Numerical modelling of living things in water for marine and estuary engineering projects

HR Wallingford

Although reliable hydrodynamic models exist of water and sediment movement, there is a need for combining these with new ecological modelling techniques in order to deal with predicting the impact of change on the populations of living things.

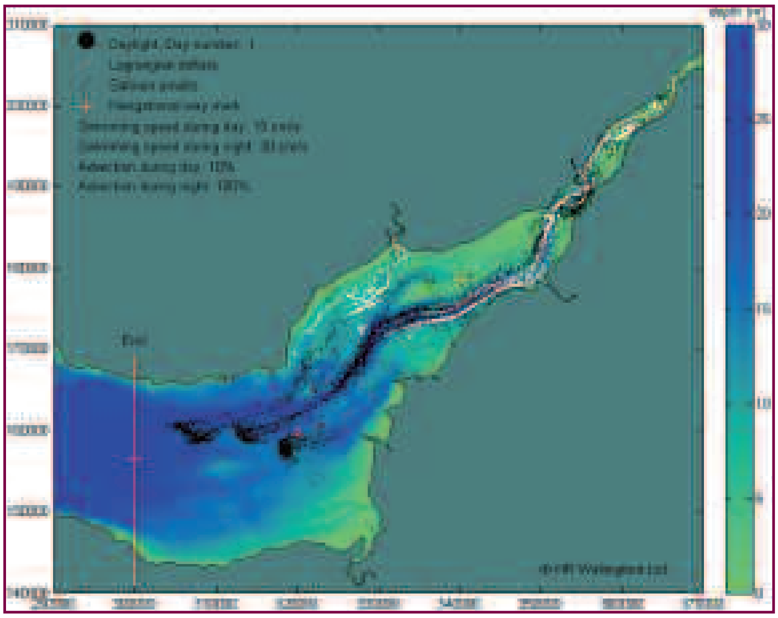
A key consideration is the influence of currents (both marine and estuarial) on aquatic lives. Most aquatic life starts off as spores, eggs, or larvae, and these exist entirely at the mercy of water currents. This is true not only for animals such as large fish that eventually grow powerful enough to overcome any natural current but also for animals that become sedentary and settle in one place, such as many marine worms, shellfish and crabs.

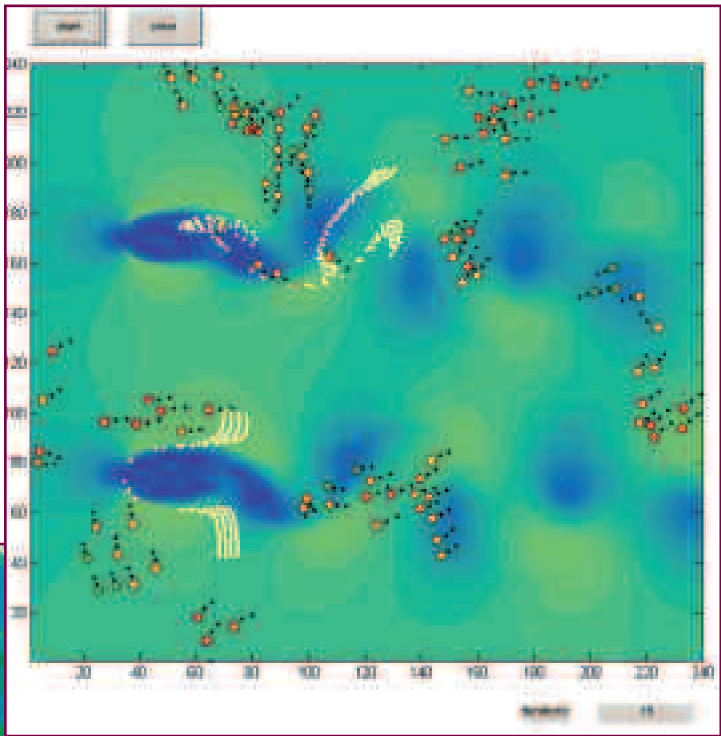
When small marine larvae are able to swim energetically – such as a couple of metres in a few hours – this can impact dispersion in a tidal estuary by many kilometres if they swim vertically at particular times in the tidal cycle. Larger creatures have larger brains, often unknown motivations, and greater swimming capacity. Thus the modelling of larger fish, (typically a few centimetres long) that can swim strongly in any direction but remain heavily influenced by currents, can become extremely challenging.

In cases such as low-head hydro power schemes, the impact on physical currents and sediments can be well predicted but there is no precedent for modelling the impact to aquatic life. Nevertheless, where it is possible to reliably predict the intended route (and motivation) for a fish species (over a limited time scale) there is now capability to model the impact. Smolts (juvenile salmon) are a good example where their intended route is known, so that hydrodynamic models of water can be combined with individual-based models of animal movement.

HR Wallingford has recently developed a fish migration model that has been successfully used to provide relative impact to specific species under different barrage scenarios. Additional models have also been developed for larval advection and complex system biological modelling. This is a relatively new but strongly growing area of scientific research and development. The results are encouraging and the complexity of natural systems provides the opportunity to develop methods for handling larger uncertainty than that normally associated with purely physical systems.

For further information about this work, contact Jay Willis, Coasts and Estuaries Group, HR Wallingford (01491 822401; E-mail: j.willis@hrwallingford.co.uk).





(Top right) *Model output showing distribution dynamics of salmon and other fish in the Severn Estuary*
(Right) *Model output showing influence of current velocity on species location and school fidelity*