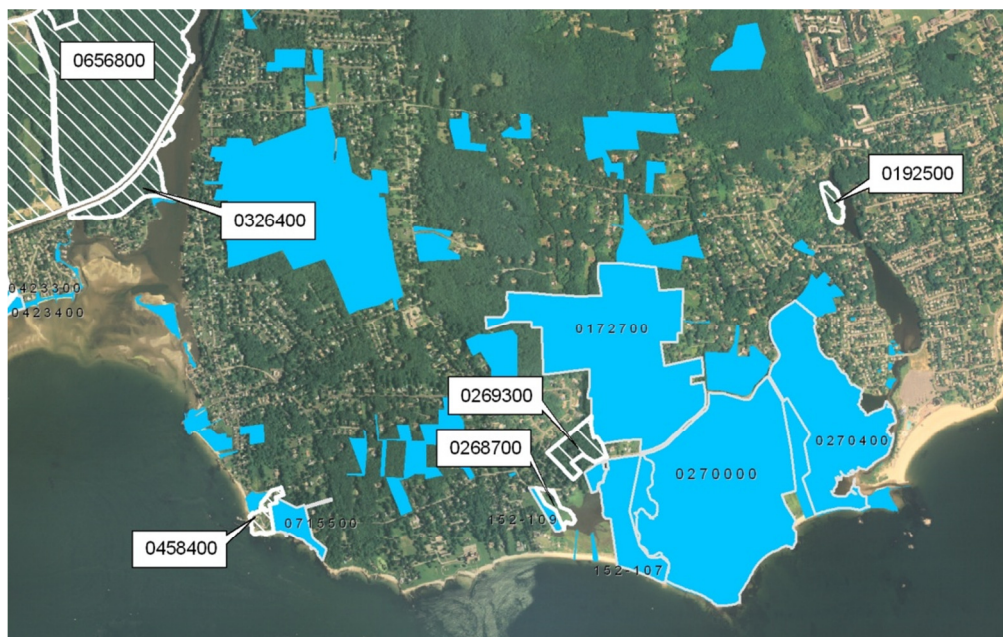


A Salt Marsh Advancement Zone Assessment of Waterford, Connecticut



Front cover image: Open space and unprotected parcels critical to the conservation of marsh advancement corridors; from the accompanying Comprehensive Map Book of Waterford, Connecticut.

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RECOMMENDED CITATION:

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Introduction

In 2006, The Nature Conservancy established the Coastal Resilience Program (www.coastalresilience.org) that provides tools and a solution framework to support decisions that reduce the ecological and socio-economic risk of coastal hazards and comprehensively improve community resilience. The Program focuses on helping decision-makers explore locally relevant, downscaled, coastal flooding scenarios from sea-level rise and/or storm surge, analyze the potential ecological, social and economic impacts of each scenario at a local, state and regional scale, and facilitate progressive solutions to address these issues. Since that time, The Nature Conservancy has assisted many coastal communities in Connecticut by providing critical information and a comprehensive, community-based, engagement process designed to improve overall resilience and sustainability.

There is a universal recognition by coastal communities in Connecticut that natural infrastructure – wetlands, forests, floodplains – is a cost effective, long-term solution to help make people, infrastructure and natural systems more resilient to extreme weather and climatic change. Fortunately, our state has a remarkable diversity and abundance of natural resources that provide habitat for wildlife and fisheries, enhance the aesthetics and quality of life for residents, and, of course, serve to buffer the shoreline and rivers as natural defenses against hazards such as storm surge, inland flooding, and sea level rise. The presence of natural resources in the state – in particular beaches/dunes, salt marsh, forested headwaters, and river floodplains – is the result of previous recognition and commitment to long-term conservation and the requisite balance with socio-economic growth. In order to maintain these natural resources it will require 1) routine and on-going management activities as well as the restoration of degraded areas, 2) forward-looking planning to accommodate changes in habitat composition and location due to climatic change and 3) enforcement, modification and/or development of new land use policies and growth strategies. There are also opportunities to integrate the services (surface runoff storage and infiltration, wave attenuation, pollutant sorption, etc...) provided by natural infrastructure via new development, redevelopment, or realignment activities. Economically important co-benefits from natural infrastructure include services such as improved filtering of pollutants from runoff, erosion control, and improved aesthetics and desirable public amenities. Taken in total, the immediate and longer-term management of and for natural infrastructure by the State, Towns, private property owners, non-profit organizations, and others will help to reduce the hazard risk and improve the resilience within Connecticut.

While longer-term changes in temperature and precipitation patterns will alter the species composition and type of habitats in a given location, the more immediate implication is the upslope migration or advancement of habitats such as salt marsh in response to continued sea level rise. Sea level rise and the impacts of flooding have and will continue to alter the presence and abundance of natural resources in Connecticut. One of the most noticeable changes is occurring at the shoreline's edge where salt marsh is in the process of advancing upslope with sea levels into areas now considered uplands. In order to clearly identify where this will occur along Waterford's shoreline, The Nature Conservancy presents the following report to assist with future planning for natural resources in the context of overall risk reduction and resiliency improvement for the community. Ultimately, it is our hope that this report will serve to inform the community about future marsh advancement locations, current land use of those

locations and which parcels are critical for securing advancement into suitable sites to ensure the persistence of natural resources in Waterford longer term.

The Salt Marsh Advancement Model used in this analysis was co-developed by The Nature Conservancy and the University of Connecticut's Department of Natural Resources Management and Engineering. A full discussion of the Model and underlying methodology is beyond the scope of this report¹, but a few important details are needed to put the following analysis into context and define how to use the results for planning and implementation.

Suitable vs. Unsuitable Advancement

In the following tables and figures suitable advancement areas are abbreviated as “Yes” and unsuitable areas are abbreviated as “No”. Suitable areas are classified based on the current land cover type - “forest” or “agrigrass” – and are expected to convert to salt marsh as hydrologic conditions change in response to sea level rise. Land cover types currently classified as “urban” (i.e. roads, buildings, parking lots, etc...) are considered to be unsuitable for marsh advancement at this time. Though much of our analysis is grouped by parcel ID and associated characteristics, these classifications – suitable and unsuitable – exist independent of the parcel boundaries. In other words, a given residential parcel can have both suitable (lawn) and unsuitable (building footprint) advancement areas.

Marsh Advancement vs. Wetland Extent

There is a key distinction in this report between the current wetland extent in a municipality and the marsh advancement areas analyzed herein. Marsh advancement areas include only the future projected wetland extent clipped to current upland land cover. Therefore, no assumption should be made about net gain or loss of current wetland extent based on this advancement area analysis. Another key consideration is that in some cases the identified advancement area will include land that converts to wetlands and subsequently to open water over time. This further demonstrates that net change in both existing and future wetland extent should not be inferred from our analysis.

Planning for the Future

The advancement and eventual establishment of coastal marshes will occur over the course of several decades and as such our analysis extends out to the 2080s. The rate of change is slow and decadal, yet at the same time it is inevitable. There is an abundance of existing property, infrastructure and natural resource assets clustered along the Connecticut coast and communities will need to formulate growth and realignment plans well in advance of the 2080s scenario presented here. The following data analysis and associated map book can assist with a resilient transition through the presentation of marsh advancement areas and an accounting of the projected changes to coastal property.

¹ Detailed methods for advancement zone can be found on the Long Island Sound coastal resilience site (lis.coastalresilience.org) and downloaded directly from here: http://lis.coastalresilience.org/xml/Advancment_Zones.pdf

Total Marsh Advancement

The full extent of marsh advancement by the 2080s is projected to be 330 acres, with 293 acres (89%) considered to be suitable sites for wetland migration in Waterford. Currently, 37 acres (11% of total) are occupied by built structures and associated infrastructure (“urban”).

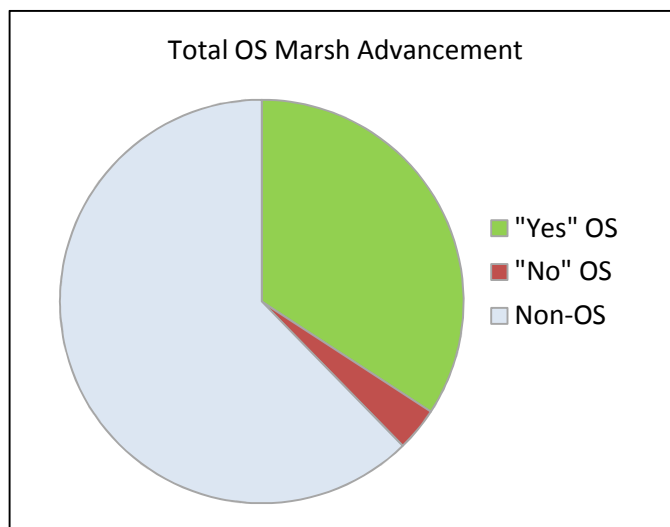
Total Marsh Advancement by 2080s		
Marsh Adv	Acres	Percent (%)
Yes	293	89
No	37	11
Total	330	100

Protected Open Space (OS) Advancement

Existing protected open space (OS) consists of state or municipal parks, conservation easements on private property, or simply properties owned by land trusts. The unifying characteristic of these properties, and what makes them a critical component of long-term community resilience, is that they currently have little to no development and are the most likely areas to remain undeveloped through the 2080s. The recognition of their role in future wetland extent and improved resilience in Waterford is vital information for land management, economic development, and planning.

Total OS Advancement

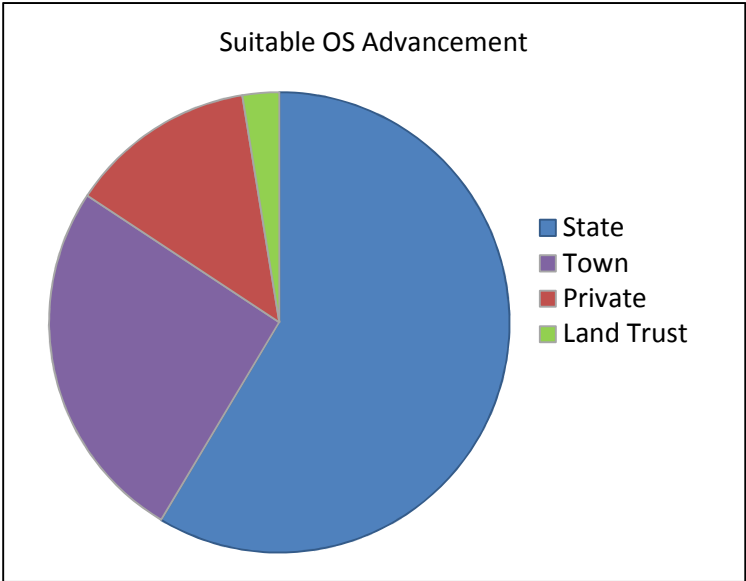
Protected OS parcels contain 124 acres of marsh advancement area with nearly that entire sum (113 acres – 34% of overall total) classified as suitable for future wetlands. Further analysis of the larger proportion of unprotected open space parcels (Non-OS) can be found in the “All Parcel” section below.



