Shoreline Decision Tree

Good Shoreline Decisions Made Easy!

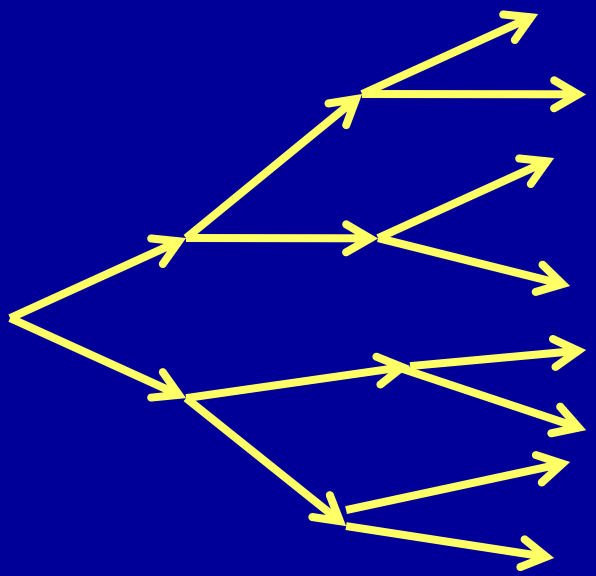
Center for Coastal Resources Management
Virginia Institute of Marine Science

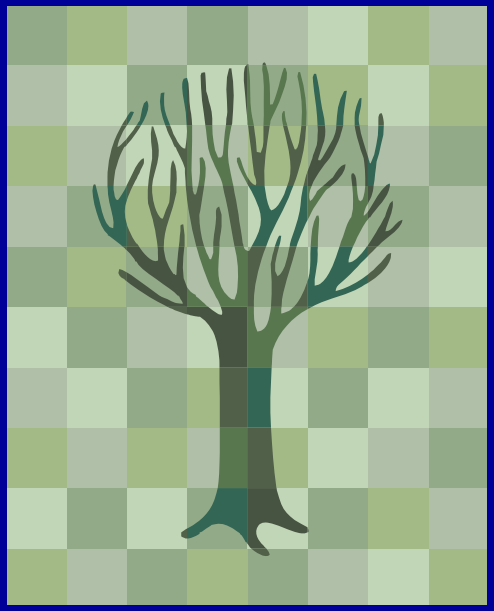
April 22, 2010

William & Mary
VIMS
Virginia Institute of Marine Science
School of Marine Science

What's a decision tree?

A tree-like graph of Q&A leading the user to a decision or recommendation





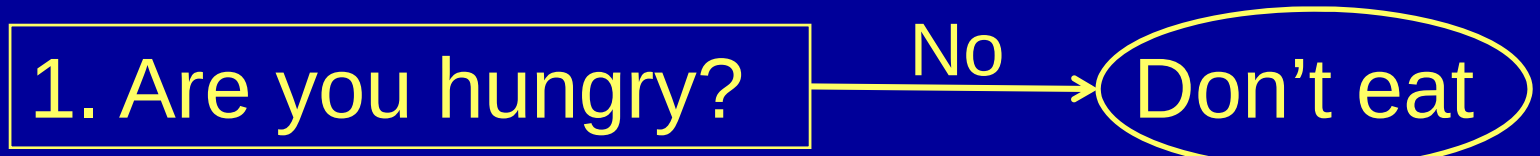
Decision Tree for Eating

Decision Tree for Eating

1. Are you hungry?

Decision Tree for Eating

Decision Tree for Eating



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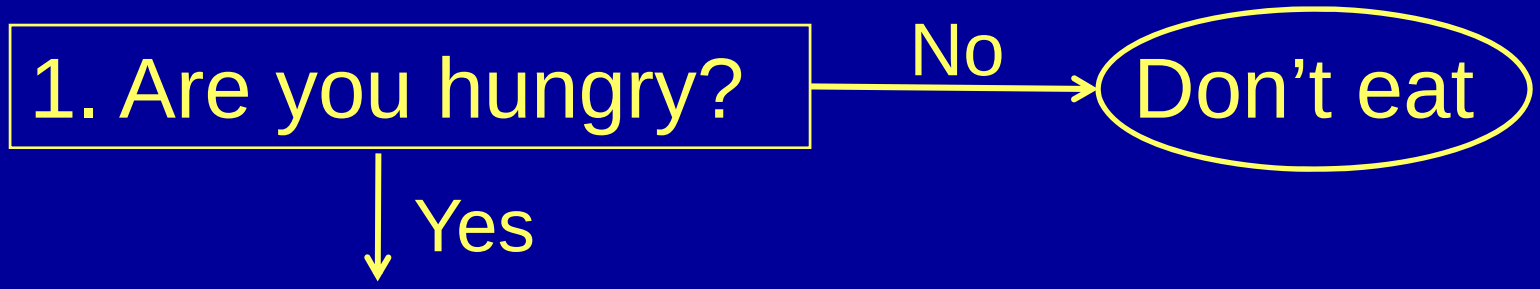
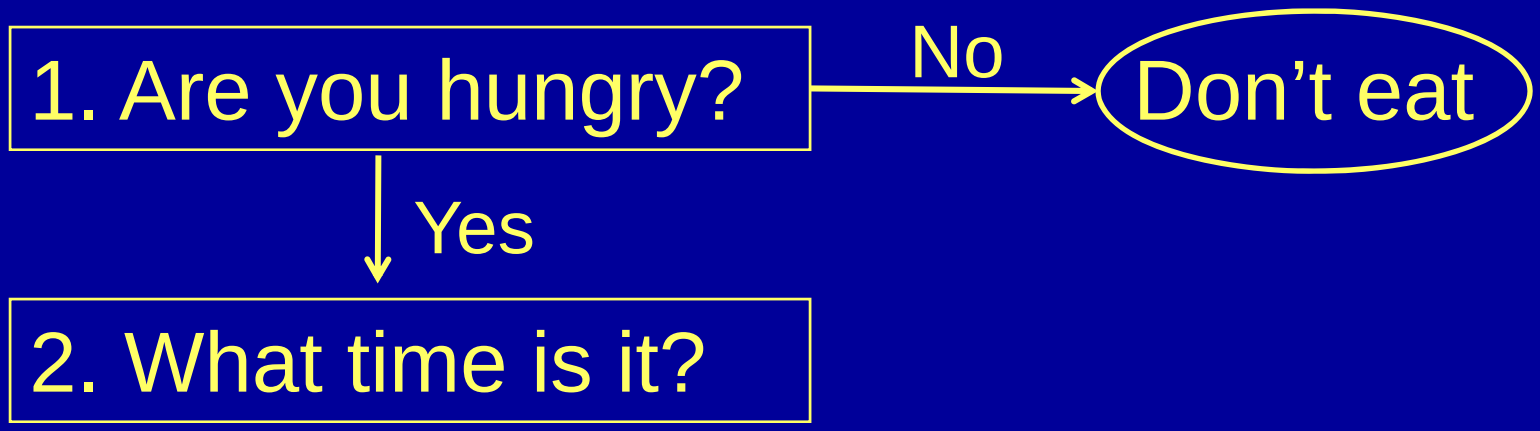


Decision Tree for Eating



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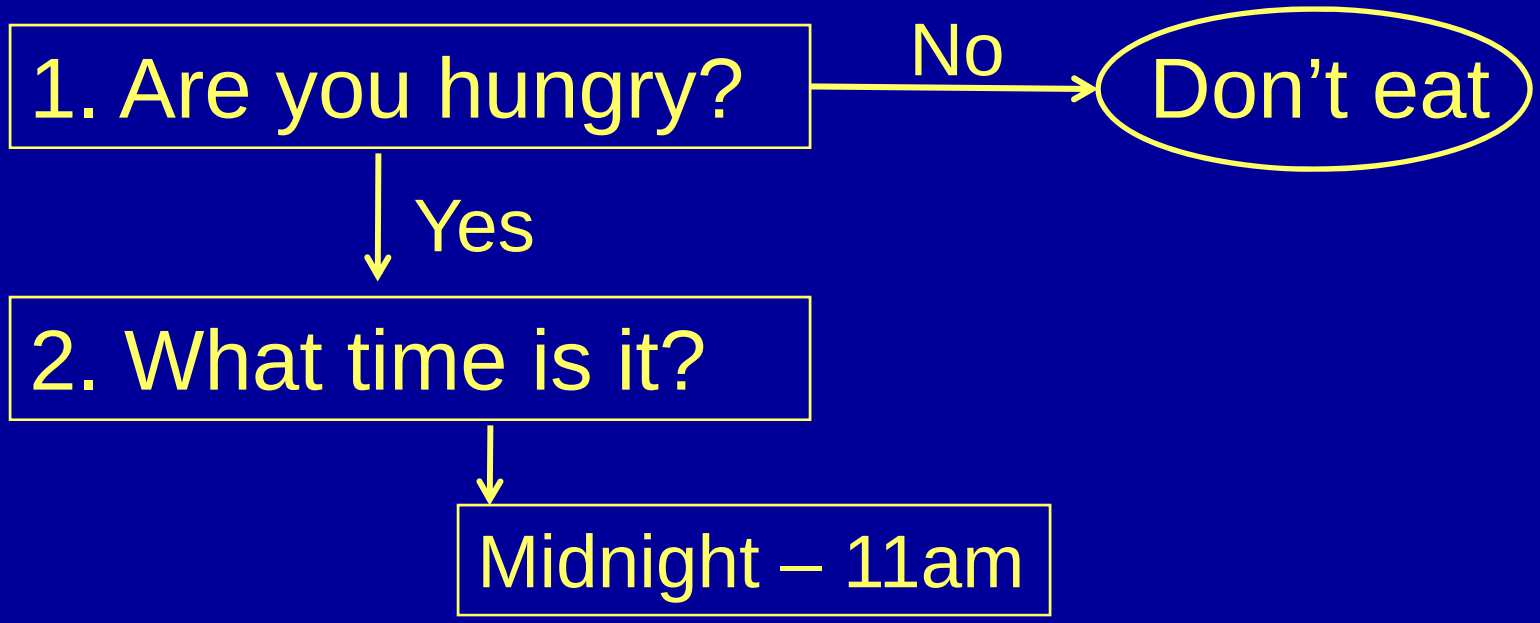

