

Examples

Try out these examples to learn the basics of modeling oil spills in Boston Harbor and Vicinity. Explore how changing tides, winds, runoff from the Merrimack River, and wastewater outflow can affect the trajectories of oil slicks. In addition, one example demonstrates how model and observation limitations can be overcome by considering both the "Best Guess" and the "Minimum Regret" (Uncertainty) solutions. This knowledge will help you in designing your own GNOME model runs.

The following conditions hold for each of the examples:

Wind: Constant at 0 knot, unless otherwise specified in a particular example.

Sewage outfall effects: No effects, unless specified.

Spill size: As specified in each example.

Pollutant type: Non-weathering, unless specified.

Model duration: 1 day.

Uncertainty: Not included, unless specified.

Use GNOME's Standard Mode and the Boston and Vicinity Location File to answer the following questions:

1. Tides are an important part of the circulation in Boston Harbor. In this example, you will examine the effects of tides by starting a spill at two different times in the tidal cycle. Run the spill in GNOME twice, once at the beginning of a flood tide [Start Time: May 4, 2000 at 6:00 p.m. (1800)] and once at the beginning of an ebb tide [Start Time: May 5, 2000 at midnight (0000)]. The winds at the time of the spill are 5 knots from the SE. In this example, we won't simulate the effects from the Effluent Outfall Tunnel. Place the 100-barrel spill near the Deer Island entrance to Boston Harbor at 42° 20.45' N, 70° 57.44' W.

"Zoom in" to the spill area and describe the differences in beach impacts between the two spills. How do the two spills differ in the amount and location of pollutant?

Hints: (1) To easily set a spill at a particular location, simply click *anywhere* on the water area of the map. In the Spill Information window that opens, you can then enter the *exact* latitude and longitude of the spill. (This method is much easier than moving your mouse around the map and watching its location in the lower left corner of the window!) **(2)** When you change the start time of the spill, you will want to change both the *spill* start time and the *model* start time. To do this, double-click the description of the spill ("Non-Weathering: 100 barrels") under **Spills** in the Summary List (the left section of the Map Window). In the Spill Information window, change the Release Start Time to May 5 at 0000. GNOME will then prompt you to change the model start time to match the spill start time. Click "Change". Because GNOME is set up to adjust the *model* start time to the *spill* start time, you should always change the spill start time first.

Answer: When the spill starts just before the flood tide, oil reaches the Charles River and the northern portion of Boston Harbor. The oil beaches in these areas and is not immediately carried back out with the ebb tide. When the spill starts at the beginning of the ebb tide, the oil also impacts the western portion of Broad Sound.

2. Wind can have a significant effect on a spill because it both moves the oil along the water's surface and drives currents. Rerun the ebb tide spill (May 5 at 0000) with 5-knot wind from the NW, then with no wind.

How do the oil's trajectory and shoreline impacts change from the previous example?

Hint: To change the wind conditions in GNOME, double-click **Wind** in the Summary List, then enter the wind speed and direction in the Constant Wind window.

Answer: Even a very light wind dramatically changes the oil's trajectory! With the SE wind in Example 1, the spill moved to the northwestern regions of the harbor. Now, with the NW wind, the spill moves to the southeast, oiling the northern shores of Long Island, Houghs Neck, Peddocks, Hull, and other harbor islands. Without the wind, the oil does not spread as far north or as far south as it does with the wind's assistance.

3. Forecasts of environmental parameters are inherently uncertain. For example, wind and weather forecasts can be "off" in the speed, direction, or timing of winds. GNOME supports a "Minimum Regret" solution in addition to the "Best Guess" solution that you have been running. The "Minimum Regret" solution takes into account our uncertainty in wind, horizontal mixing, and currents.

Rerun the previous scenario, increasing the wind to 10 knots from the NW. This time, run GNOME with the "Minimum Regret" solution turned on.

Briefly discuss the difference between the "Best Guess" (black) and "Minimum Regret" (red) trajectories. Why do you think this type of information would be useful?

Hint: To include the Minimum Regret (Uncertainty) solution, click the box labeled "Include the Minimum Regret solution" under **Model Settings** in the Summary List.


Answer: The "Minimum Regret" solution shows where else the spill could go if the currents, winds, or other model inputs were a little bit different. In this case, the "Minimum Regret" solution shows that the spill impacts could be more severe in the northern and western regions of the harbor, with the possibility of pollutant reaching areas near Deer Island, Spectacle Island,

and Boston Inner Harbor. To the east, the spill could also be more extensive, with oil floating north of Little Harbor and Cohasset Harbor.

