Tidal Restrictions Synthesis Review: Executive Summary

ES.1 Introduction

The coastal ecosystem is comprised of a wide array of tidally influenced habitats such as mud flats, barrier beaches, and wetlands, including salt-, brackish-, and freshwater marshes as well as mangroves and other types of shrub or forested swamps. Tidal wetlands are important transitional habitats located between uplands and the larger estuary environment. In that role, they provide numerous ecosystem services, which include: providing nursery and spawning habitat for different life stages of fish and shellfish; providing nesting and foraging habitat for salt marsh specialist birds and migratory waterfowl; acting as carbon sinks and, in the instance of high-salinity salt marsh, keeping methane gas emissions low; providing uptake, processing and/or flushing of nutrients; and providing protection against coastal storms. Loss of functioning tidal wetlands is a critical and ongoing issue, especially as sea levels are predicted to rise. One potentially significant and addressable contributor to tidal wetland degradation and loss in the United States is tidal restriction.

A tidal restriction occurs when a structure or built landform limits or prevents tidal exchange between upstream and downstream habitats. These structures can reduce or eliminate tidal exchange, which can lead to direct loss of tidal wetlands through alteration of their hydrologic regime and/or to their function through lower salinities that “freshen” salty and brackish tidal wetland types. Common examples of tidal restrictions include dikes, berms, dams or levees, undersized bridges and culverts, road causeways, ditches, and water control structures (e.g., tide gates or weirs). Many of these tidal restrictions were put in place specifically to alter site hydrology for agriculture, flood control, mosquito control, or to protect infrastructure, among other purposes. However, some of the most common tidal restrictions are those related to transportation, where altered hydrology is an unintended effect of installed bridges, culverts, and causeways.

This document summarizes the state of knowledge of tidal restriction extent and their potential effects on the coastal environment. Furthermore, this document identifies needs and provides recommendations for tidal restriction avoidance and removal when practicable. These recommendations are intended to help state and local transportation departments, state and federal resource agencies, municipal governments (including planning and flood control entities), their partners, and other stakeholders, take actions to remove tidal restrictions from the landscape. It is important to note that some tidal restrictions provide a vital role in protecting infrastructure, and many factors should be considered in prioritizing which to address.

This document was developed under an Interagency Agreement between the U.S. Environmental Protection Agency (EPA) and the Federal Highway Administration (FHWA) and was conducted through literature review, as well as through interviews with subject matter experts. The document is organized into the following topics: 1) Type and Abundance; 2) Potential Adverse Effects; 3) Existing Tools to Facilitate Avoidance or Removal; and 4) Recommendations.

ES.2 Type and Abundance

Tidal restriction can result from structures in three general categories: 1) structures built to impede the movement of water, such as dikes, dams, and levees; 2) structures built to move or drain water, including ditches, weirs, and tide gates; and 3) transportation structures, such as bridges, culverts, and causeways. In order to determine the extent of existing tidally restrictive structures in the U.S., three main types of sources were consulted: 1) direct surveys of tidal restrictions conducted by others; 2) estimates derived from available modeling; and 3) related sources or those which can act as a proxy for tidal restriction, such as salt marsh quality or aquatic organism passage (AOP). For each state where information was available, the sources are described in detail in this synthesis. In general, there is a lack of information on the abundance of tidally restricting structures, especially along the southeast Atlantic and Pacific coasts. Direct surveys are scarce and of those completed, the degree of restriction is not often documented, as the primary goal of such studies is often salt marsh restoration potential. Many of the direct surveys of restrictions have focused on the northeastern U.S. (NH, MA, ME), as well as the Gulf Coast (FL, AL, MS, LA, TX).

Modeling efforts estimate that 1,764 severe transportation-related tidal restrictions and 70,450 acres of affected salt marsh are found along the northeast and mid-Atlantic coasts (Maine to Virginia). While modeling efforts necessarily include assumptions and are not always field verified, these can provide insight into locations with opportunities for reducing potential restrictions. In addition to direct inventories and modelling efforts, there are also a few related data sources that may function as proxies for estimating type and abundance of tidal restrictions. These include data on salt marsh quality and AOP available in some states.