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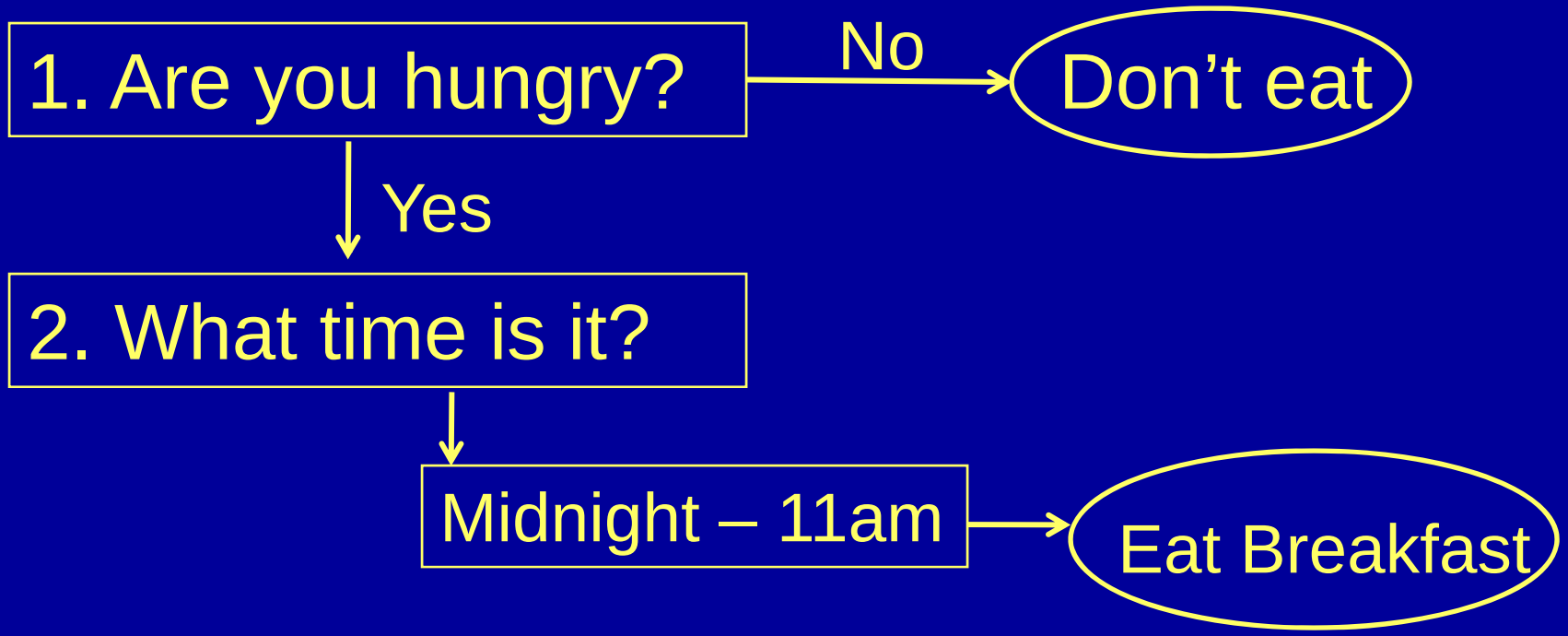
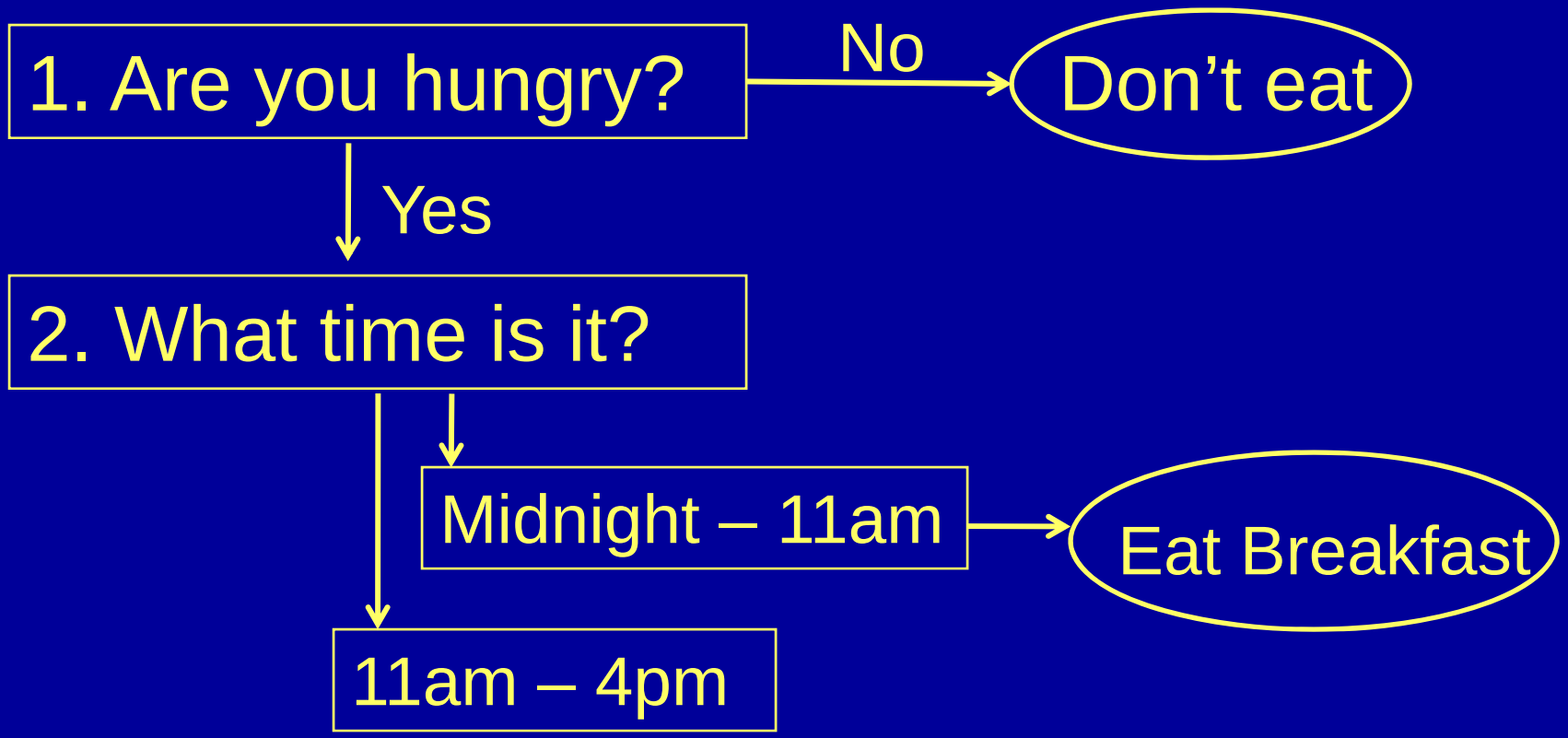