Responders use both the "Best Guess" and "Minimum Regret" trajectories to make decisions about how they will allocate response resources. Sometimes a highly valued environmental resource (e.g. an endangered species) may be important enough to protect, even if it has a low probability of being oiled.

4. The Merrimack River has very high flows in the spring. This strong pulse of fresh water into the Gulf of Maine leads to a coastal current in Massachusetts Bay. Run two spill scenarios of 70,000 gallons of non-weathering oil near the entrance to Gloucester Harbor at 42° 34.73' N, 70° 38.97' W. Run one scenario during the spring freshet, on May 15, 2000 at 3:45 p.m. Run another scenario during the fall on October 15, 2000 at 7:15 p.m. Both of these times represent the beginning of a flood tide. In each case, there are no winds. For these examples, you can turn off the "Minimum Regret" solution.

How does the oil's trajectory change from the spring to the fall example?

Hints: (1) To change the spill information in GNOME, double-click the description of the spill, as you did in Example 1. In the Spill Information window, change the amount of pollutant and the release start time and location. (2) If your view of the map doesn't show the spill location, double-click the "Zoom-Out" control, , on the GNOME toolbar to fit the map to the window.

Answer: In the spring, much of the oil is pushed to the southwest, away from Gloucester Harbor. In the fall, however, most of the oil ends up in the harbor.

5. Different types of pollutants weather differently. In the previous examples, the pollutant that spilled did not change with time (it was "non-weathering"). Now you are going to run a scenario that compares the effects of different types of pollutants.

A damaged vessel begins to leak fuel as it heads into Boston Harbor along Nantasket Roads. The vessel spills 30,000 gallons of product between 6:00 and 6:30 p.m. on May 4, 2000 as it travels from 42° 19.16' N, 70° 53.55' W to 42° 18.76' N, 70° 55.25' W. There are no winds.

Run the above scenario for a barge carrying **fuel oil #6** and for a fishing vessel carrying **diesel fuel**. At the end of your 24-hour prediction, write down the mass balance for each product in the table below.

	Fuel Oil #6 (gallons)	Diesel (gallons)
Released	30,000	30,000
Floating		
Beached		
Evaporated and Dispersed		
Off map		

Hints: (1) The spills you have set in previous examples have been point source spills, representing catastrophic releases at a particular time and location. The spill described in this example is a spill from a vessel that is leaking as it is moving. To model this "line source" spill in GNOME, you'll need to enter the ending time and location of the spill in the Spill Information window. To do this, click the box labeled "Different end release time" and enter the ending time (May 4, 2000 at 1830). Then click the box labeled "Different end release location" and enter the ending location of the spill (42° 18.76' N, 70° 55.25' W). (2) To view the mass balance for each scenario, click the right-pointing triangle next to the spill description ("Fuel Oil #6: 30000 gallons") under **Spills** in the Summary List. Then click the right-pointing triangle next to "Spot Mass Balance" to view the mass balance for the "Best Guess" trajectory.

Answer: Heavier oils remain in the environment longer than lighter, refined products. You can see that much more diesel has evaporated and dispersed than fuel oil #6 after 24 hours in the water. (Your numbers may differ slightly.)

	Fuel Oil #6 (gallons)	Diesel (gallons)
Released	30,000	30,000
Floating	17,430	13,110
Beached	7,200	6,390
Evaporated and Dispersed	5,370	10,500
Off map	0	0

6. The new Effluent Outfall Tunnel discharges wastewater in Massachusetts Bay, about 14 km from Boston Harbor. Numerical modeling studies suggest that the discharge will have little or no effect on surface currents in the region in the summer and a small effect on surface currents in the winter. To demonstrate how this discharge may impact spilled oil trajectories, run a 10-barrel linear spill over the outfall site from 42° 24.97' N, 70° 47.04' W to 42° 21.96' N, 70° 46.98' W. Start the spill at noon on February 15. Run GNOME twice for this spill, once with the sewage outfall effects option turned on, and once with no sewage outfall effects.

How does the wastewater outfall impact the oil's trajectory?

Hint: Make the necessary changes to the spill details in the Spill Information window. Then, to include the sewage outfall effects but keep all other Location File settings the same, double-click "No outfall effects" under **Location File** in the Summary List. In the windows that follow, you can change any of the conditions that you set earlier. In this case, you only want to add the outfall effects. Click "Next" to bypass windows that don't need to be changed. In the Sewage Outflow window, choose "Add surface outfall effects" from the menu.

Answer: Few, if any, discernible changes result from adding the effects of the sewage outfall; however, in the scenario that includes the sewage outfall effects, there is an area in the middle of the trajectory that tends to remain clear of oil.