Total OS Marsh Advancement		
OS type	Acres	Percent (%)
"Yes" OS	113	34
"No" OS	11	3
Non-OS	206	63
Total	330	100

Suitable OS Advancement by Owner

A closer look at the protected OS advancement (113 acres – 34% of total advancement (330 acres)) reveals that the state of Connecticut owns 66 acres of suitable advancement area, more than half the protected OS total (58.5%) and almost a quarter of the overall total (22.5%). The Town of Waterford is the next largest owner with 29 acres, which accounts for 26% of the OS total and 10% of the overall total.

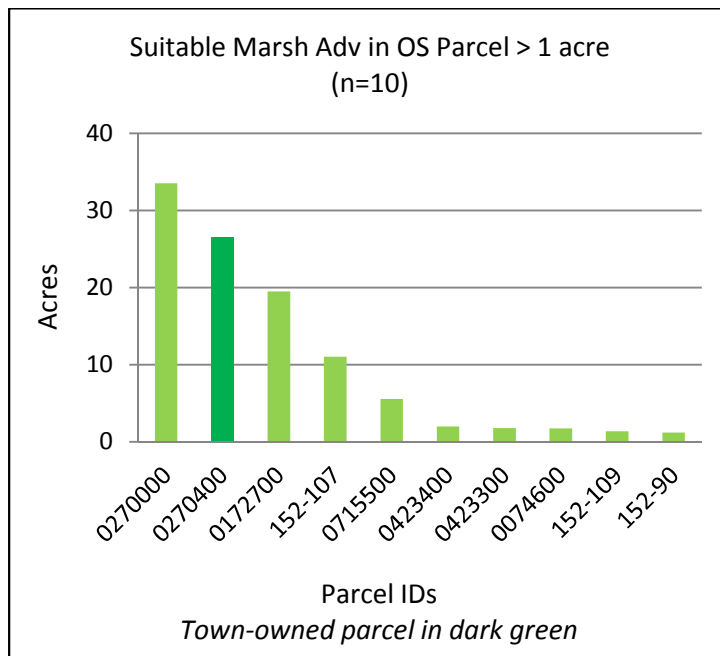


Suitable OS Advancement			
OS type	Acres	% of total "yes" OS	% of total "yes" adv
State	66	58.5	22.5
Town	29	26	10
Private	15	13	5
Land Trust	2.9	2.5	1
Total	112.9	100	38.5

(next page)

Suitable Advancement by OS Parcel

There are 47 protected OS parcels that contain suitable advancement in Waterford and, as typically is the case, the distribution is greatly skewed towards a handful of the largest sites. Only 10 parcels contain an advancement zone greater than 1 acre and together these parcels add up to 104 acres, or 93% of the suitable OS advancement total. Further enhancing the skew are the top 4 OS parcels that each contain greater than 10 acres of suitable advancement, accounting for 80% of the protected suitable advancement and nearly a third of the overall total. The specified parcels can be viewed via the corresponding Map Book pages indicated in the table below.



Suitable Adv in OS Parcels > 1 acre				
Parcel ID	Acres	% of total "yes" OS	Owner	Map Book Page #
0270000	33.5	30	State	9
0270400	26.5	23.5	Town	9
0172700	19.5	17	State	9
152-107	11	10	State	9
0715500	5.5	5	Private	8
0423400	2	1.7	Private	8
0423300	1.8	1.6	Private	8
0074600	1.7	1.5	Private	None
152-109	1.4	1.2	Land Trust	9
152-90	1.2	1.1	Land Trust	8
Total	104.1	92.6		

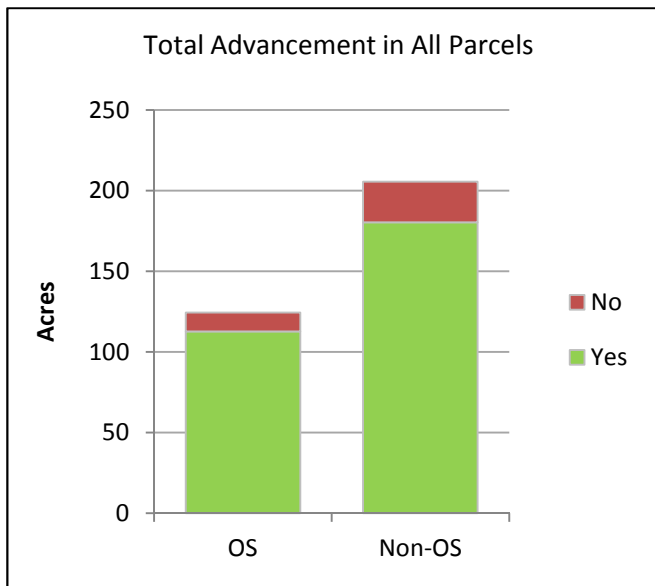
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All Parcels

This section provides an analysis of suitable marsh advancement in all parcels, whether they are classified as protected open space or not. The following results help to put the OS analysis into perspective, as well as identify important unprotected private parcels in the marsh advancement landscape of Waterford.

Total Advancement: Protected (OS) vs. Unprotected (Non-OS)

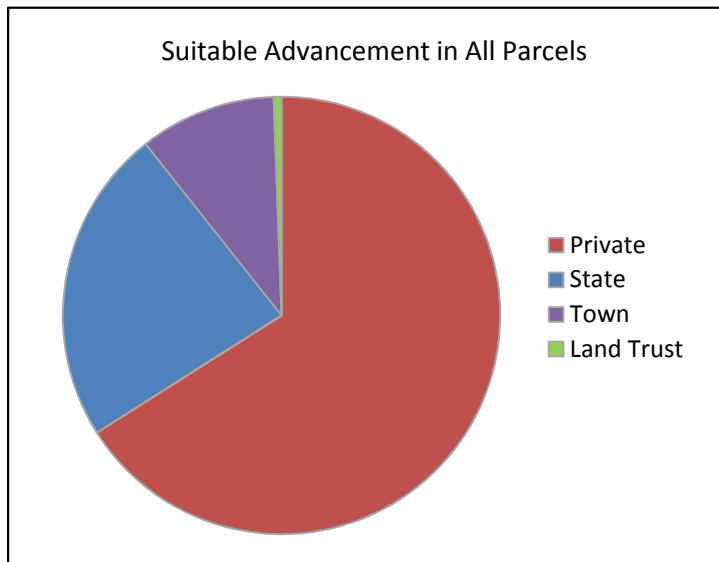
Suitable OS advancement (Yes) greatly outnumbers unsuitable OS advancement at a rate of nearly 10:1. That relationship holds for Non-OS (unprotected) parcels, albeit at a slightly smaller ratio closer to 7:1. Most notably, though, suitable unprotected advancement is 180 acres, which is 60% larger than suitable protected OS advancement indicating that unprotected parcels are projected to receive the greatest amount of the marsh advancement. This information has two important implications for future planning; 1) today's unprotected property will play a vital role in maintaining Waterford's wetland resources in the future, and 2) a large amount of critical development (25 acres), namely residences and transportation infrastructure, will be in conflict with rising seas and advancing marshes.



Total Advancement			
Parcel type	"yes" acres	"no" acres	Total
OS	113	11.5	124.5
Non-OS	180	25	205
Total	293	36.6	329.5

Suitable Advancement by Owner

State and town-owned property contain the majority of suitable OS advancement, but when all parcels are considered private property becomes the largest owner type. Private ownership contains a total of 193 acres of suitable advancement, or two-thirds of the overall total. The share of suitable advancement found on state and town-owned property remains at more or less the same levels with 68 acres and 29.5 acres, respectively, or 23% and 10% of the overall total for Waterford.

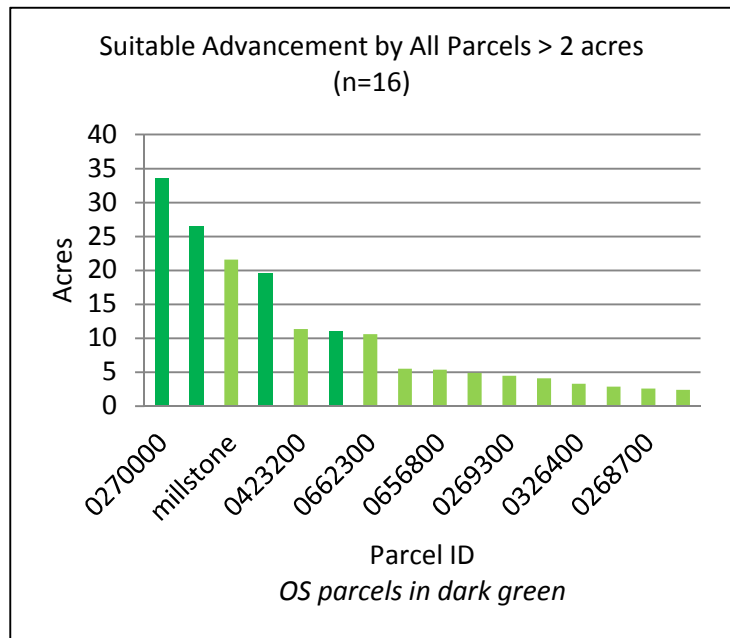


Total Suitable Marsh Advancement		
Owner Type	Acres	% of total "Yes" Adv
Private	193	65.9
State	68	23.3
Town	29.5	10.1
Land Trust	1.7	0.6
Total	292.2	100

(next page)

Suitable Advancement in All Parcels

There are a total of 618 parcels with at least some measurable suitable advancement but only 16 contain greater than 2 acres. This small subset accounts for the majority of suitable advancement at 174 acres, or 60% of the overall total. Moreover, there are 7 parcels with 10 acres or more of suitable advancement, which adds up to 134 acres (46% of the overall total). The only town-owned parcel in the entire group is the Town Park with 26.5 acres of suitable advancement, making it the second largest site. The specified parcels can be viewed via the corresponding Map Book pages indicated in the table below.



Suitable Marsh Adv by All Parcels > 2 acres <i>* Indicates protected OS parcel</i>				
Parcel ID	Acres	% of total "Yes" Adv	Owner	Map Book Page #
0270000*	33.5	11.4	State	9
0270400*	26.5	9.1	Town	9
Millstone	21.5	7.4	Private	6, 19, 20
0172700*	19.5	6.7	State	9
0423200	11.5	3.9	Private	6, 16
0269500*	11	3.8	State	9
0662300	10.5	3.6	Private	6, 16, 17
0715500*	5.5	1.9	Private	8
0656800	5.4	1.8	Private	6, 17
0665100	4.9	1.7	Private	6, 14, 17
0269300	4.5	1.5	Private	7, 21
0458400	4.1	1.4	Private	6, 20
0326400	3.3	1.1	Private	6, 17
0611000	2.9	1	Private	6, 16
0268700	2.6	0.9	Private	7, 21
0192500	2.4	0.8	Private	7, 18
Total	174.3	59.6		

Appendix

Please consult your Marsh Advancement Resource Disc for the complete list of suitable and unsuitable advancement in both groups of parcels – OS and All Parcels.

