IV. SAMPLING DESIGN

This section discusses the considerations in selecting sampling methods to define oil distribution or oil impacts in various parts of the water column and to commercial fish species, gear, equipment, and processing operations.

IDENTIFYING INFORMATION NEEDS

The first step in designing a sampling program is to identify the questions that are being asked by the UC, the fisheries work group, and the public. These questions will drive the spatial and temporal scope of the sampling, the target species (if sampling seafood), location within the water column, number of samples to be collected, and analyses to be conducted. The sampling design should take into consideration potential routes of exposure to fishery organisms, gear, fish holds, vessels, and processing facilities (see Section II). It is important that the statistical design be robust enough to provide the information needed at a confidence level sufficient to support decision-making.

Assessing the potential impacts of oil spills to fisheries does not necessarily require direct sampling of the fish species themselves. Information about the distribution of oil on the water surface, throughout the water column, in the vicinity of seawater intakes, and on the seafloor may provide sufficient data to facilitate decision-making. Water quality sampling may yield information regarding the presence or absence of spilled oil both spatially and temporally.

The sampling program should consider the potential risks of an oil spill contaminating commercial fishery resources by addressing the following factors:

What type (or types) of oil was spilled?

As discussed in Section II, different types of oil behave differently when spilled to water. The oil may remain on the surface, in surface slicks and tar ball fields, or it may be distributed in the water column at various depths. Some oils may sink to the bottom and form patties on the seafloor.

What is the potential fate and behavior of the spilled oil?

The oil properties and environmental conditions will determine whether the oil is likely to stay in whole oil form, or to dissolve into the water column. The weathering and emulsification processes that occur following an oil spill are dynamic, so it is important to consider that the fate and behavior of spilled oil may change over time depending upon the nature of the release.

What are the potential routes of exposure and impacts to fishery resources?

In designing a sampling program, data collection should consider all of the potential routes of exposure. For example, if a crab fishery is at risk, the most obvious route of exposure to the crabs themselves is through direct contact with whole oil on the seafloor. However, because crab vessels utilize live holds that are constantly pumping seawater, there is a risk that oil may enter the crab hold through a vessel's seawater intake. Therefore, the sampling program might consider the presence and distribution of oil on the crabs themselves, on the seafloor, on fishing gear or vessels, in the water column at the depth of vessel seawater intakes, or using a combination of methods.

Information about how the fishery is conducted will help to assess the potential routes of exposure and possible fishery impacts. Factors to consider include:

- The target species' behavior, life cycle, and feeding habits;
- The timing and location of the fishery;
- The type of gear used to catch the fish;
- The manner in which fish are stored onboard the vessel; and,
- The manner in which fish are transported to processing.

APPLICATION OF SAMPLING METHODS TO ASSESS POTENTIAL FISHERY IMPACTS

Section V of this manual contains a set of methods and procedures to conduct a commercial fisheries water quality sampling program. There is no prescribed set of sampling methods for any given fishery, and the methods in this manual may be combined, adjusted, or amended to suit the incident needs. Selection of a sampling method requires consideration of the following:

- The target species' behavior, life cycle, and feeding habits;
- The timing and location of the fishery;
- The type of gear used to catch the fish;
- The manner in which fish are stored onboard the vessel;
- The manner in which fish are transported to processing facilities; and,
- The manner in which fish are processed once brought on board the vessel.

Detection Limits

In applying a water quality sampling method and analyzing and interpreting the results, it is important to consider the detection limits of each method. Detection limits may be determined by one or more of the following:

- Location of the sampling sites
- Amount of time sampling equipment is left on station

- Affinity of spilled oil for sampling materials
- Background contamination levels (oil from other sources)
- Environmental factors at sampling sites (wind, waves, currents)
- Sensitivity of laboratory analyses
- Human error

STATISTICAL DESIGN

A commercial fisheries water quality sampling program collects and analyzes data to support fishery management decision-making. The data collected may be qualitative, quantitative, or a combination of both.

