption.

This approach may become unworkable if there are very many small fishing and processing operations in the spill area, as can be the case in some fishing villages in developing countries. Tracing the links between suppliers and processors may simply be too convoluted. In such a situation, it is recommended that a specimen assessment should be made of gross processing profit per unit weight of raw material. Fishing losses will be assessed on the number and type

Table 4 – Processing business model

SALES		
Weight of product (kg / year)	W	= $(C_r$ x D_w x Y)
Average price at sale	P_p	
Total annual income	*V*	= *(W x P_p)*
PRODUCTION FACTORS		
Capacity per working day (kg raw)	C_r	
Working days / year	D_w	
Yield raw: product	Y	
Efficiency / worker / workday (kg raw)	E_r	
Fuel / kg raw material	F_r	
Ingredients / kg raw material	I_r	
Other consumables / kg raw material	O_r	
VARIABLE COSTS		
Unit price of raw material	A	
Total cost of raw material	B	= (A x C_r x D_w)
Labour pay (per worker per workday)	C	
Labour cost	D	= (C_r / E_r) x C
Fuel price	E	
Fuel cost	F	= (E x F_r x C_r x D_w)
Ingredients price	G	
Ingredients cost	H	= (G x I_r x C_r x D_w)
Consumables price	I	
Consumables cost	J	= (I x O_r x C_r x D_w)
Transport	K	
Selling / marketing cost	L	
Repairs and maintenance	M	
Total variable costs per year	*n*	= *(B + D + F + H + J + K + L + M)*
FIXED COSTS		
Rent	P	
Depreciation	Q	
Interest	R	
Total fixed cost per year	*s*	= *(P + Q + R)*
Total costs per year	*t*	= *(n + s)*
GROSS PROFIT	U	= (V - n)
NET PROFIT	T	= (V - t)

of vessels working in the defined area, to arrive at lost catch volumes. The unit processing profit can be applied to the catch volume for the village or area concerned, and compensation distributed to the community as discussed in the section of first screening.

Approach to variables

Methods of interview and secondary sources of information should be similar to those already described for fishing and aquaculture.

If the key variable of capacity (C_r) has to be addressed (i.e., if it is not possible to apply boat volumes), the questions should be structured around a most / least approach and constraints around handling the volumes at the higher end of the estimate. Interview results can be cross-checked with equivalent un-impacted businesses, those further up the value chain, or possibly governmental sources. The situation could also be cross-checked when the unit is working again, with actual measurement of throughput.

Yield from raw to processed product (Y) is a key variable and difficult to assess without data. Again, questions should be structured around quality of the raw material, what makes for a good / bad product, effects of seasons, etc., before merely asking about the yield outright. Questions about planned output and actual production compared to expectations, should also give some confidence (or otherwise) in the answers. It is likely that many small units will process the same species in the same way in some countries, and the questions should be repeated until a consistent and credible picture emerges. Unaffected processors are obviously a key alternative source. Some of the older technical literature should also contain data on yields of some of the commonly processed species in Africa and parts of Asia.

The issue of the number of days worked per year (D_w) is probably best approached from a general discussion on workload, and what dictates busy or quiet periods. Most artisanal processing operations are likely to have a seasonal pattern of work, dictated by changes in fishing patterns. Discussion of this, the number of days per week worked in respective seasons, and how they cope in busy periods or get by in the quiet ones, should yield some useful answers. Again, unaffected processors are the best source for cross-checking. It is likely that the assessors will need to model the weeks or months of disruption after the spill, rather than use an annual figure, unless there is no seasonality. The issue may not be critical if it proves possible to assess the gross profit on a unit weight of raw material, in which case supply vessel volumes can be safely applied.

Issues relating to working patterns can then easily be followed by discussions of issues relating to labour and productivity (E_r). Again, questions on most / least labour employed should be tied in to estimates of the range of daily throughput, to estimate productivity. It may prove possible to measure the productivity when the plant is open again. Interviews with those involved in processing could also be useful: workers may be able to describe piece pay-rates and what they earn per day, where such payment methods are used.

Careful consideration will need to be given as to the extent labour is considered a fixed or variable cost. The general approach in such situations in the past is that casual labour is laid off for the period of interruption, while formally employed staff are retained, their wages being met out of compensation paid to the owner of the facility. In small-scale fish processing, the labour situation is likely to be complex, with considerable semi-formal employment of family members, perhaps at advantageous rates. It will be very difficult to draw a line between casual and formal labour in developing countries. Given that alternative employment opportunities and safety nets are likely to be minimal, and also a high degree of dependence on casual processing wages in household income strategies, it is recommended that there is an acceptance of most labour costs as fixed in such situations.

Fuel use (F_r) is an important issue in artisanal smoking/drying. Wood and charcoal are becoming less abundant as pressures on timber resources are felt. The fuel suppliers themselves will have a good view as to how much they normally supply to a village or individual processor in a given period and the cost. This can be compared to estimates of raw material throughput to establish usage rates. Care may be needed here as these suppliers may also be making claims. Un-impacted processors, non-governmental organisations, and governmental bodies with concerns in this field, together with the technical literature, may also provide relevant data.

Ingredients (primarily salt) and consumable use (I_r) and (O_r) should become apparent through carefully structured questions, with un-impacted processors the only likely useful source for cross-checking.

Repair and maintenance costs have been listed as variable costs in this model, in contrast to those for fishing and aquaculture. This is because the majority of the outgoings will be volume-related. The actual figure will be difficult to establish without records. Discussion should centre on spending patterns to keep the business operating, for example, how often they need to mend ovens or other equipment, and whether it is a drain on their finances. These costs are probably best discussed in the context of other consumables. It is not always easy to differentiate this category of expense from depreciation, which should be looked on as an allowance towards new equipment, rather than the cost of patching up that currently in use.

Price obtained for the finished product (P_p) is also clearly critical, but should be quite easily established from questioning those next in the value chain, who transport and sell the product outside the area of production; with cross-checks in markets and un-impacted processors. As with fisheries and aquaculture assessment, it will be necessary to assess the point of sale and items included or excluded, such as bags / packaging, transport and sellers, agents, or co-operative fees. Governmental departments, non-government organisations, and donor agency development projects may also hold relevant data. For some of the commonly produced and traded species, there is market monitoring and reporting by regional or international bodies.

Wider considerations

As with the aquaculture model, the notes describing fish processing assessment, for purposes of illustration, describe a simple situation, with uniform processing businesses processing a single product in a similar manner. Again the reality will be different, and the assessors will have to take into account variations and analyse them separately as far as is reasonable. A processor may, for instance, work with two or more species, with the species mix changing with season. Prices, yields and capacities may be different for each species. Likewise, the vessel – processor relationships may alter with the changing pattern of fishing.

The assessors should also be aware of the underlying trends that may influence the processing industry. They should be researched to the extent reasonably possible, and incorporated into the assessments. Processing has always been subject to the vagaries of the fish capture and aquaculture sub-sectors, and securing supply is a constant concern. Trends within these industries will have already been researched and their influences can be accounted for in the assessment process, as they would in reality.

Changes that may already be affecting the way the business functions may relate to tightening labour laws and working conditions, local labour market developments, and fuel and consumable cost changes. Regulations relating to hygiene may also have an impact. These may include both costs of complying with standards aimed at protecting domestic and export consumers, and disposal of processing waste. Finally, market trends may also influence how the business would have performed over the period of interruption. The same seasonal and other patterns discussed for the primary producers will also influence the processors. Processors have, perhaps, a greater ability to adjust their output and product to follow market demand trends, compared to the catchers and farmers, who are less flexible in their methods of production.

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