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Comprehensive Map Book of Waterford, Connecticut



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Overview Maps

Marsh Advancement	3
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Inset Maps

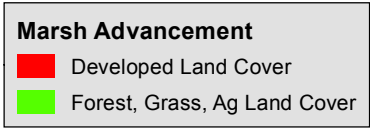
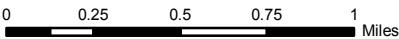
Unprotected Parcels	11
Advancement per Parcel	23

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Marsh Advancement by the 2080s

Town of Waterford, CT

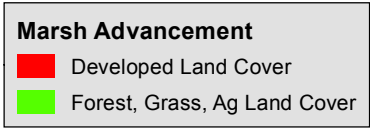
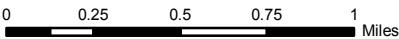
Marsh Advancement - NW



Marsh Advancement by the 2080s

Town of Waterford, CT

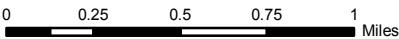
Marsh Advancement - SW



Marsh Advancement by the 2080s

Town of Waterford, CT

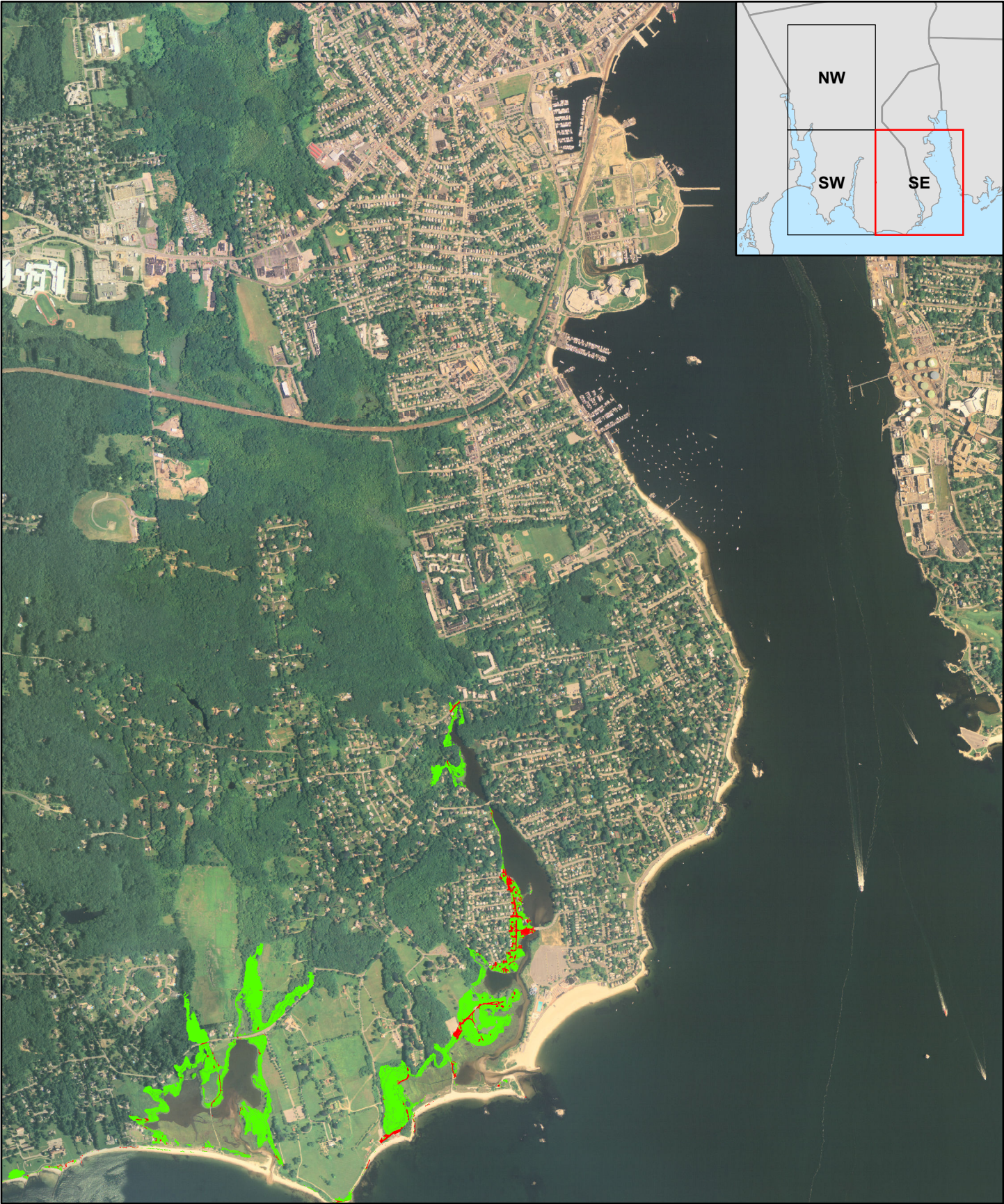
Marsh Advancement - SE



Marsh Advancement

Developed Land Cover

Forest, Grass, Ag Land Cover



Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - SW

Note: Only parcels with greater than 2 acres of suitable advancement are shown. The NW inset contains no such parcels and thus is not included in this series.



0 0.25 0.5 0.75 1 Miles

Parcels

Unprotected Parcels

Marsh Advancement

Developed Land Cover

Forest, Grass, Ag Land Cover



Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - SE

0 0.25 0.5 0.75 1 Miles



Note: Only parcels with greater than 2 acres of suitable advancement are shown. The NW inset contains no such parcels and thus is not included in this series.

Parcels

Unprotected Parcels

Marsh Advancement

Developed Land Cover

Forest, Grass, Ag Land Cover



Marsh Advancement by the 2080s

Town of Waterford, CT

Critical Parcels - SW

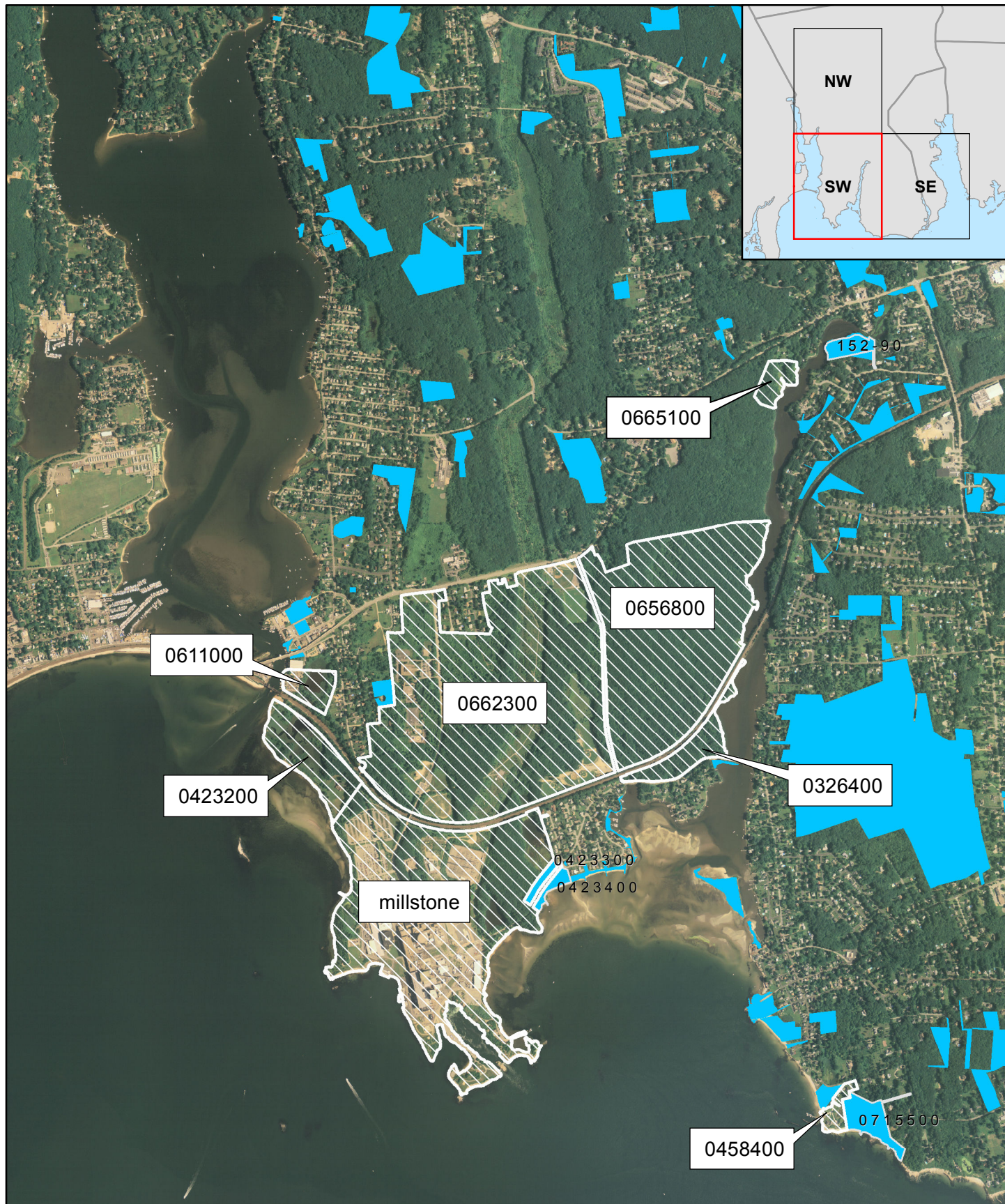
0 0.25 0.5 0.75 1 Miles



Note: Unprotected parcels with > 2 acres of suitable advancement are the focus of this map. The NW inset contains no such parcels and thus is not included in this series. Protected open space parcels with > 1 acre of suitable advancement are labeled and outlined as well.