Decision Tree for Eating



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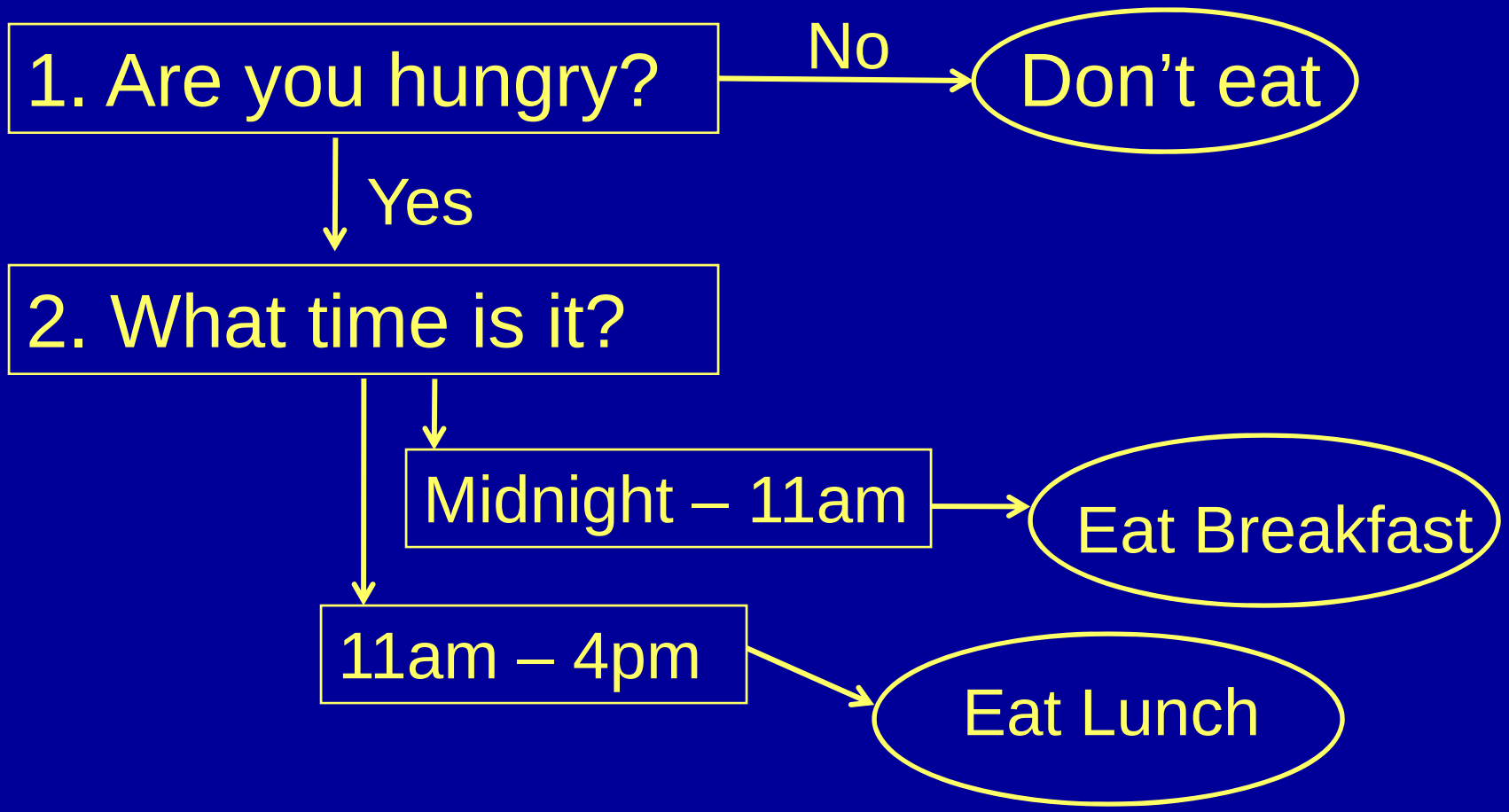

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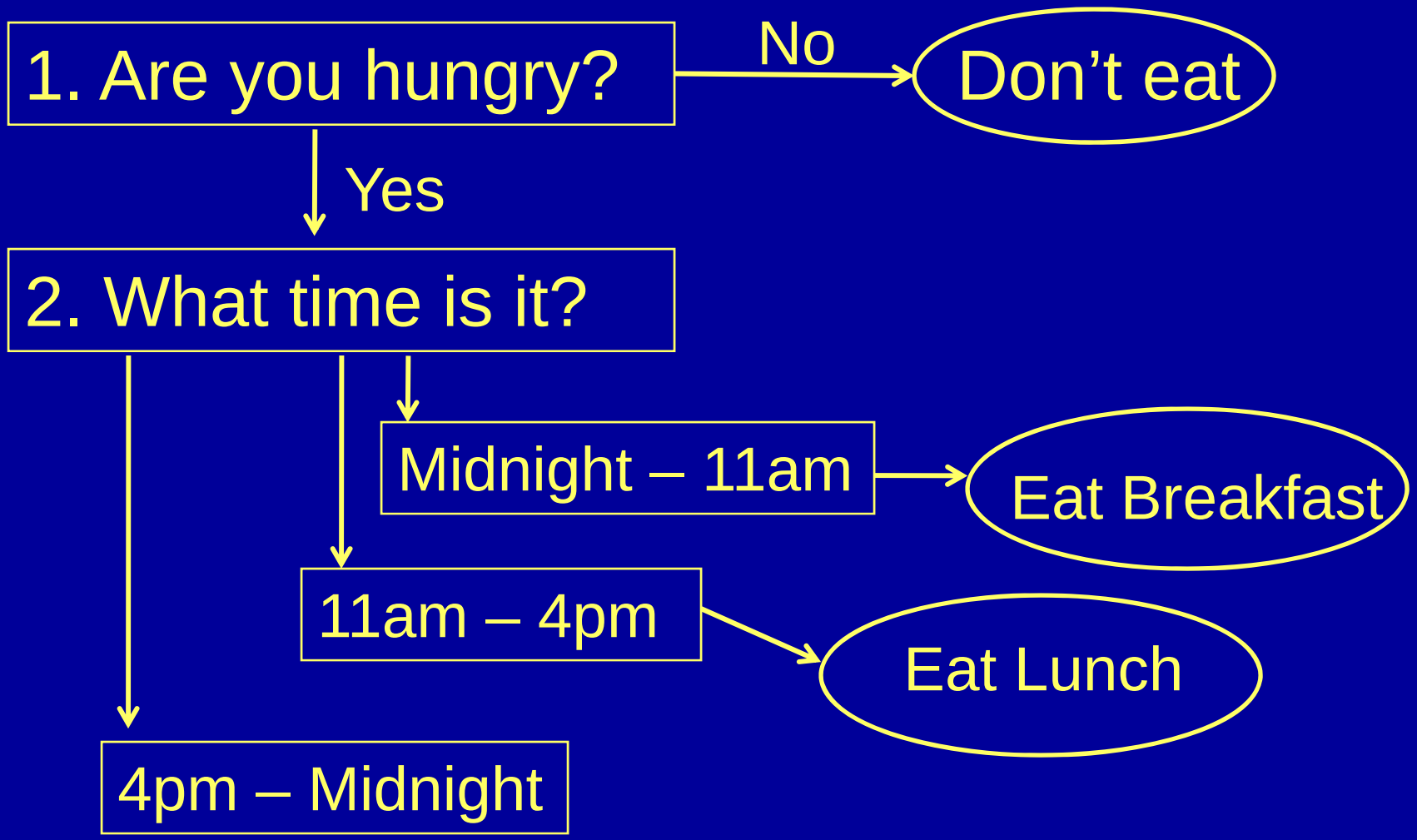
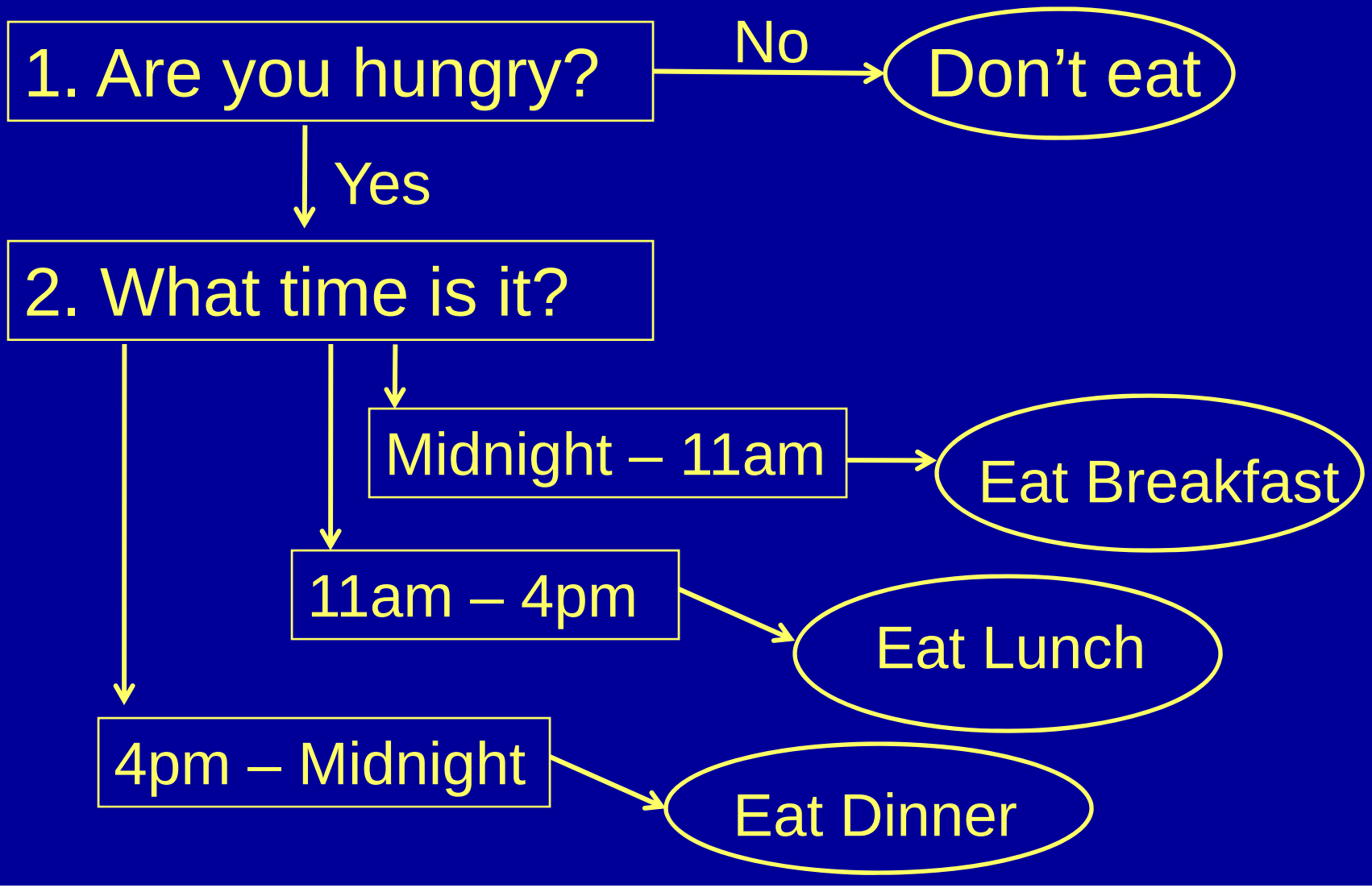
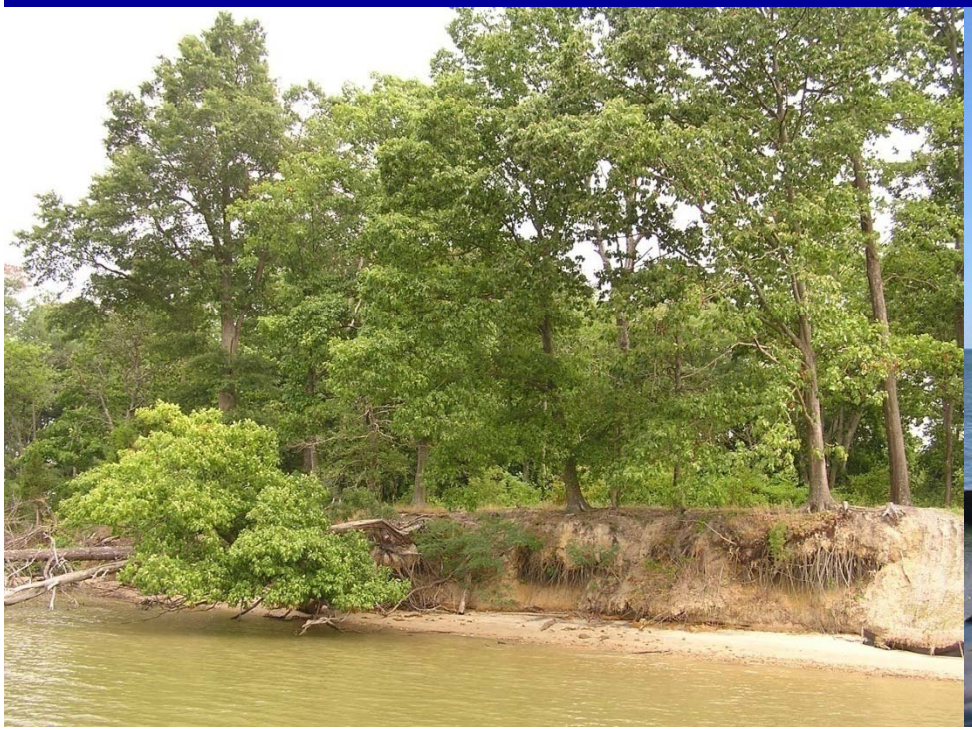