In general, transportation infrastructure is a common cause of tidal restriction where restrictions have been evaluated or modeled, especially in the northeast and mid-Atlantic. Other sources of restriction, however, such as dikes, mosquito ditching, and water control structures may be more important in certain regions of the U.S., but knowledge of their extent is limited.

ES.3 Potential Adverse Effects

Tidal wetland function is greatly influenced by the frequency and duration of tidal inundation, which in turn affects salinity levels. Tidally restricted wetlands experience lower frequency of tidal inundation and can also be drained or impounded, depending on the type of restriction. The main effect of tidal restriction on tidal wetlands is reduced salinity and a change in inundation time, whether it be of shorter or longer duration. These restriction effects can reduce the extent of tidal wetlands and/or impact their function, which can result in:

- An increase in invasive species such as *Phragmites australis*;
- A decrease in the ability of tidal wetlands to remove pollutants;
- Loss of habitat and/or barriers to movement for marsh dependent species;
- A decrease in carbon storage potential and greater methane emissions; and
- A reduction in marsh elevations that can impact the wave attenuation and shoreline stabilization properties of tidal marsh.

In addition to effects on the natural environment, restrictions formed by transportation infrastructure may also create maintenance issues for the structures themselves due to a restriction's effect on flooding, erosion, and scour forces. In general, tidal restoration can reverse the impacts of a restriction, though the speed and degree of recovery will often depend on the type of restriction removed and its severity.

ES.4 Existing Tools to Facilitate Avoidance and Removal

There are a number of existing tools, resources, policies, and practices that can be applied towards avoiding and/or removing tidal restrictions. Some have been developed specifically for that purpose, and others can be appropriated from other disciplines, such as AOP, conservation planning, and regulatory actions. There are five general categories of tools, with various sub-categories for which a summary is listed in Table ES1. For more information on specific tools mentioned, refer to Section 4.

TABLE ES1: Available tools to facilitate tidal restriction avoidance and removal.

Sub-Category	Summary of Available Tools / Resources / Policies / Practices
Restriction ID and Prioritization for Removal Tools	
Existing Atlases and Inventories	Direct tidal restriction surveys.
Tidal Crossing Assessment Methods	Qualitative and quantitative field methods to determine presence and degree of restriction.
Remote Sensing	Models that rely on remotely gathered information to identify tidally restricted areas or simulate proposed tidal restoration actions.
Conservation & Ecological Restoration Planning	Models and estuary assessment methods primarily developed for prioritizing conservation and/or restoration efforts that can be used to determine tidal restriction extent.
Tidal Restoration Project Planning and Implementation Tools	
N/A	NOAA "Returning the Tide" guidance manual developed using tidal hydrology restoration projects in the southeast U.S.
Structure Design and Operation Tools	
Roadway and Structure Design	Existing transportation engineering manuals and guidelines.
Tide Gates	Tide gate designs that promote greater upstream tidal inundation, and a literature review and synthesis of tide gate retrofit and removal projects in the Pacific Northwest.
Regulatory Tools	
Clean Water Act (CWA) Compensatory Mitigation	Mitigation programs or actions that use the re-establishment of tidal wetlands from the removal or retrofit of a tidal restriction for mitigation credit under the CWA, with a focus on dam removal and transportation improvement projects.