Parcels

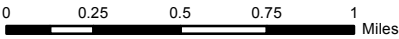
- Unprotected Parcels
- Protected Open Space



Marsh Advancement by the 2080s

Town of Waterford, CT

Critical Parcels - SE

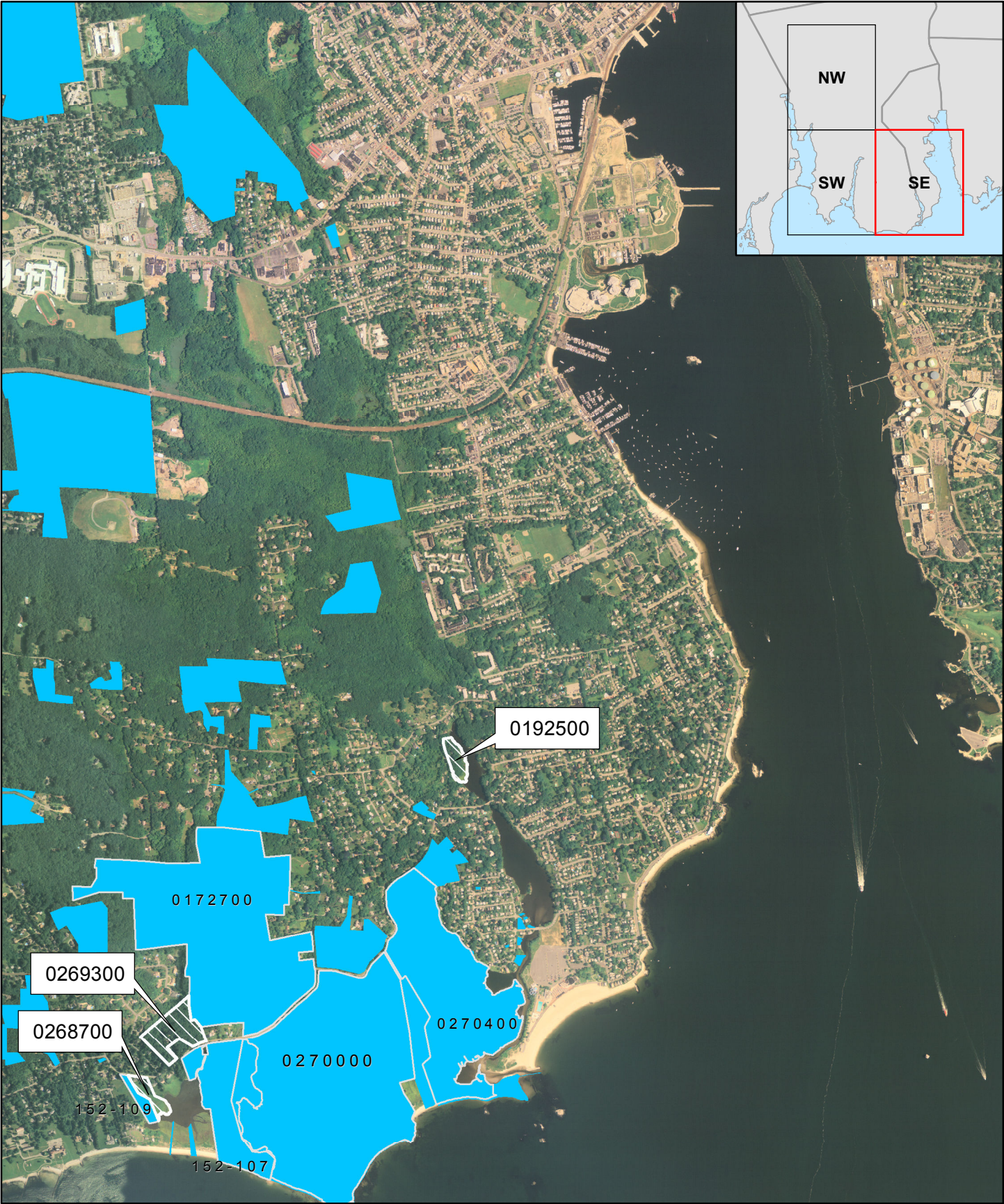


Note: Unprotected parcels with > 2 acres of suitable advancement are the focus of this map. The NW inset contains no such parcels and thus is not included in this series. Protected open space parcels with > 1 acre of suitable advancement are labeled and outlined as well.

Parcels

Unprotected Parcels

Protected Open Space

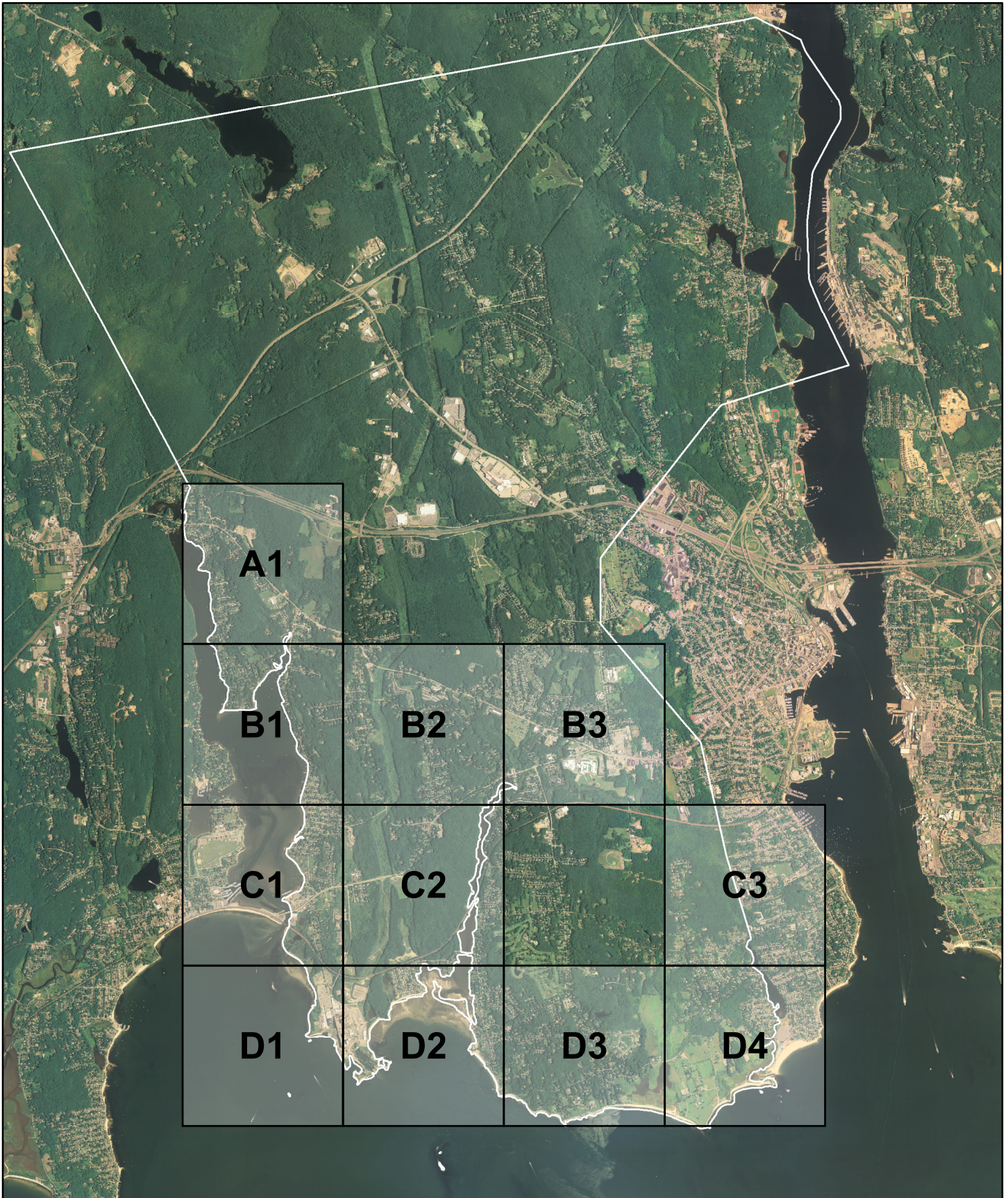


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Marsh Advancement by the 2080s

Town of Waterford, CT

Map Index - Unprotected Parcels





0 500 1,000 2,000 3,000 Feet

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Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map A1

Parcels

Unprotected Parcels

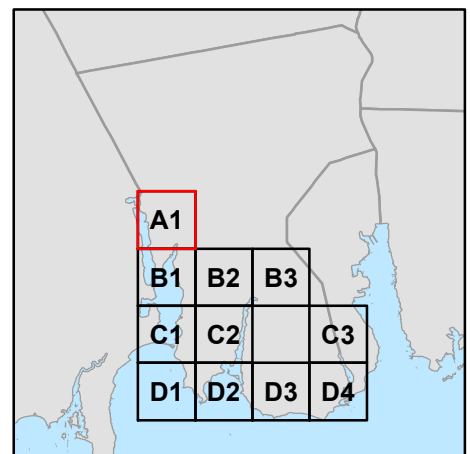
Marsh Advancement

Undeveloped Land Cover

Forest, Grass, Ag Land Cover

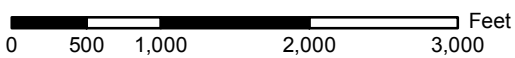


Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.





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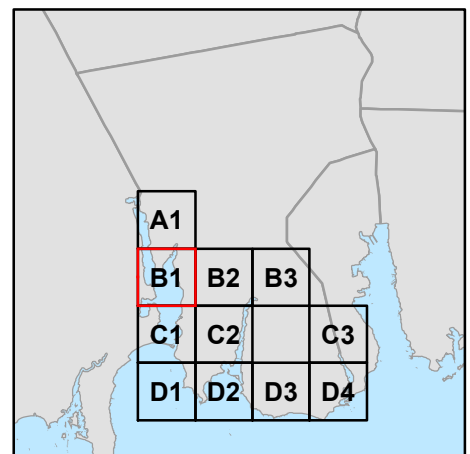
Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map B1

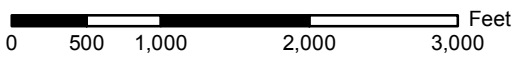


Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.



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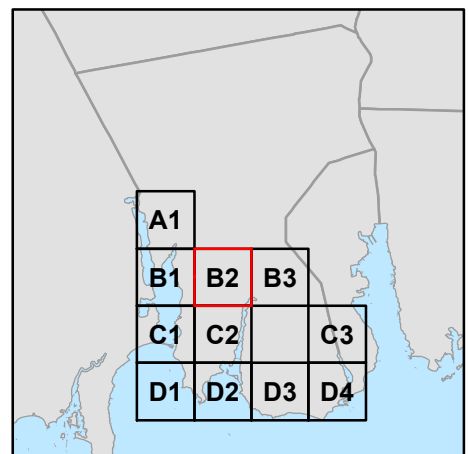
Marsh Advancement by the 2080s

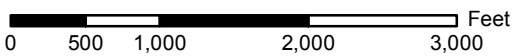
Town of Waterford, CT

Unprotected Parcels - Map B2



Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.





Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map B3

Parcels

Unprotected Parcels

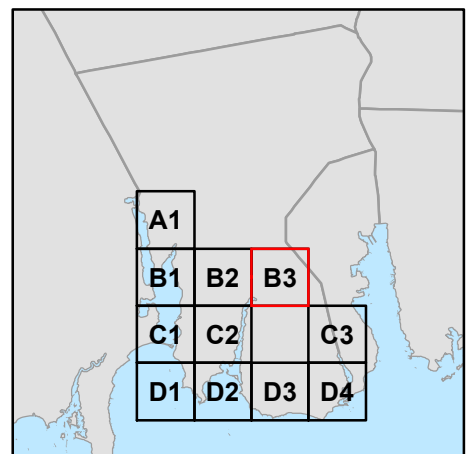
Marsh Advancement

Undeveloped Land Cover

Forest, Grass, Ag Land Cover

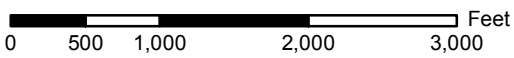


Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.





