Inlet-Widening as N-mitigation strategy: *Draft (1/15/2015)*

C. Weidman
chris.weidman@state.ma.us

Background

Inlet-widening/modification has been proposed as a non-traditional strategy to improve estuarine water quality and ecological function by removing nitrogen loads more quickly from the estuarine water column through increased tidal flushing. The general concept is based on the assumption that inlets, to one degree or another, act to limit tidal exchange between the enclosed estuary and its oceanic source. Within the estuary, this restriction should result in a smaller tidal range and attenuated tidal phase relative to its oceanic source. Less tidal exchange will also be characterized, within the estuary, by longer water mass residence times, greater watershed-derived nutrient concentrations and lower salinities. So, it is proposed that increasing the width and/or depth of an inlet will lessen the restriction on tidal exchange, increase tidal flushing and allow more effective removal of estuarine nitrogen loads.

Inlet-widening (IW) is attractive as an N-mitigation approach because of its simplicity of concept and its potential cost-effectiveness. However, there are significant concerns among coastal scientists (refs), in light of the complexity of the coastal hydrodynamic and sedimentological environment, about the method's practical effectiveness, long-term maintenance costs and potential for unintended environmental consequences. These questions related to the efficacy of IW as viable mitigation strategy will not be discussed here in detail, but to enumerate a few: 1) does IW actually result in a significant and long-term increase in tidal exchange in a given system, 2) will the modified inlet maintain its enlarged dimensions without the need for frequent and costly maintenance dredging, and 3) would IW increase local storm flooding risks.

On Cape Cod, several IW projects have been discussed and two have been formally proposed, Bournes Pond in Falmouth and Muddy Creek in Chatham, though only the former is motivated primarily for the purpose of N-mitigation (refs). At present, IW as an effective strategy for nitrogen removal is still largely theoretical and the need exists for well-controlled and monitored pilot projects to assess the methodology.

IW monitoring protocol

First, it is assumed here that something like the monitoring strategy developed for the MEP nutrient-loading TMDL assessments will be a basic component of any future water-quality monitoring program regardless of the mitigation approach (s) deployed. Since this methodology was used to establish the TMDL for each estuarine system, it seems logical that a similar protocol would be used to gauge the expected overall effect of mitigation efforts on each system.

To assess the specific effectiveness of an approved and deployed IW project, additional monitoring protocols should be in place to monitor the hydrodynamic conditions that underlie the IW approach. Approved IW projects should include vetted hydrodynamic modeling that predict specific tidal characteristics that are indicators of enhanced tidal exchange. These would include forecast changes in tidal range, MHW, MSL, and MLW as well as storm surge flooding. For example, in Falmouth's Bourne's Pond IW proposal (ref) modeler John Ramsey indicates that there should be a detectable drop in MLW post inlet modification, which in turn implies achieving greater tidal flushing (and more N-removal).

It would be best if there were at least 1 year of hydrodynamic monitoring prior to inlet modification for both modeling and post-alteration comparison purposes. Protocol, both pre- and post-modification, should require automated continuous monitoring of 1) water levels inside and outside the estuary, as well as within the inlet (for a total of 3 tidal stations), and 2) inlet current velocities. Tidal stations ought to have precise vertical control for relative reference. Inexpensive equipment (~$1000/unit) is available to continuously monitor each of these parameters, although there would be personnel costs associated with maintenance and data analysis.

IW project plans specify precise inlet channel dimensions as these are fundamental to the IW approach. These dimensions, before and after modification, are used as the basic modeling variables for quantifying the degree of enhanced tidal exchange and estimation of N-removal. They are also used to predict inlet current velocities critical to the ability of the channel to maintain itself. A primary concern about the viability of IW mitigation is the very real potential for frequent infilling of the artificially enlarged inlet. Should the inlet dimensions vary from design criteria, as a result of shoaling for example, then the desired tidal flushing would also be at variance from design. If IW N-mitigation is to function as planned, then inlet morphometry must be maintained as close to design as possible. So, the need for frequent monitoring of inlet morphometrics is a critical oversight component for IW mitigation projects. Concurrent inlet morphometry, current velocity and inlet water level can be used to directly calculate tidal exchange and can be checked against model prediction.

How often should inlet bathymetry be surveyed? This is a difficult but critical question and is dependent on understanding the complex interaction of the local sedimentological and hydrodynamical environment, a situation extremely hard to model or forecast with accuracy. However some reasonable estimate of infilling must be applied in order to calculate the frequency of inlet maintenance and its associated costs. Historical inlet maintenance records might provide a minimum frequency estimate. However, infilling might be expected to increase after alteration as inlet velocities would likely lower as a consequence of cross-sectional enlargement. It would be prudent to survey more frequently (weekly or monthly) in the early post-modification period and develop a survey schedule based on observed infilling over time.

Finally, in consideration of the important issue of unintended environmental impacts (e.g, increased flooding, enhanced erosion, excessive shoaling, etc.), IW projects, in the pilot period at least, ought to be sites where these impacts could be easily managed or reversed without incurring great cost. Smaller scale projects should be favored over larger ones, and locations involving major infrastructure (e.g., bridges, roads) ought to be avoided until there is a better understanding of IW as a viable N-mitigation strategy.