Sub-Category	Summary of Available Tools / Resources / Policies / Practices
Regulatory Tools	
Infrastructure Maintenance and Regulatory Compliance	CWA and National Flood Insurance Program regulations that govern structure maintenance and/or changes to structures that affect upstream base flood elevations.
Aquatic Organism Passage (AOP) Compliance	Programs or actions that mitigate for impacts to AOP under state laws that may also result in removal or avoidance of tidal restrictions.
Endangered Species Act (ESA) & Magnuson-Stevens Fishery Act (MSA) Compliance	USFWS*and NOAA* decisions on actions that affect species regulated under the ESA or the MSA that may also result in removal or avoidance of tidal restrictions.
Funding Tools	
National Oceanic and Atmospheric Administration	The Coastal Resilience Grant Program and Community Based Restoration Grant Program fund resilience and restoration projects, which may include tidal restriction removal.
U.S. Fish and Wildlife Service	The National Coastal Wetlands Conservation Grant Program may be applicable to tidal restriction removal projects. The Coastal Program and the National Fish Passage Program provide financial and technical assistance to projects that restore coastal habitats or remove fish barriers.
U.S. Army Corps of Engineers	The Estuary Restoration Act and Water Resources Development Act provide funds to estuary restoration projects and fish and wildlife habitat restoration projects that could be used to remove tidal restrictions.
Federal Emergency Management Agency	The Public Assistance and Hazard Mitigation Grant Programs fund facility damage and hazard mitigation projects. The National Flood Insurance Program Community Rating System provides incentives to municipalities to lower flood insurance premiums.
Federal Highway Administration	The Emergency Relief and Emergency Relief for Federally Owned Roads programs offer funds to repair or replace damaged infrastructure.
U.S. Department of Agriculture, Natural Resources Conservation Service	The Watershed Protection and Flood Prevention Program funds projects for watershed protection, including ecosystem restoration type activities. This program has funded coastal habitat restoration and fish barrier removal projects.
U.S. Environmental Protection Agency	CWA section 319 grants fund activities that address nonpoint source pollution (including hydrologic modifications). Wetland Program Development Grants target building capacity of state and tribal water agencies to increase the quantity and quality of wetlands in the U.S. The National Estuary Program Coastal Watersheds Grant Program may fund projects that address loss of habitats, including tidal wetlands, within certain geographies.
Multiple Agencies	Funds disbursed under the Natural Resource Damage Assessment process required for actions regulated under CERCLA*and the Oil Pollution Act. To mitigate environmental damages caused by these actions, projects where tidal restrictions were removed have been completed. The Five Star and Urban Waters Restoration Grant Program funds local partnerships to improve water quality, watersheds, species and habitats.

**NOAA=National Oceanographic and Atmospheric Administration, USFWS= United States Fish and Wildlife Service*
CERCLA= Comprehensive Environmental Response, Compensation, and Liability Act ("Superfund")

ES.5 Recommendations

The non-binding recommendations build from information gaps and needs identified from a discussion of the existing tools, resources, policies, and practices to address tidal restriction, as well as wider use of promising tools that are currently being used at a state or regional level. The eleven recommendations are arranged into four categories and are followed in the report by a discussion of potential actions and challenges to implementation, where applicable.

Category 1: Reduce Data Gaps

1. Use and adapt existing tidal crossing field evaluation methods to confirm the existence of restrictions, determine their severity, and prioritize them for removal where practicable.
2. Support and utilize remote-based methods to identify and target restrictive structures, as well as datasets that further these efforts.
3. Incorporate potentially restrictive structures of all types into existing locational databases (GIS) or produce new ones where none currently exist.
4. Determine effectiveness of alternative tide gate designs for increasing tidal flow upstream and standardize operational parameters that balance ecological and societal needs.
5. Increase use of modeling to predict restorative effects of removing tidal restrictions to inform compensatory mitigation efforts.

Category 2: Coordinate with Aquatic Organism Passage Practitioners to Leverage Resources in Support of Shared Goals

6. Collaborate with and/or supplement efforts of AOP practitioners to evaluate tidal restrictions.
7. Encourage greater cooperation between AOP and tidal restriction communities and better alignment of practices and goals.

Category 3: Better Integrate Tidal Restriction Considerations into Transportation Planning Processes

8. Incorporate awareness of the role of transportation structures as potential tidal restrictions early in the transportation project planning process.
9. Balance ecological needs with structural and budgetary constraints in transportation structure design.

Category 4: Explore Regulatory Processes and Policy Goals that Support Tidal Restriction Removal

10. Explore regulatory processes that can be used to more efficiently authorize removal of transportation-related tidal restrictions during maintenance or emergency situations and clarify USACE and other Federal Agencies permit authorities to allow for broader use for projects that result in net increases to aquatic function.
11. Build support for the use of tidal restriction removal and restoration of upstream habitats as compensatory mitigation under the Clean Water Act, Rivers and Harbors Act, and other regulatory programs.