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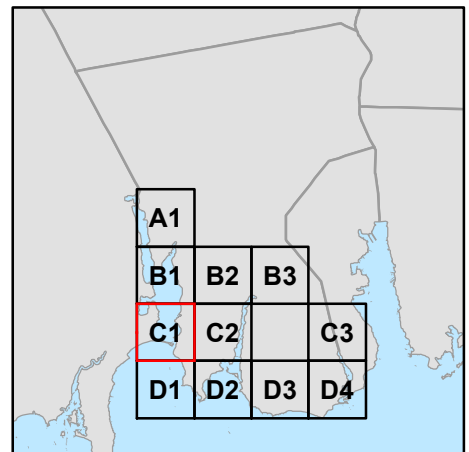
Marsh Advancement by the 2080s

Town of Waterford, CT

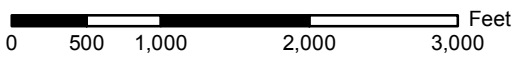
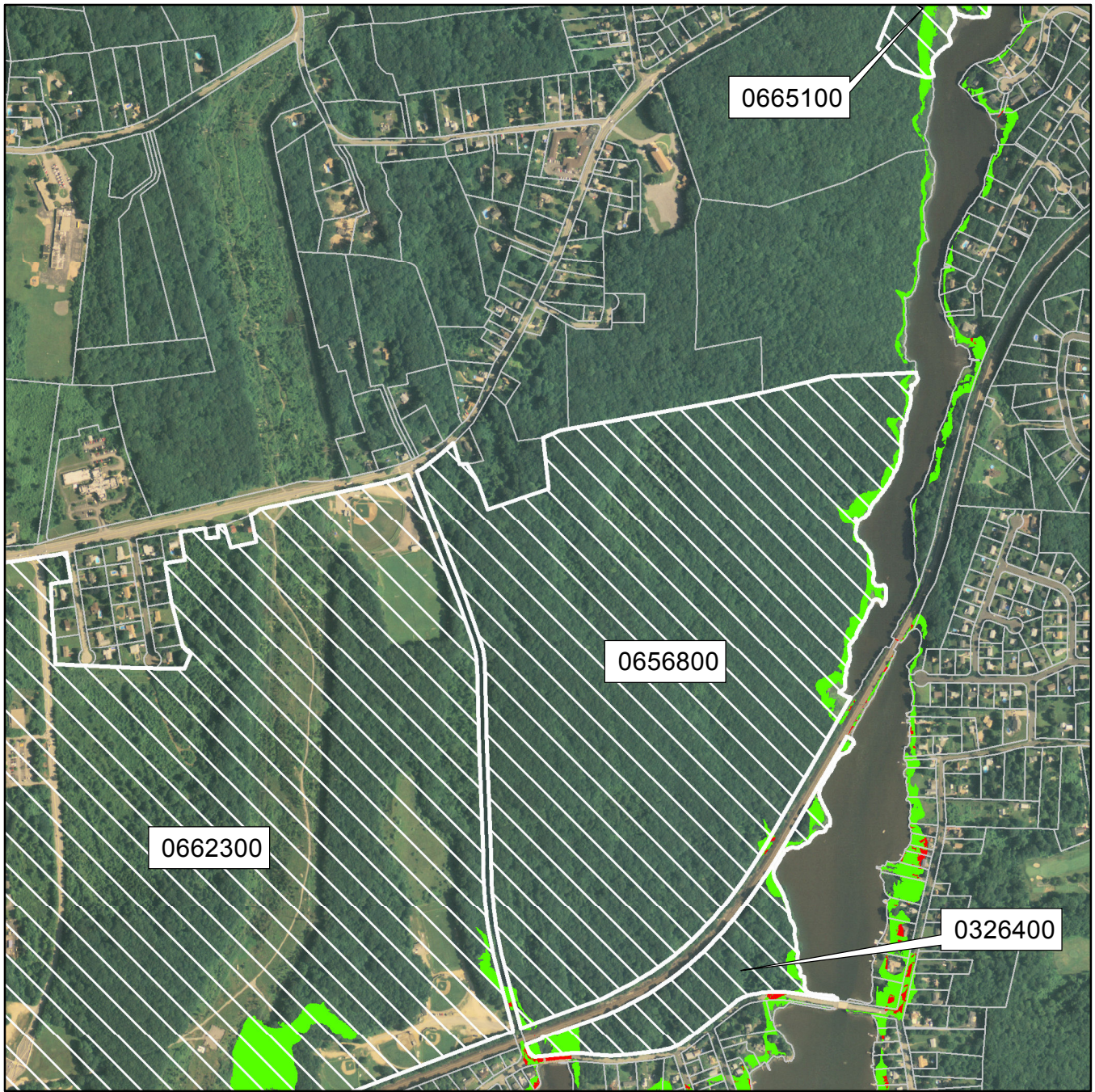
Unprotected Parcels - Map C1



Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.



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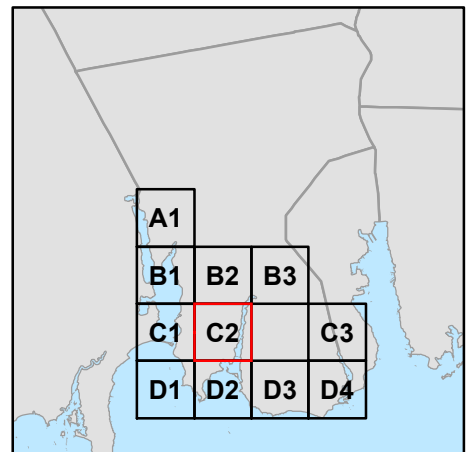
Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map C2



Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.





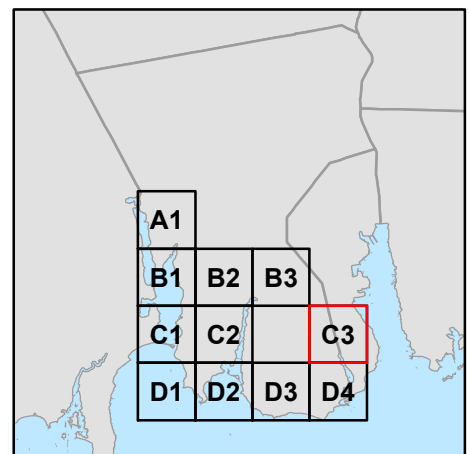
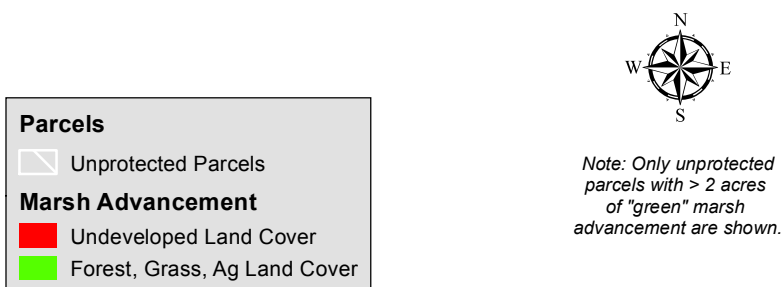
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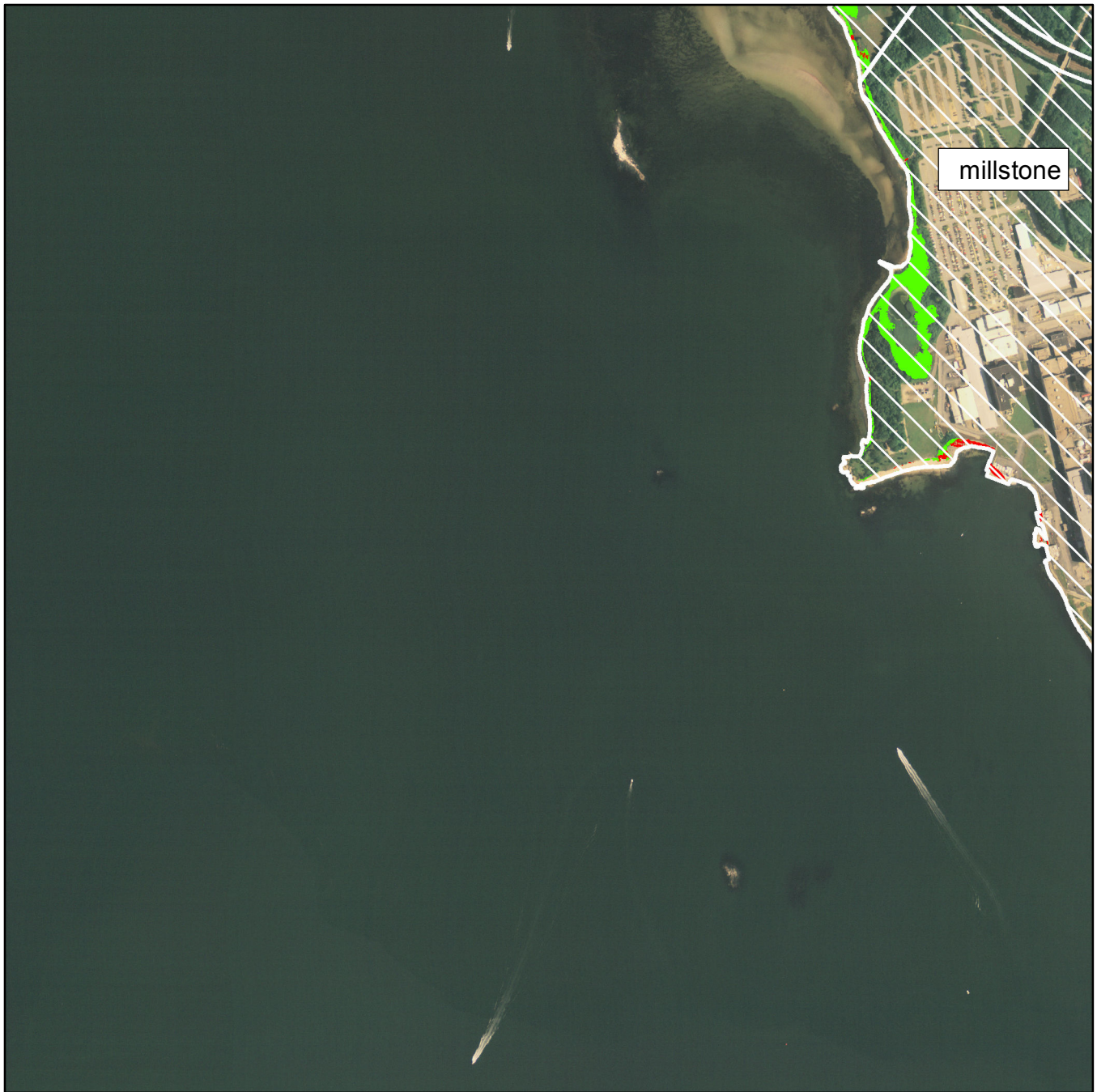
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Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map C3





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0 500 1,000 2,000 3,000 Feet

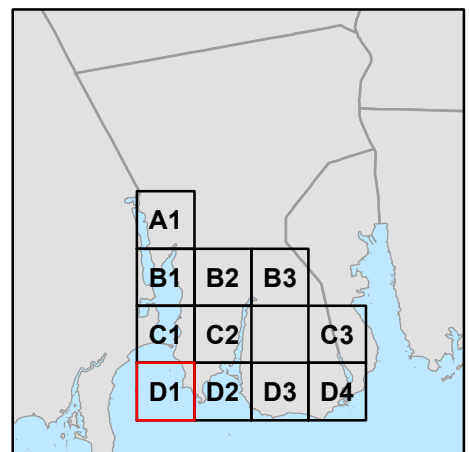
Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map D1

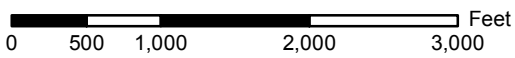


Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.



