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Journal of Marine Research Classic Articles

Control of salinity in an estuary by a transition

by **Henry Stommel and Harlow G. Farmer**

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EDITOR'S COMMENTARY

In 1900, Martin Knudson (Knudson 1900; Burchard et al. 2018) considered the salt and volume fluxes for a steady-state estuary. He arrived at very useful relationships between the flux of fresh water coming in from upstream compared to the output salinity and volume flux. While these relations are fundamental and extremely useful, they do not close the problem. Rather, there is always one more piece of information needed; for example, to know the flux of brackish water onto the shelf, you still have to know the outflow salinity.

Stommel and Farmer sought to close the problem by adding one more constraint. First, they assumed that the flow at the estuary's mouth has two layers (outflow above inflow) and that there is plentiful tidal energy available to generate vertical mixing within the estuary. Given these assumptions, they added the constraint that the flow at the mouth is hydraulically controlled. This "overmixing" condition can be interpreted to mean that mixing inside the estuary leads to maximal volume fluxes or, equivalently, that no internal waves can propagate into the estuary from outside. This new constraint is enough added information to close the problem and so make specific predictions about outflow salinity. The authors then tested their ideas with a laboratory experiment and with what observations they could find.

Although the Stommel and Farmer model was neither perfect nor universal (as the authors themselves took pains to say), it was still the most useful closure around. As such, it was later widely applied, with variable success, to a range of cases: from small rivers up to the Mediterranean outflow. While more recent syntheses (Geyer and MacCready 2014) have superseded the overmixing concept, it remains an important landmark.

—*Kenneth H. Brink*

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