Protocols for Oil Spill Modeling

Prepared for RIOST RI Oil Spill Science Team

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Objectives

In the event of an emergency response to an oil spill, ASA will work closely with RIDEM and RIOST personnel to design and implement emergency data collection, analyze circumstances and consequences of pollutant releases, and perform preliminary assessment of the need for studies.

The objectives of the oil spill modeling group are to:

- Ensure that models, needed data sets, and technical personnel are ready to support scientific activities during oil spills;
- Collect and document needed ephemeral data during the first few days after the spill, that might be overlooked or lost otherwise;
- Perform trajectory and oil fate modeling to predict the likely distribution of oil on the surface and in the water column at various times in the future (to assist in the response); and
- Evaluate potential consequences of the spill to biota, habitats, and socioeconomic resources (to assist in effective allocation of personnel, effort and resources to collect ephemeral data).

Procedures

In the event of an emergency response to an oil spill, ASA will work closely with RIDEM and RIOST personnel to design and implement emergency data collection, provide forecasts of oil trajectories and fates, analyze circumstances and consequences of pollutant releases, and perform preliminary assessment of the need for studies. ASA maintains a wide range of models that simulate currents, pollutant transport, physical-chemical behavior, exposure of biological organisms, toxicological and population level impacts, and loss of human services such as lost harvest and recreational opportunities. During the response, ASA will implement circulation (hydrodynamics), oil spill, and chemical spill modeling. Modeling results will assist responders and scientists evaluating the potential impacts and natural resource damages resulting from pollutant contamination. ASA's model systems directly interface with existing data sets and geographical information systems used in RI, and they readily provide graphical outputs for communication of results. The following models useful for spill response have been developed and are maintained by ASA.

- HYDROMAP and WQMAP (BFHYDRO): Hydrodynamic models that generates currents and water level for water bodies.
- OILMAP: Oil spill trajectory model that rapidly generates predictions of the movement and weathering of spilled oil.
- SIMAP: Oil spill impact model that provides detailed predictions of the trajectory, fate, and biological effects of spilled oil.
- CHEMMAP: Chemical dispersion model that predicts the trajectory, fate, and biological effects for chemicals and products.
- AIRMAP: Atmospheric dispersion model that predicts the concentrations of chemicals released into the atmosphere.

ASA also maintains a computer system that provides these models with oceanographic, water quality and meteorological information for Narragansett Bay and Rhode Island coastal waters. The system, COASTMAP, is a decentralized Internet-based integrated data collection and distribution system that acquires historical, real time and forecast data from external data sources, such as the NOAA Coastal Ocean Forecast System (COFS) for the east coast of the United and the National Weather Service Extra-Tropical Storm Surge (ETSS) model as well the National Weather Service station forecasts. Real time observations are acquired from various NOAA systems: the Physical Oceanographic Real-Time System (PORTS), the Center for Operational Oceanographic Products and Services (CO-OPS) and the National Buoy Data Office (NBDC) systems as well as the United States Geological Survey (USGS) river gauging system. The data are processed to provide localized information on present, historical and forecast conditions needed to drive the hydrodynamic and transport models. Hindcast, nowcast and forecast simulations generated by the hydrodynamic and other process models can be ingested by COASTMAP where it is integrated with the database so that it is available to other users and the public.

Data needs for oil spill modeling are listed in Table 1.

Table 1. Data Needs for Oil Spill Impact Assessment Modeling

Spill scenario information

- Location(s) – descriptive and latitude, longitude
- Depth of the release (at surface or depth under water)
- Volume (or mass) spilled (of each oil spilled, if more than one oil)
- Fraction of spill volume which is water
- Date and time the release began
- Time course of spill (duration and release rate or amount each interval; by location if moving release)

Properties of the oil(s) spilled

- Type
- Viscosity
- Density or API gravity
- Mousse
    - Ability to emulsify to a mousse
    - Water content of mousse
- Distillation data
- Aromatics content
    - BTEX, by compound
    - Substituted benzenes, by compound (GC/MS)
    - 2-5 ring PAHs, by compound (GC/MS)
- Aliphatics content
    - Volatiles (C4 – C9; boiling point <180^{o}C)
    - Semivolatiles (C10 – C16; boiling point <400^{o}C)