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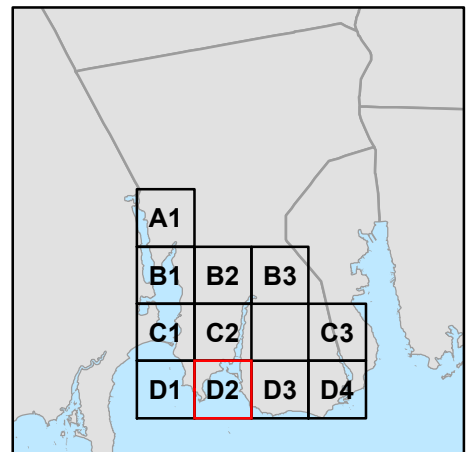
Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map D2



Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.



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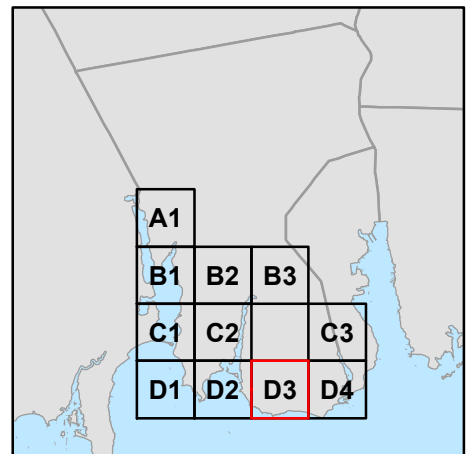
Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map D3



Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.



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0 500 1,000 2,000 3,000 Feet

Marsh Advancement by the 2080s

Town of Waterford, CT

Unprotected Parcels - Map D4

Parcels

Unprotected Parcels

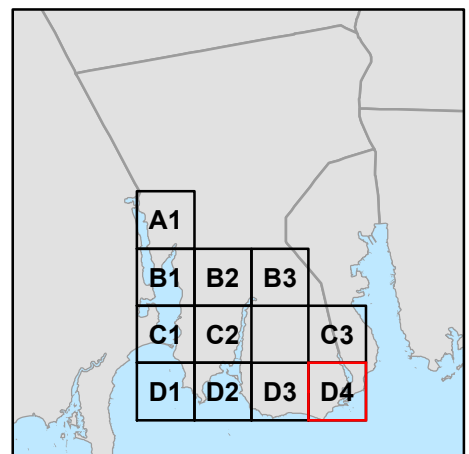
Marsh Advancement

Undeveloped Land Cover

Forest, Grass, Ag Land Cover



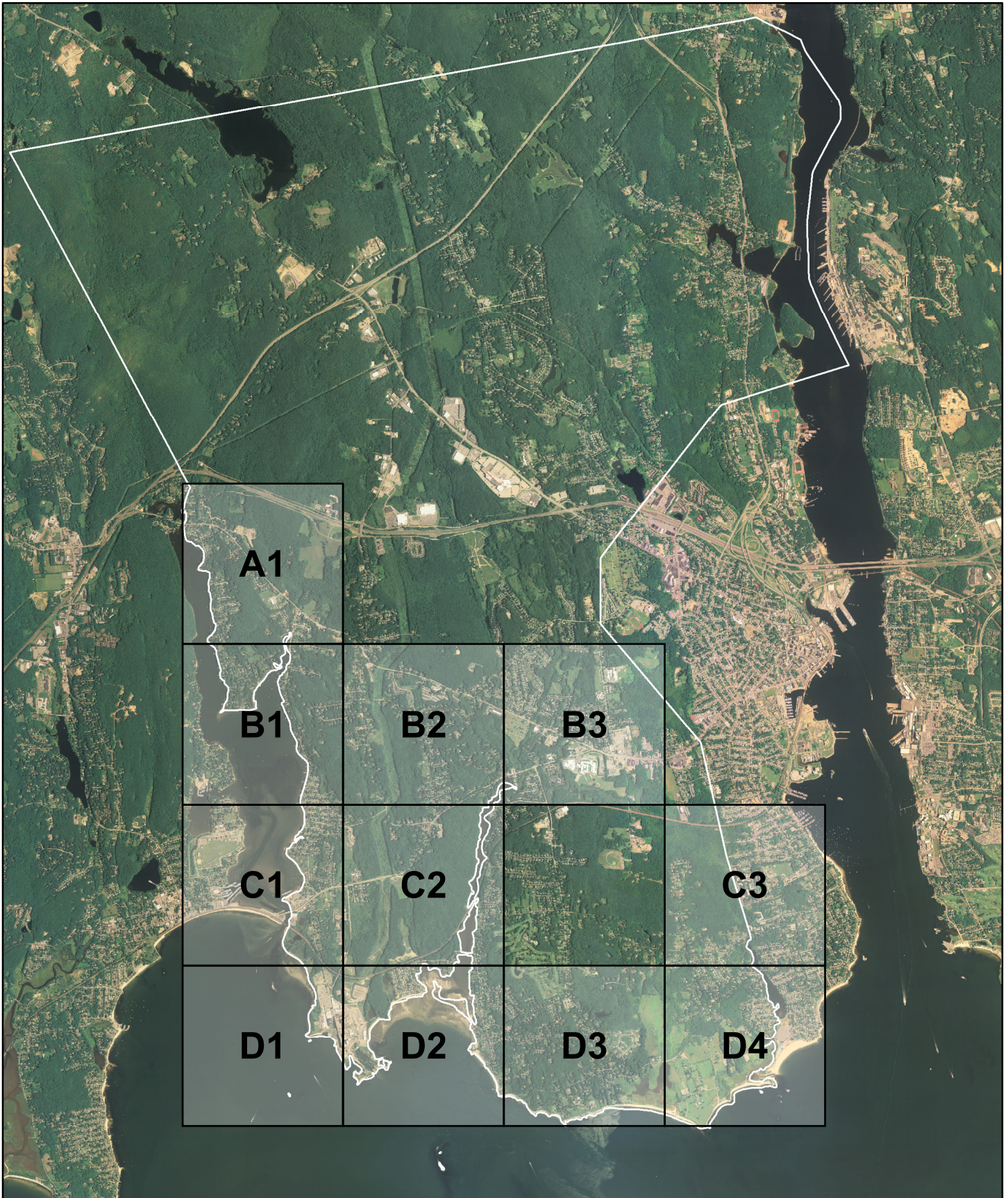
Note: Only unprotected parcels with > 2 acres of "green" marsh advancement are shown.