Decision Tree for Eating



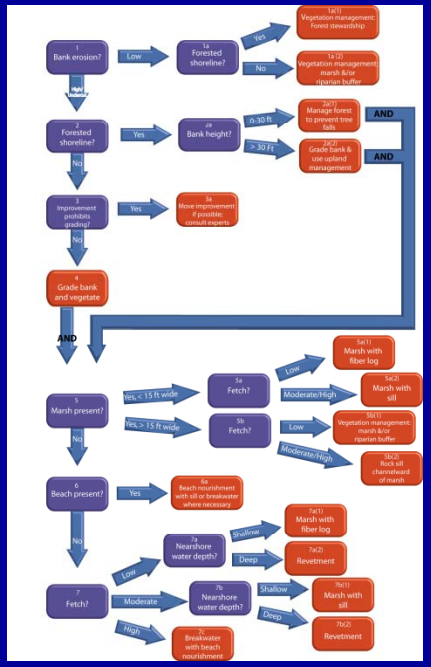
Decision tree for management of

- undefended shorelines and
- those with failed shoreline structures



Decision tree for shoreline management

The first of a suite of tools to help you make decisions regarding coastal resources.

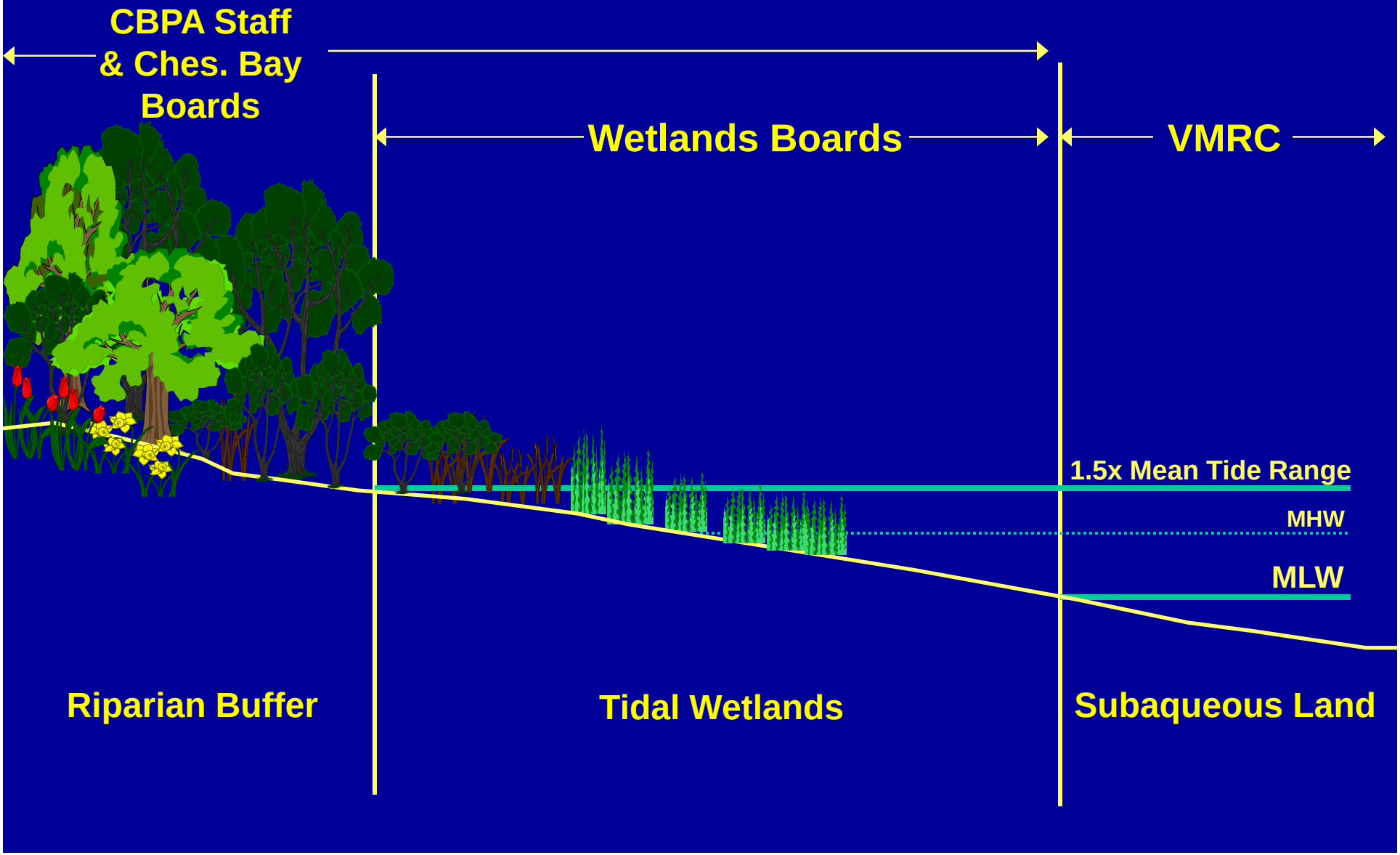


Decision tree for shoreline management

The first of a suite of tools to help you make decisions regarding coastal resources.