Available observations on oil fate and effects

- Oil coverage on water surface and shoreline over time, with volumes and/or thicknesses
    - Over-flight
    - Shoreline surveys (e.g., SCAT surveys)
- Measured water column concentrations of PAHs, BTEX, substituted benzenes, TPH (samples from impacted and unimpacted locations)
- Analysis of sediment samples for PAHs (samples from impacted and unimpacted locations)
- Analysis of animal samples for PAHs (samples from impacted and unimpacted locations)
- Data on tainting of fish and shellfish
- Areas and times of closures – preferably as GIS polygons
- Time history of all cleanup activities with details of mass/volume removed

Environmental data

- Air temperature over first few days
- Water temperature, by location and depth if applicable

- Salinity, by location and depth if applicable
- Currents (current measurements, hydrodynamic modeling)
- Water height, multiple locations (at water body boundaries is best)
- Freshwater discharge rates for important sources
- Wind data from all available sites surrounding the immediate area
- Wave heights of surf, if surf zone involved (by location and over time)
- Suspended sediment concentration

Geographical data:

- Shoreline type – as GIS data
- Mapping of habitats – as GIS data. Based on shore types, vegetation, mollusk reefs and bottom types
- Bathymetry – soundings data (available for most open water areas, but may need to be measured for smaller water bodies and inlets)
- Locations and nature of critical resources: e.g., aquaculture, bird nesting colonies, nursery areas, marinas, recreational areas, sites of special concern

Biology

- Wildlife – Birds, mammals and reptiles
    - Numbers per area (#/km^2): over-flights, census and survey data before oil reaches threatened areas
    - Numbers of oiled wildlife by species, location, date collected

- Fish and macroinvertebrates
    - Trawl surveys to observe which species groups are present, and the density of those species in threatened areas
    - Life history characteristics for species in area
        - Temporal migration patterns – determine whether migratory species are present in area during time of spill
        - Spawning time and location – determine whether spill occurred near spawning locations and during spawning periods

- Intertidal and shallow subtidal benthos
    - Presence/absence information: species potentially impacted
    - Numbers per area (#/km^2) and size frequency data: survey data before oil reaches threatened areas
    - Numbers of killed animals by species, location, date collected

- Zooplankton
    - Plankton tows to determine species presence and species density in threatened areas
    - Detailed counts of sensitive life history stages (e.g., ichthyoplankton)

Personnel

Table 2 lists ASA personnel and their role in modeling tasks to support the RIOST response.

Technical Staff	email	Role in RIOST
Deborah French McCay	dfrench @appsci.com	Project manager, fates and effects modeling, biological oceanography and assessment, NRDA expertise and guidance, ecological risk
Craig Swanson	cswanson @appsci.com	Assistant project manager, hydrodynamics, pollutant transport and water quality modeling
Eric Anderson	ela @appsci.com	Assistant project manager, oil and pollutant transport modeling, spill response guidance
Jill Rowe	jrowe @appsci.com	Marine ecology, habitat assessment, NRDA guidance, spill trajectory, fates and effects modeling
Chris Galagan	chris @appsci.com	GIS, trajectory and fates modeling
Nicole Whittier	nwhittir @appsci.com	Chemical engineering, spill trajectory and fates modeling, chemical assessment
Matthew Ward	wardm @appsci.com	Hydrodynamics, trajectory and fates modeling
Subbayya Sankaranarayanan	subbayya @appsci.com	Hydrodynamics modeling
Paul Hall	phall @appsci.com	Hydrodynamics, trajectory and fates modeling

All ASA personnel work in the ASA office:

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Equipment

The model systems are all implemented on personal computers using Microsoft Windows and NT operating systems. Thus, laptops and desk top machines will be used, and are available at ASA. All key personnel have personal laptops ready for use in a spill.

Internet access is necessary for communications, downloading data, and publishing results. This is available at the ASA office in Narragansett and at the Coastal Institute of URI, ¼ mile from the ASA office.