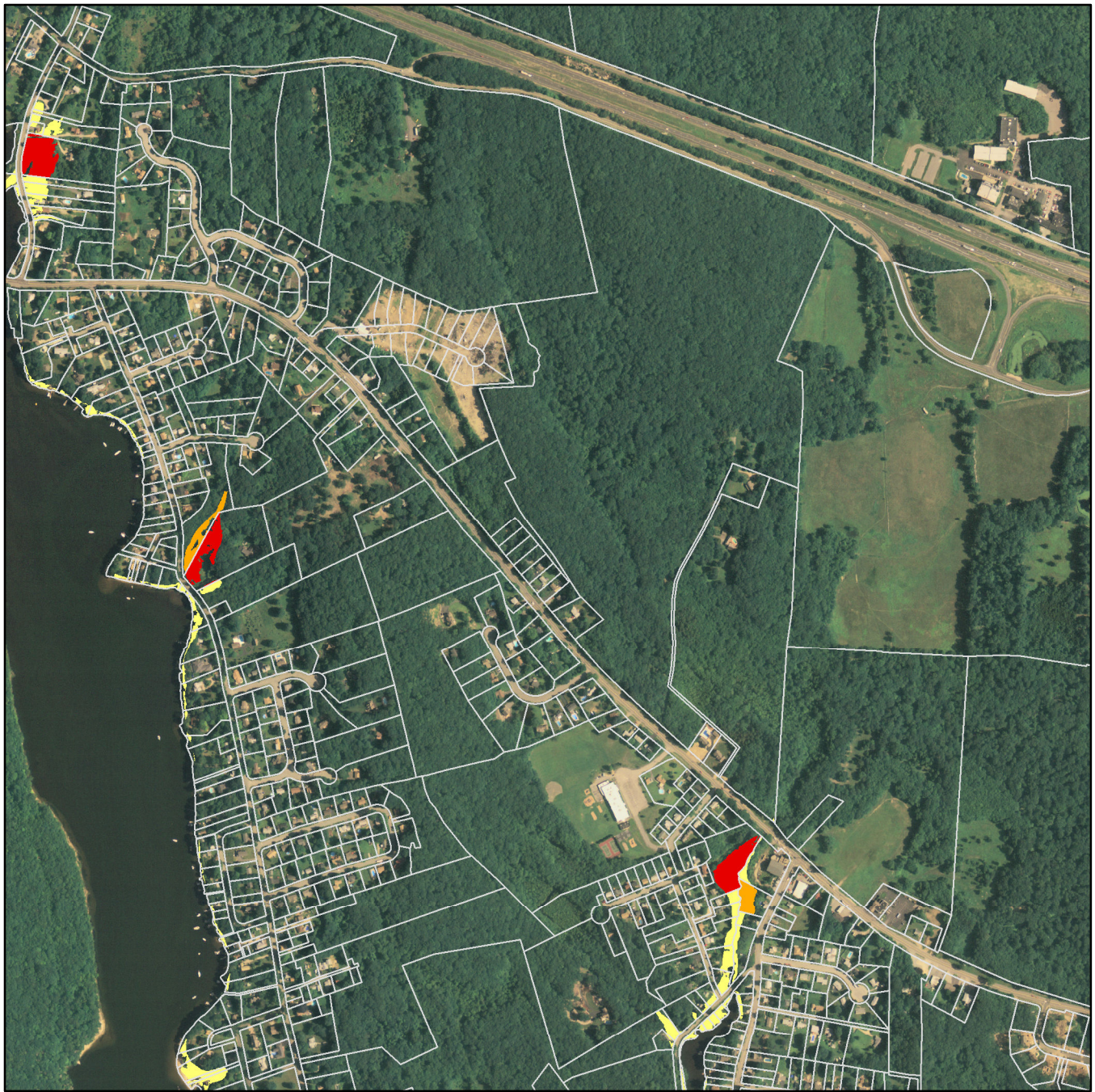


Marsh Advancement by the 2080s

Town of Waterford, CT

Map Index - Advancement per Parcel





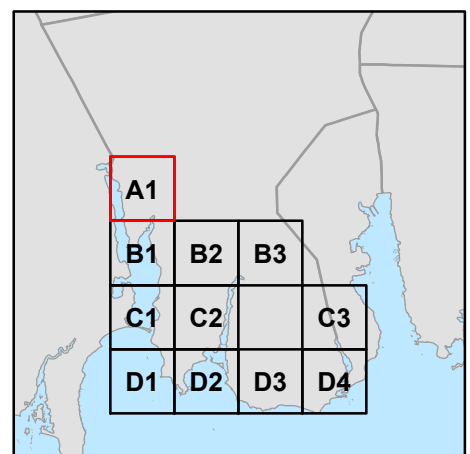
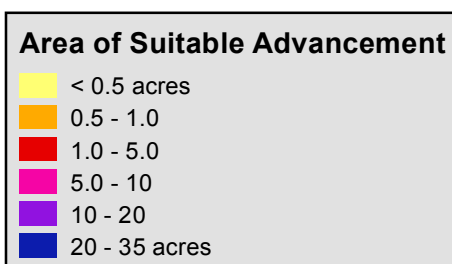
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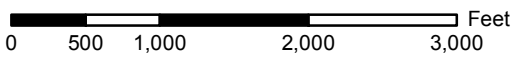
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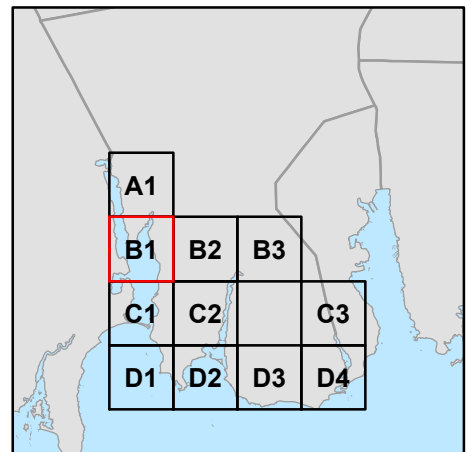
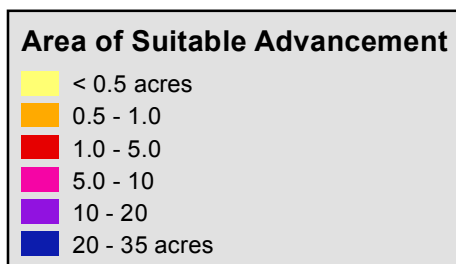


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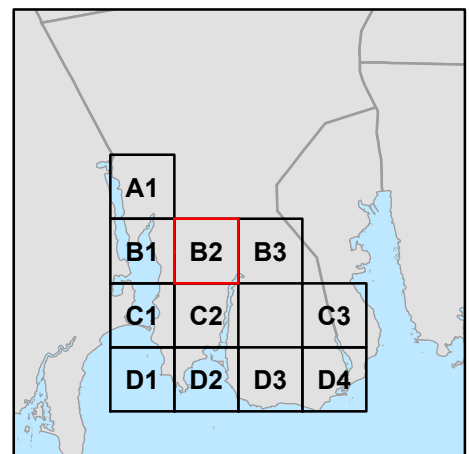
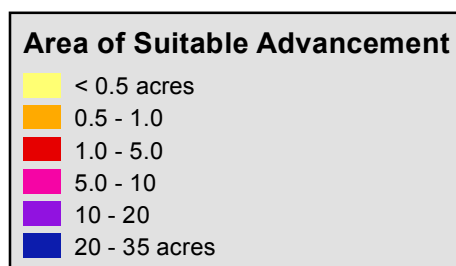
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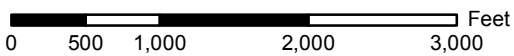
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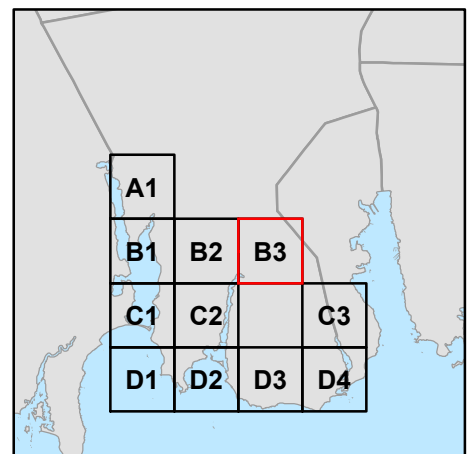
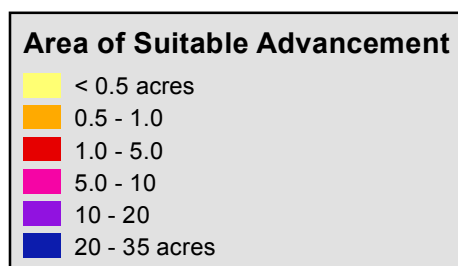




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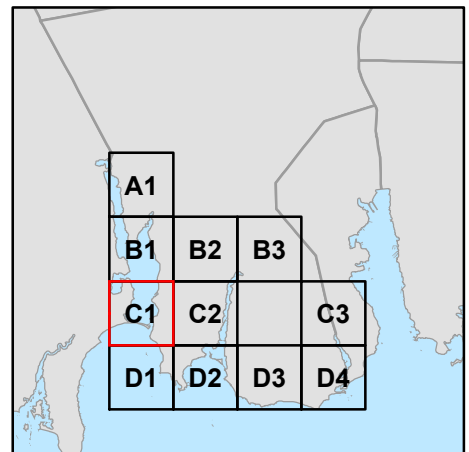
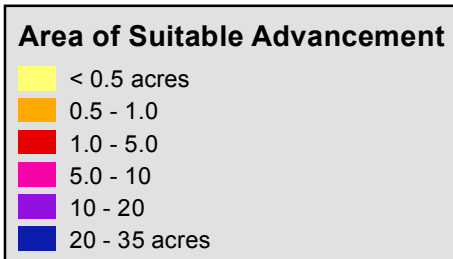
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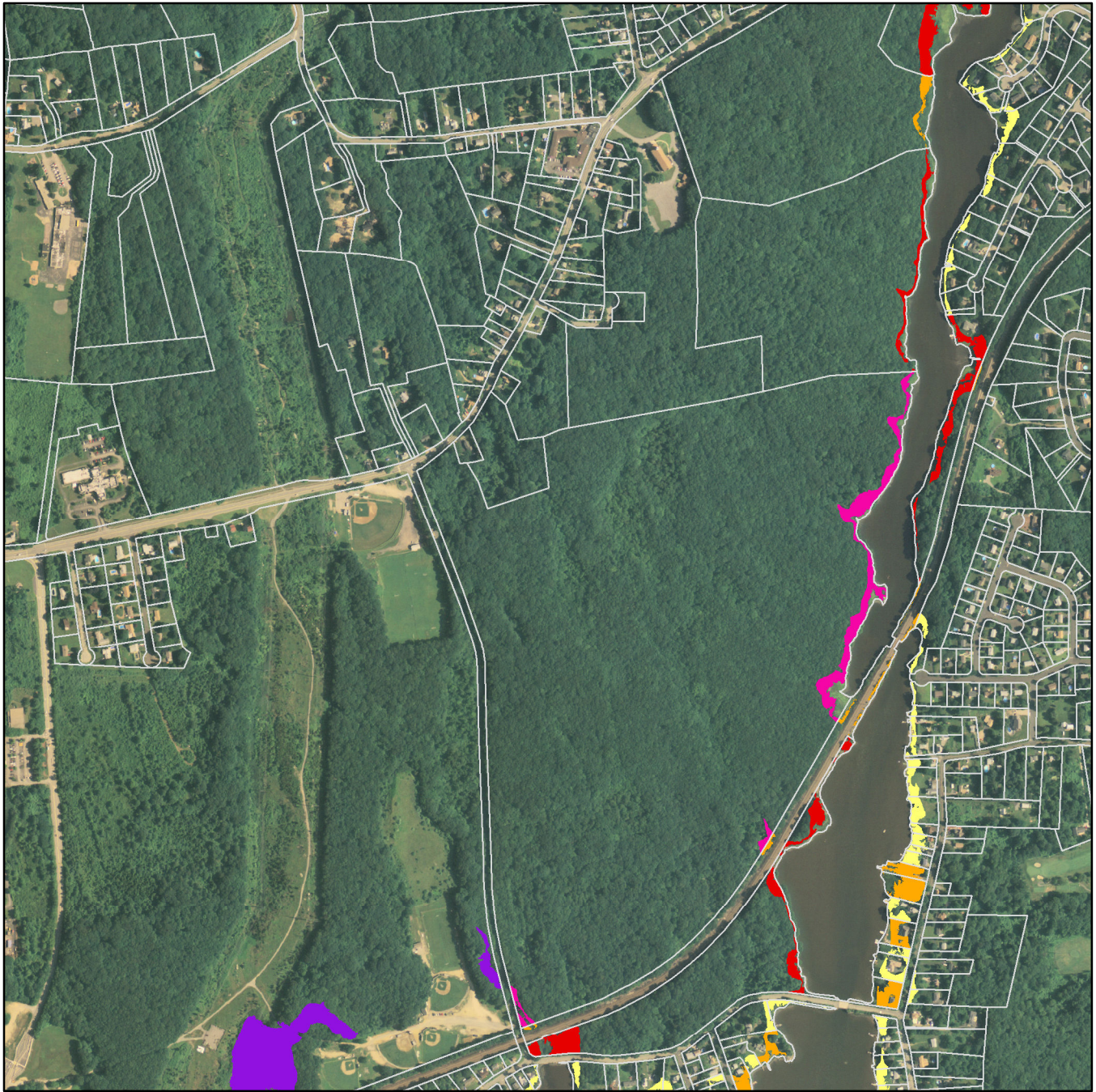
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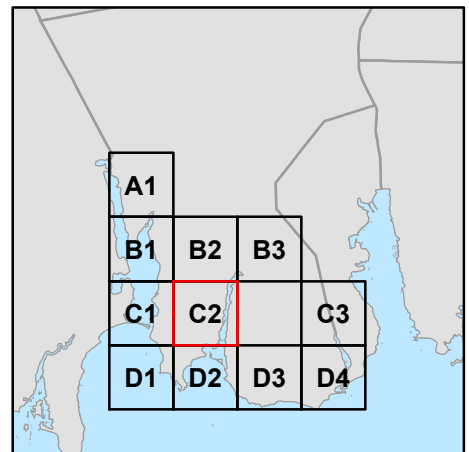
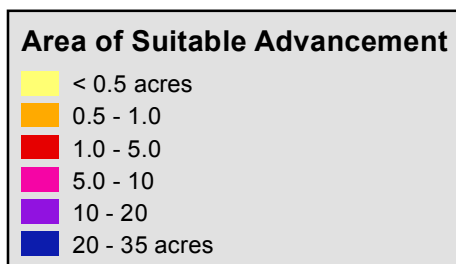
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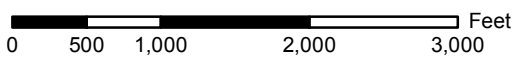
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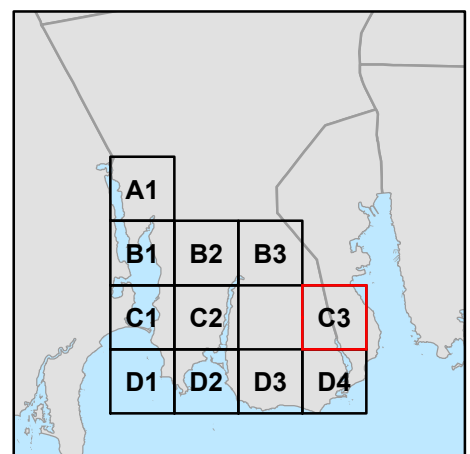
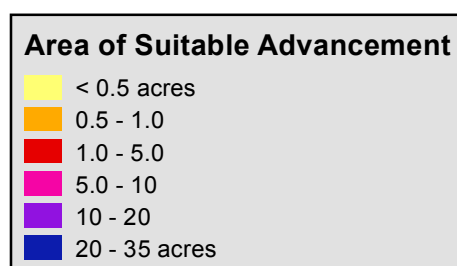