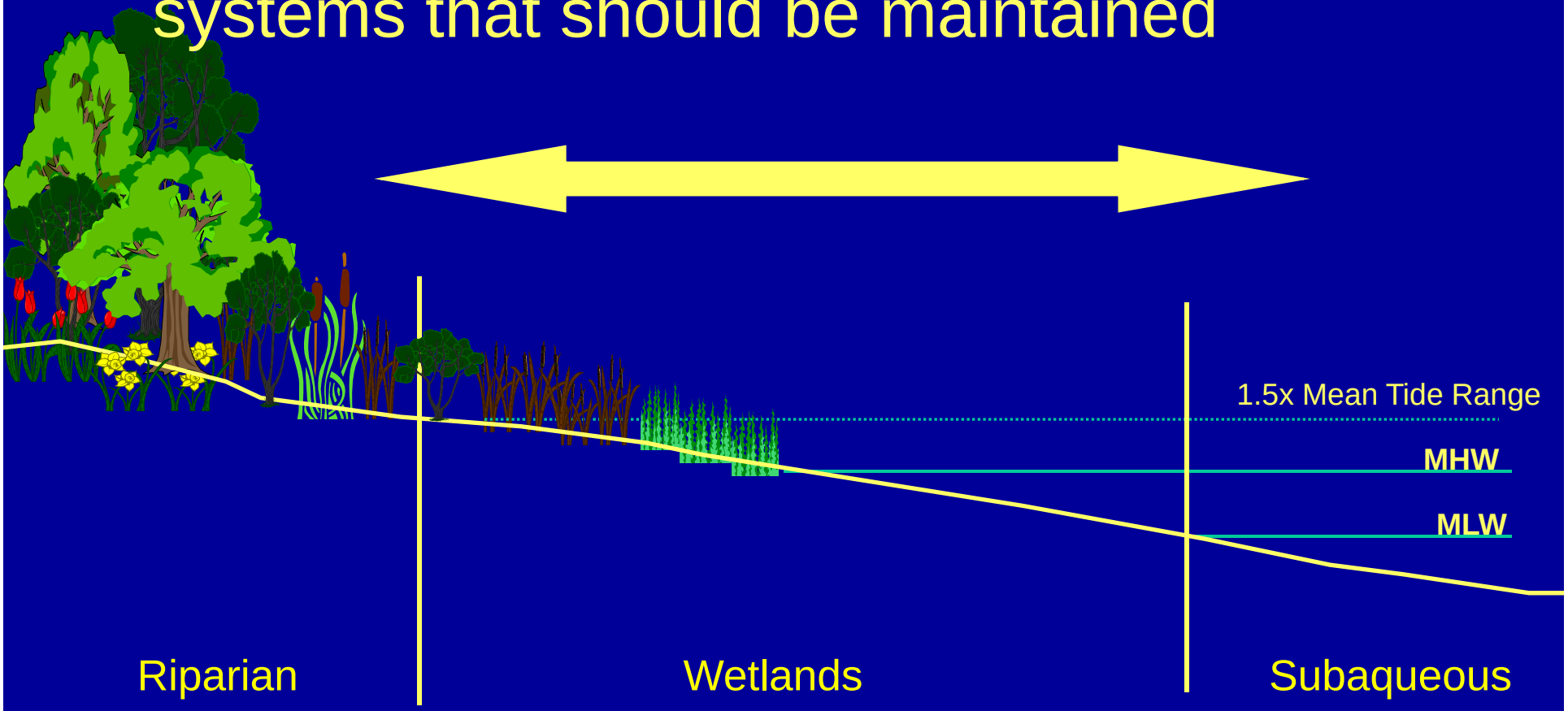
Driven by the principles of integrated shoreline management.

Even though Virginia's tidal shorelines are managed in small segments, they should be considered as a whole unit.



Integrated Approach

There are complex interactions between terrestrial and aquatic systems that should be maintained



Integrated Shoreline Management

Basic Goal:

- Avoid activities that adversely impact subaqueous, intertidal, and riparian zones in order to maintain habitat, water quality improvement and erosion control benefits of these areas

Integrated Shoreline Management

- Preferred approach: preserve, create, enhance the natural system (riparian forest, marsh, beach, dune, subaqueous bottom)

What's so great about the natural shoreline?

Ecosystem Services

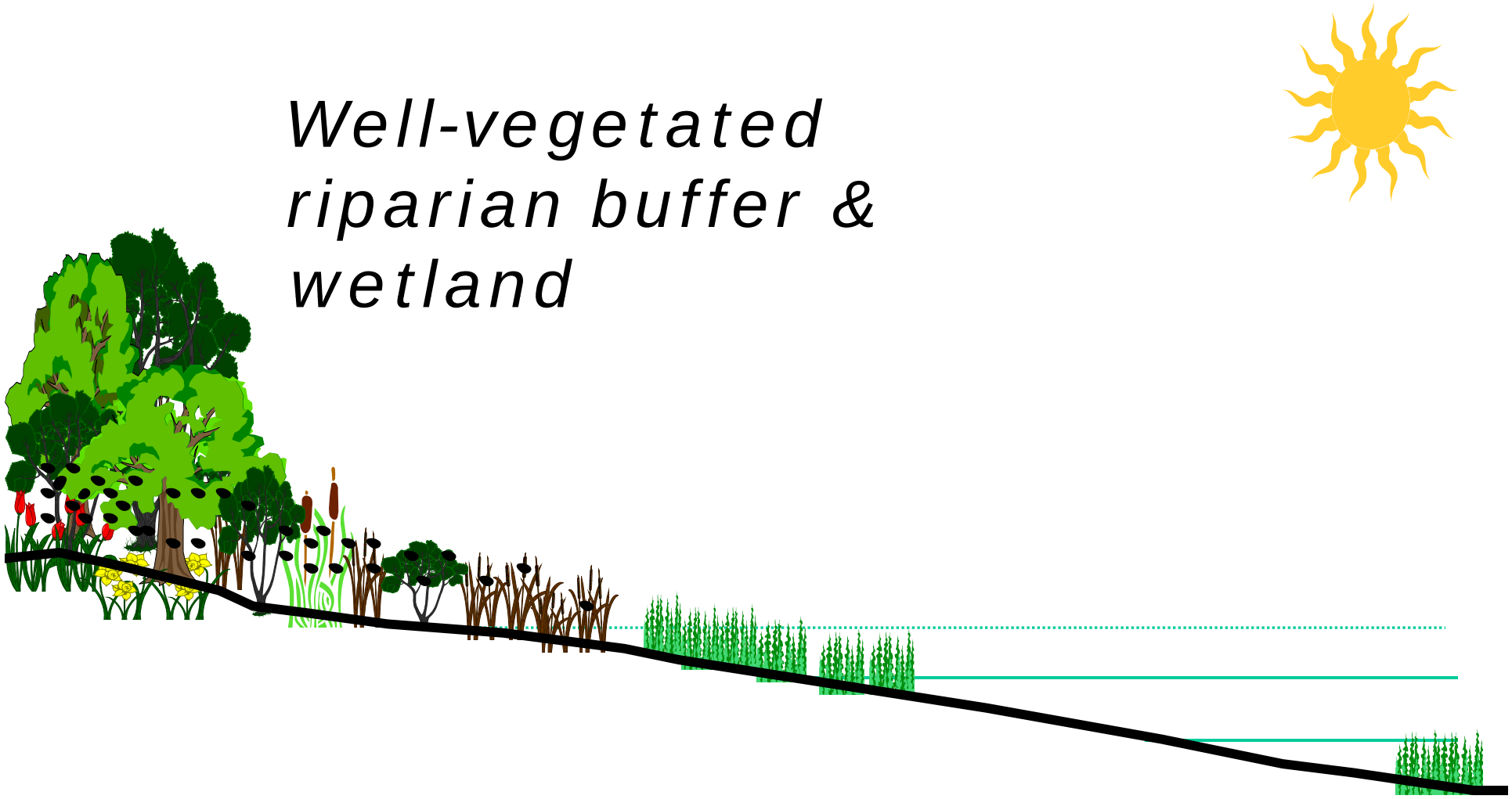
- Water quality improvement
- Stabilization/Erosion control
- Habitat