For the purpose of this manual, qualitative data may be defined as information that is primarily *descriptive* in nature. The results of qualitative data collection are often narrative in nature, but can include maps or pictures that describe non-mathematical observations. In a commercial water quality sampling program, qualitative data may be collected through the recorded observations of sampling technicians, vessel personnel, or others. This type of information may have integral value to fishery managers, and may be used to infer trends. However, it does not lend itself to mathematical or statistical analysis (Leedy, 1993).

Quantitative data is usually numerical. Commercial fisheries water quality sampling programs may be designed as quantitative studies and as such yield data sets which may then be appropriate for statistical analysis. In quantitative studies, data is analyzed statistically in order to infer meaning. One approach to quantitative analysis of sampling data may be through expression of results as catch per unit effort (CPUE). CPUE can be used to express the oil encounter rate in terms of the number of oil encounters per total volume of water sampled each survey. CPUE is most commonly used to estimate population sizes by fisheries and wildlife biologists, based on the assumption that the rate of removal per effort expended from a population will be proportional to the density or size of the population. Therefore the proportionate "yield" of oil encounters in the tow net may be seen as an indicator of the general "population" of tar balls in a water body.

CPUE may be reported as tar balls or oil encounters per million gallons of water sampled. This provides a means for comparison over time to determine overall trends in oil encounter rates within a given area.

Once statistical analysis has been performed, data may be presented in any number of ways. The result of quantitative analysis from a water sampling data set may be a single number or value that can then be compared over time or space to other values. Often, graphs are used to depict such comparisons.

While it is essential that the sampling design collect the appropriate type of data, it is equally important that the resulting data set be sufficiently robust to support the commercial fishery decisions that need to be made. Because commercial fisheries water quality sampling studies may be designed and implemented *ad hoc* under significant time constraints and with limited resources, the resultant data sets may not be statistically robust to provide a high enough confidence measure to support decision-making. This does not negate the value of the information; however, decision-makers must be provided the full picture of what the resultant data set does and does not provide.

RESOURCES & LOGISTICAL CONSIDERATIONS

The sampling procedures in Section V describe in general terms the resource sets, vessels, and personnel required to implement the procedure. Many of the sampling methods described in this manual can be implemented using improvised materials. Because the water quality sampling program is focused on commercial fisheries, many of the sampling methods use the same vessels, gear, and configurations as are used in the fishery.

While resource availability and logistics should not dictate the scope or methodology of a water quality sampling program, it is important to consider these practical issues in the sampling design. Resource and logistical considerations may include the following:

- Availability of sampling equipment
- Availability of trained sampling technicians with requisite hazmat certification
- Availability and suitability of vessels to serve as sampling platforms
- Contractual and insurance considerations for operating from vessels-of-opportunity
- Availability and cost of dock facilities for meeting sampling vessels
- Back-up equipment and gear in case of technical difficulties
- Extra batteries and chargers as needed

PUTTING IT ALL TOGETHER: THE SAMPLING PLAN

The sampling plan is the document that describes the plan of operations for collecting the data needed to answer the policy and practical questions raised by the UC, fisheries managers, stakeholders, and the public. A recommended process for collecting these inputs is described in Section V of this manual.

A commercial fisheries water quality sampling plan should include the following:

- **Goals -** Goals are general statements about what type of information you hope to collect through the sampling program. For example, "*The primary goal of the water quality sampling program is to collect information regarding potential oil contamination, either as tar balls or dissolved phase oil, in waters that could impact fishery resources through direct oiling of the seafood or by impacting the transportation and/or processing of seafood products.*"
- **Objectives -** Objectives are more specific statements which include both an action verb and a content reference. They may also include a standard of performance or a statement of condition. For example, *"An objective of this phase of the water quality sampling program is to determine the maximum distance from shore that whole oil (in the form of tar balls, tar patties, fresh oil, mousse, or other whole oil form) is present."*
- **Methods –** This section should briefly describe the sampling methods that are to be used. It should include information such as location of sampling stations, length of tows (if appropriate), intervals at which sampling devices will be checked, etc.
- **Spatial and Temporal Scope –** The spatial scope should identify the geographic areas that will be tested during the sampling program. This may be done descriptively, or with a map, or both. The temporal scope should identify the time period during which the sampling will occur. It may be possible to coordinate the timing of sampling trips with incident operational periods, but this is not necessary and often may not be feasible.
- **Equipment and Materials –** This section should describe the equipment and materials necessary to use the methods to meet the objectives.
- **Operational tasking for sampling personnel and vessels –** Operational tasking may be included in the sampling plan. The tasking should provide specific direction to the sampling technicians and vessel crew regarding the plan of operations. The operational tasking may include coordinates for sampling stations, time for check-ins with shore-based personnel, heading and speeds for vessel transits, and other specific directions.
- **Sample collection, handling, and analyses –** The sampling plan should identify how samples will be collected, stored, and documented. If laboratory analyses are planned, the specific type of analysis should be identified in the plan, including reference to the appropriate state or federal standards.

Typically, the sampling plan would be designed by the person or persons responsible for carrying out the sampling program. In a typical oil spill Incident Command System (ICS) organization, a Sampling Group Supervisor would run the program as part of the Environmental Unit (Figure IV-1). The sampling program may also be implemented separate from the incident response, in which case the ICS organization would not apply. However, it is strongly recommended that water quality sampling fall under the larger umbrella of the spill response, to ensure maximum coordination with the UC and to facilitate sharing of information and resources.

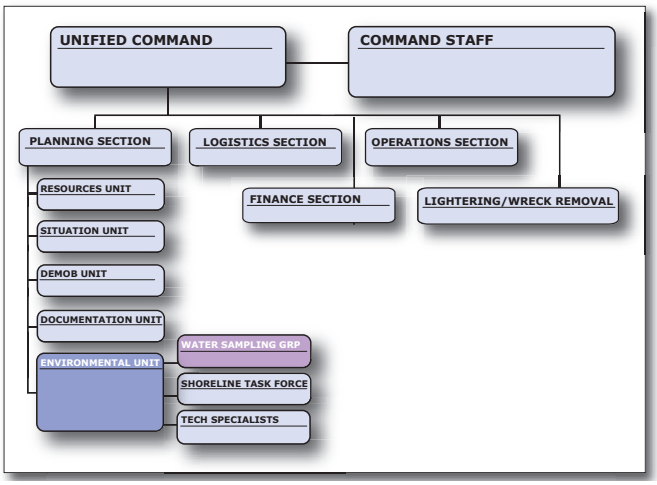

Figure IV-1. Location of Sampling Group within typical ICS.

Once a draft sampling plan has been developed, it should be vetted through the appropriate channels either within the incident, within the agency sponsoring the program, and/or the Commerical Fisheries Work Group or other policy body. It is critical that the fishery managers and other decision-makers who will be using the information gathered through the sampling program review the plan to ensure that the data collected is appropriate to the information needs. A work group or policy body is a useful mechanism for vetting sampling plans. It is also important that the UC review the plan, to ensure that it is consistent with incident priorities.

Appendix E contains an example of a Sampling Plan from the *M/V Selendang Ayu* oil spill response.

DATA ANALYSIS AND EXPRESSION OF RESULTS

Depending upon the information needs of the incident and the time constraints faced by the sampling program, results may be expressed in a variety of manners. When data is appropriate for statistical analysis, the results of a given sampling trip or program may be expressed numerically. For example, tow net sampling data may be expressed using *catch per unit effort*, which is a numerical description of the number of encounters with oil per volume of water sampled.

Sampling data may also be expressed graphically, using maps, charts, or graphs. Maps are especially useful in expressing oil encounters in a geographic context. Charts or graphs may be used when a numeric data set is available. Photographs are also valuable in communicating the results of a sampling program.

Appendix F contains examples of results maps and data from the *M/V Selendang Ayu* oil spill Commercial Fisheries Water Quality Sampling Program.