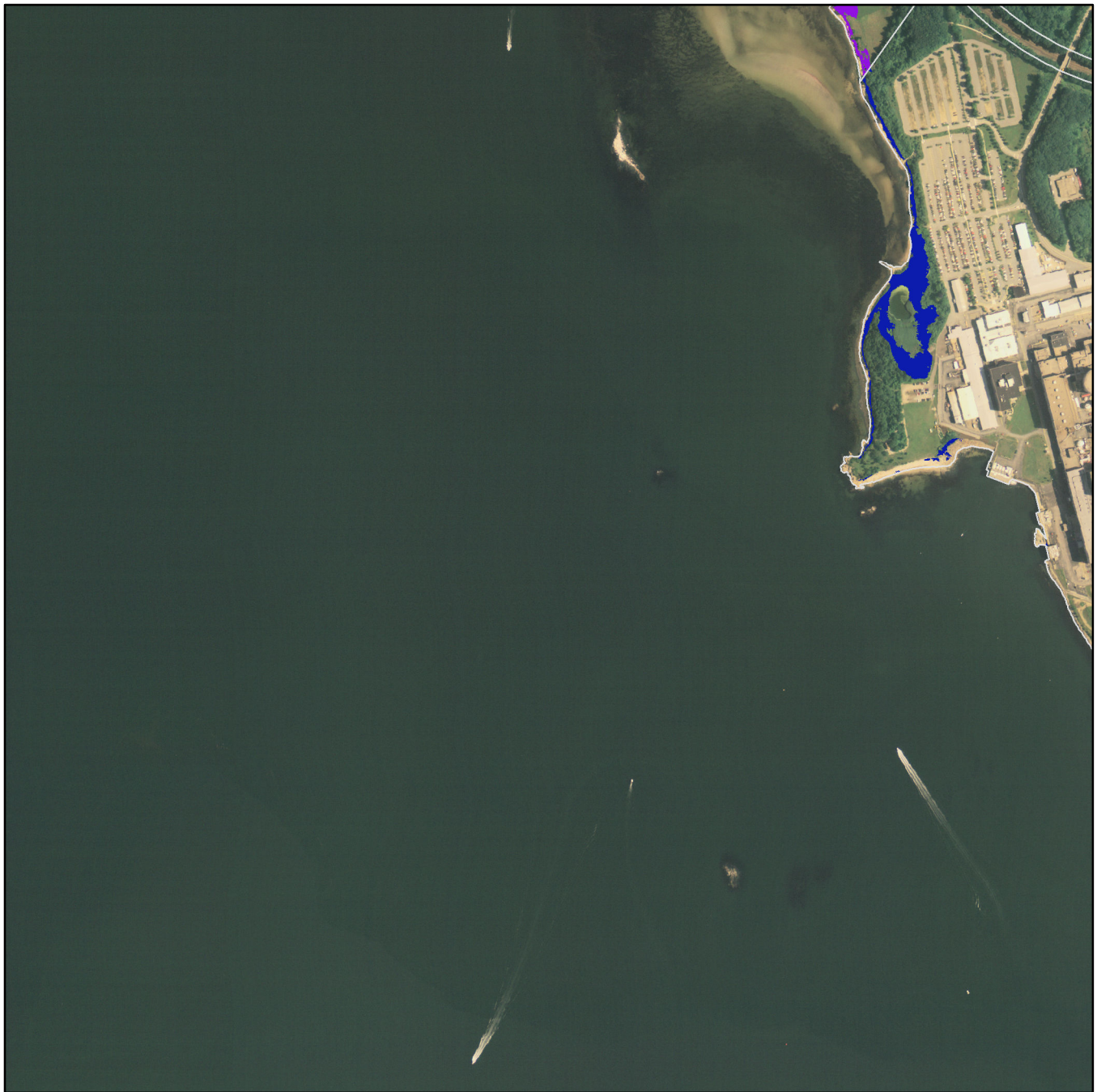
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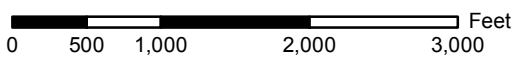
Town of Waterford, CT

Advancement per Parcel - Map C3





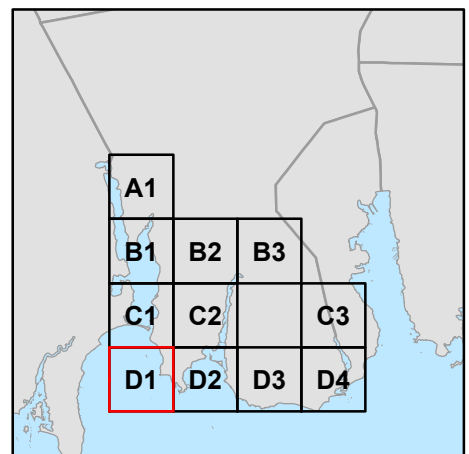
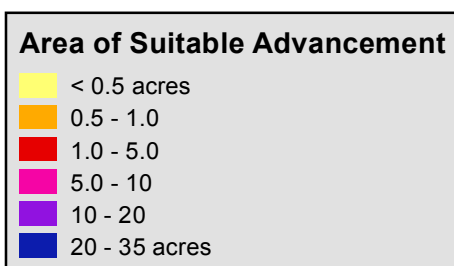
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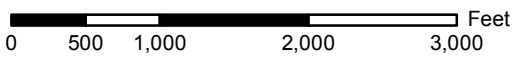
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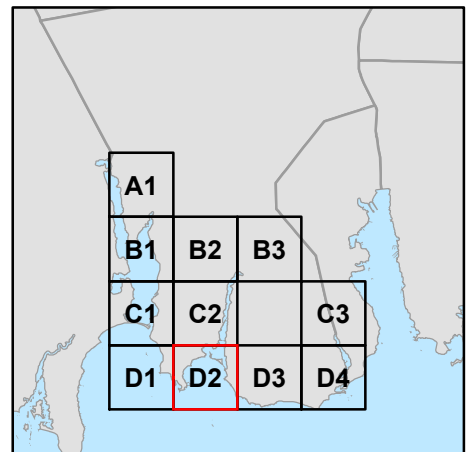
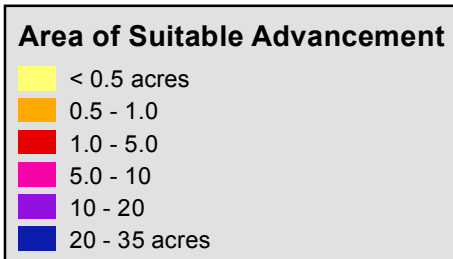
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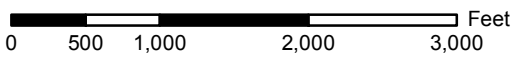
Town of Waterford, CT

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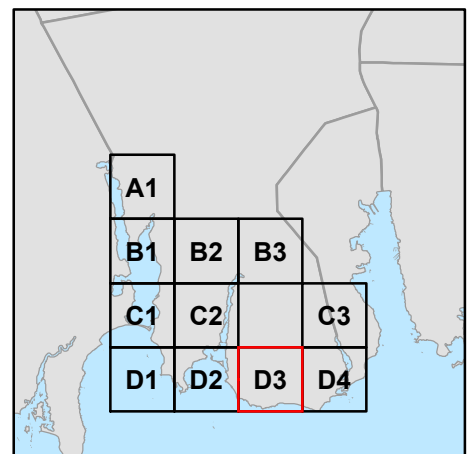
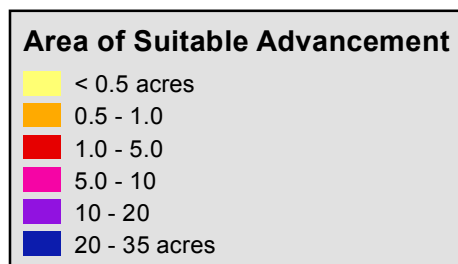
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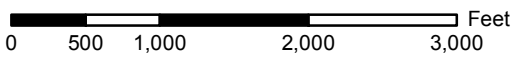
Marsh Advancement by the 2080s

Town of Waterford, CT

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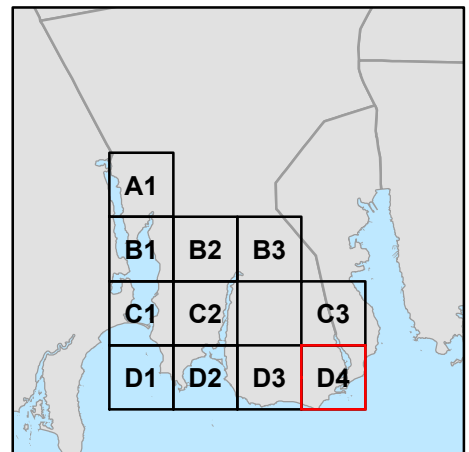
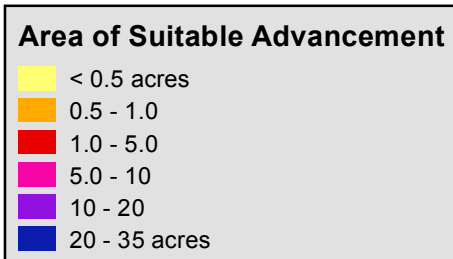
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