Ecosystem Services

- Water quality improvement
- Stabilization/Erosion control
- Habitat

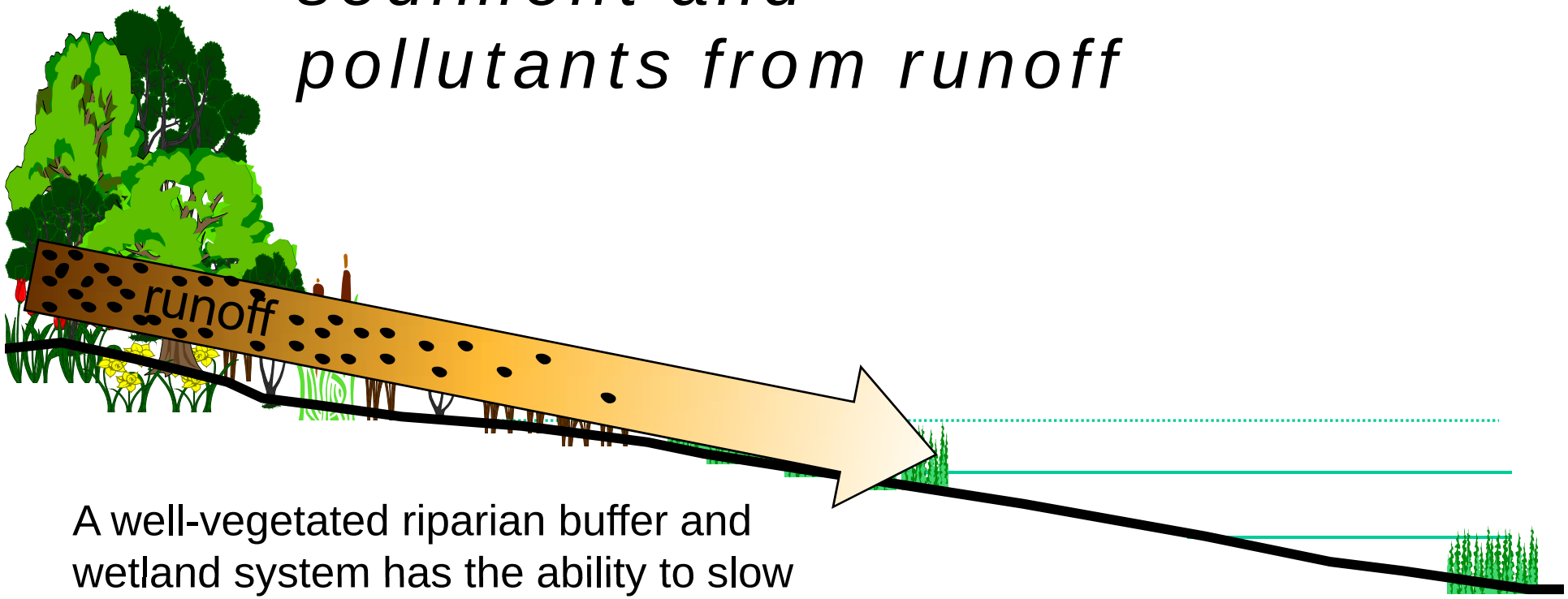
Water Quality Improvement

Well-vegetated riparian buffer & wetland



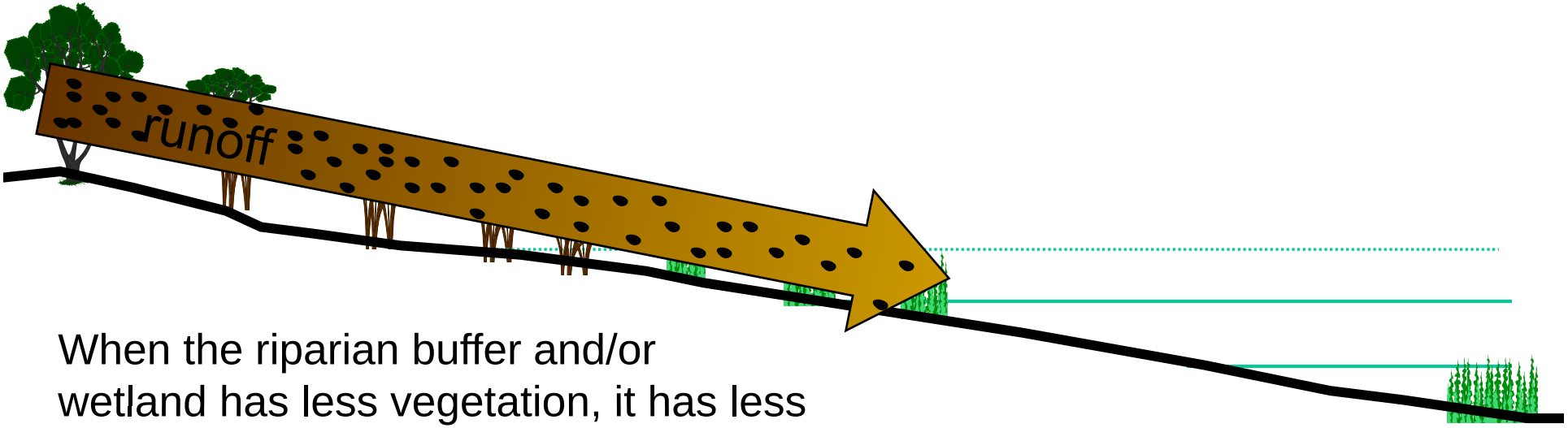
Water Quality Improvement

Plants remove sediment and pollutants from runoff



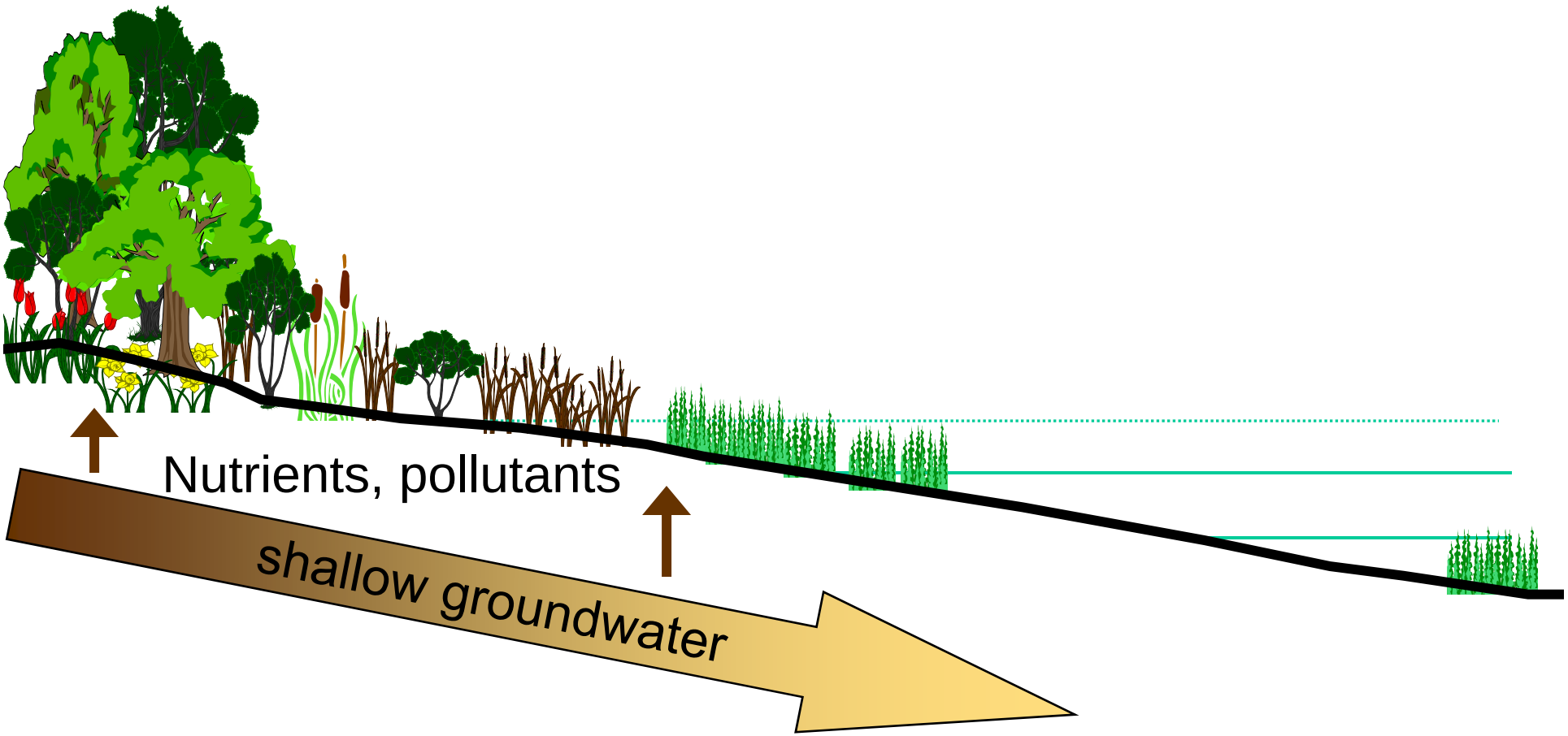
A well-vegetated riparian buffer and wetland system has the ability to slow the rate of flow and remove sediments from the surface water runoff.

Less vegetation =
Less sediment removed

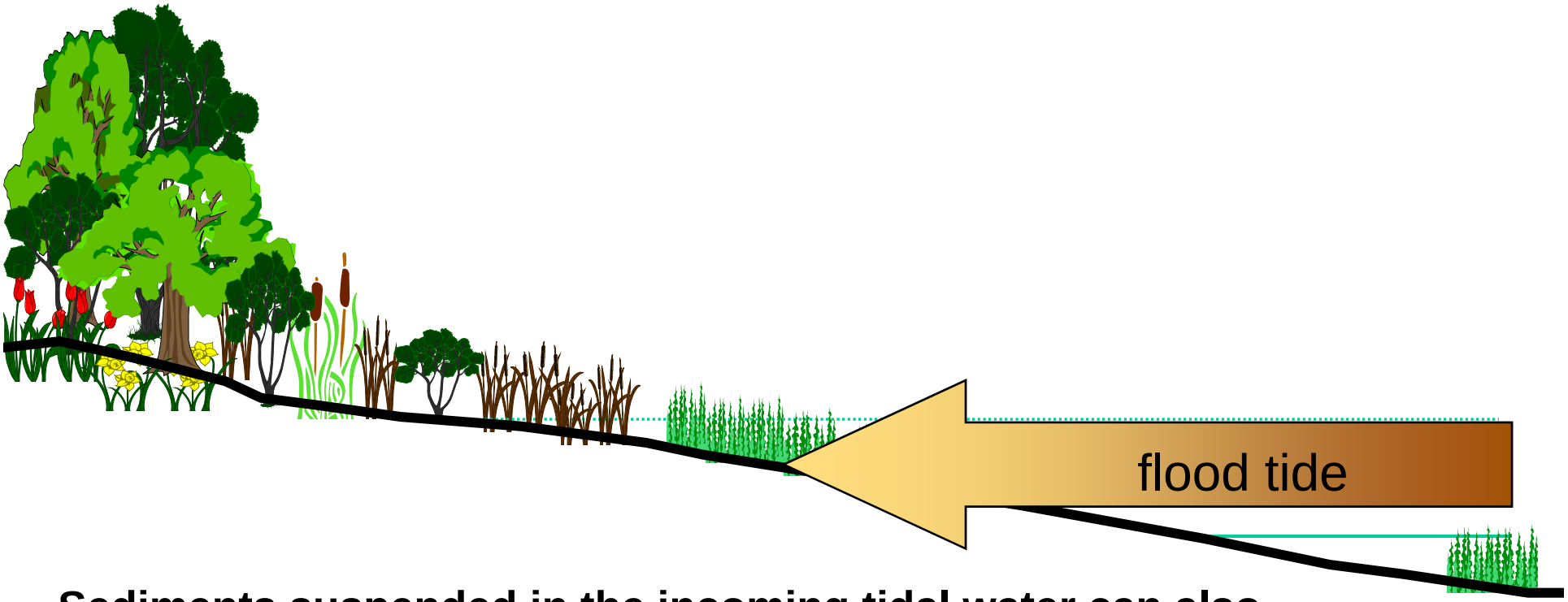


When the riparian buffer and/or wetland has less vegetation, it has less ability to remove sediment & pollutants from the runoff.

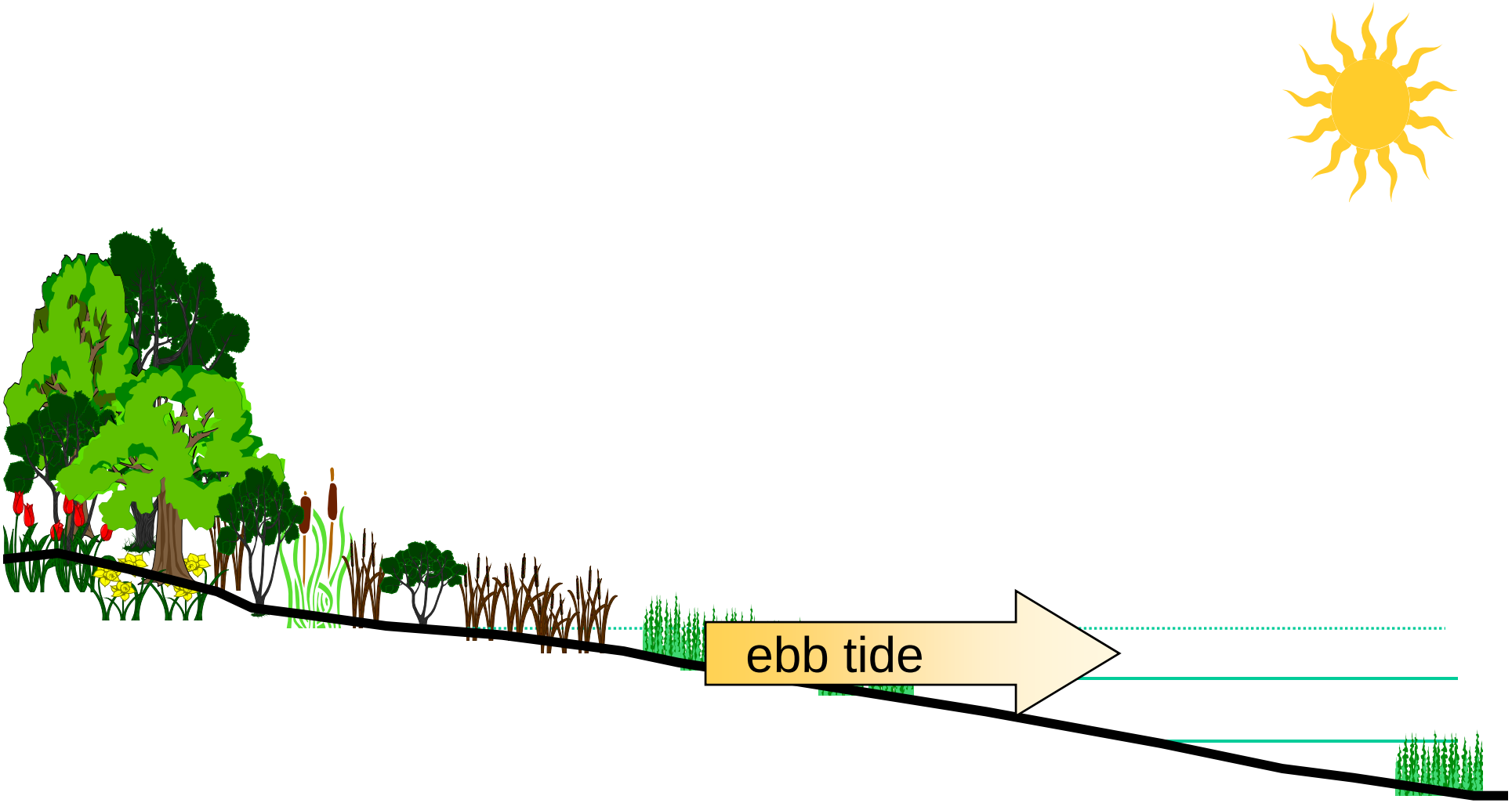
Plants remove pollutants and nutrients from groundwater



Plants remove sediments from tidal water



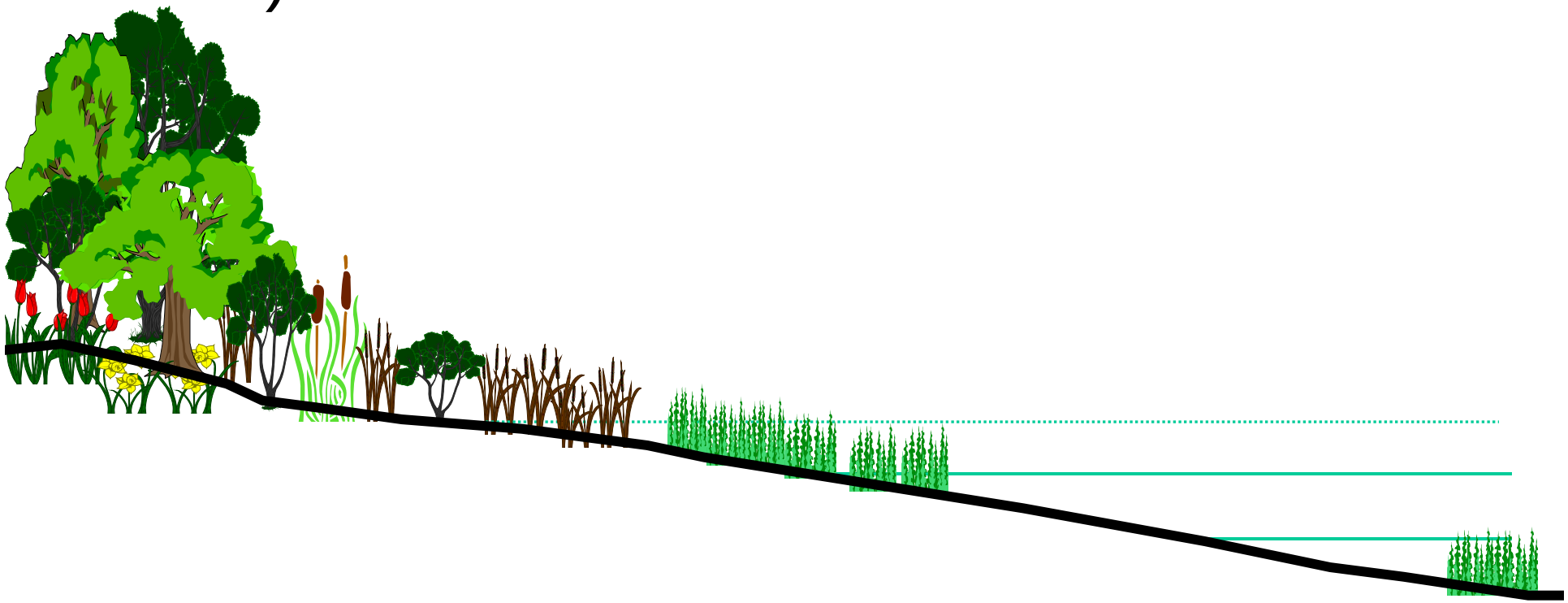
Sediments suspended in the incoming tidal water can also be removed by marsh plants….



…leaving the outgoing water cleaner than when it first washed over the marsh.

To maximize water quality benefits:

- Gentle, sustainable slope/stable bank
- Densely vegetated with mix of deep-rooted plants (grasses, shrubs, small trees)



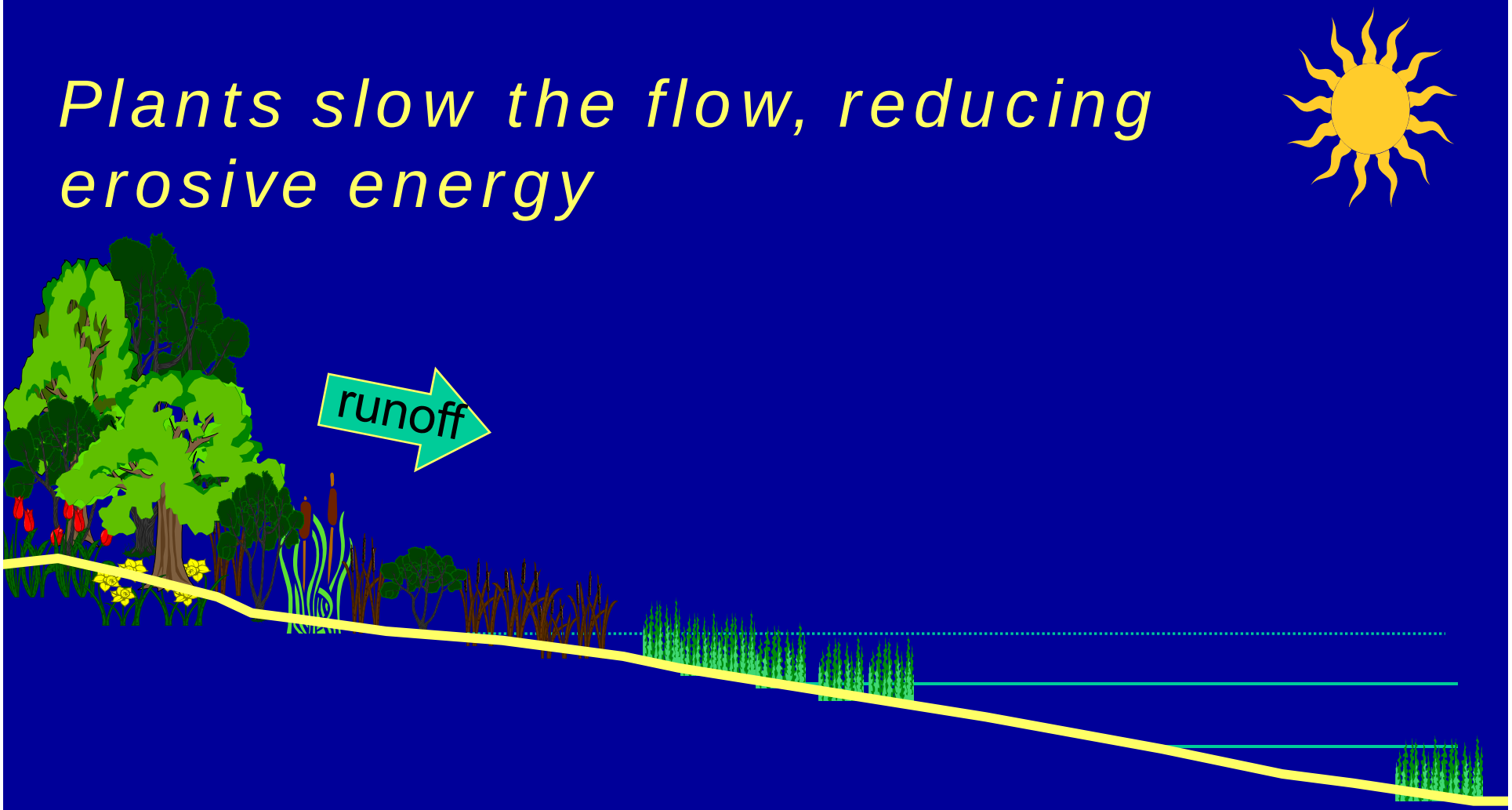
Ecosystem Services

- Water quality improvement
- Stabilization/Erosion control
- Habitat

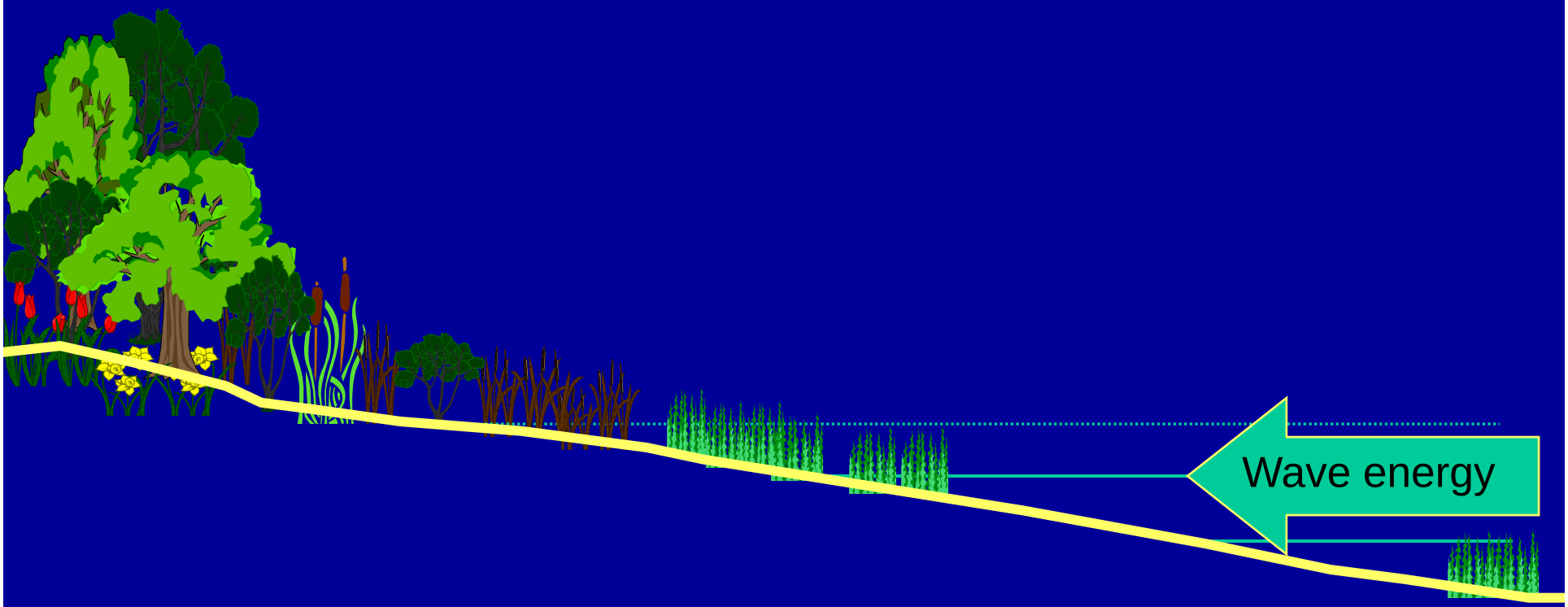
Stabilization/Erosion control

- Below the ground, roots & rhizomes stabilize soil/sediment
- Above the ground, flowing water is slowed by stems

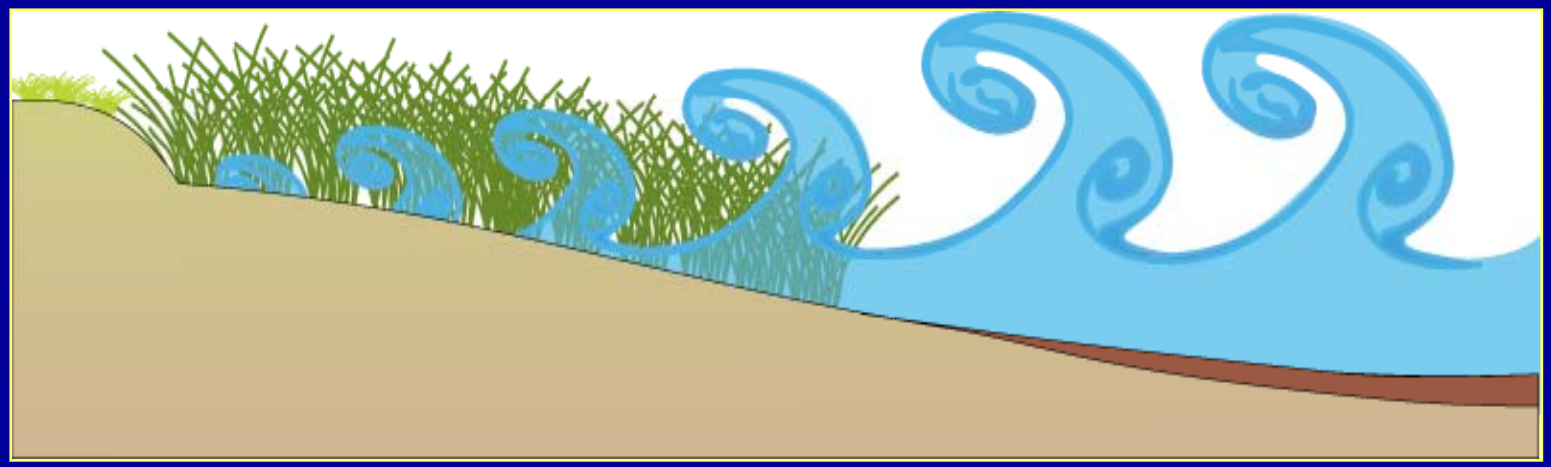
Plants slow the flow, reducing erosive energy



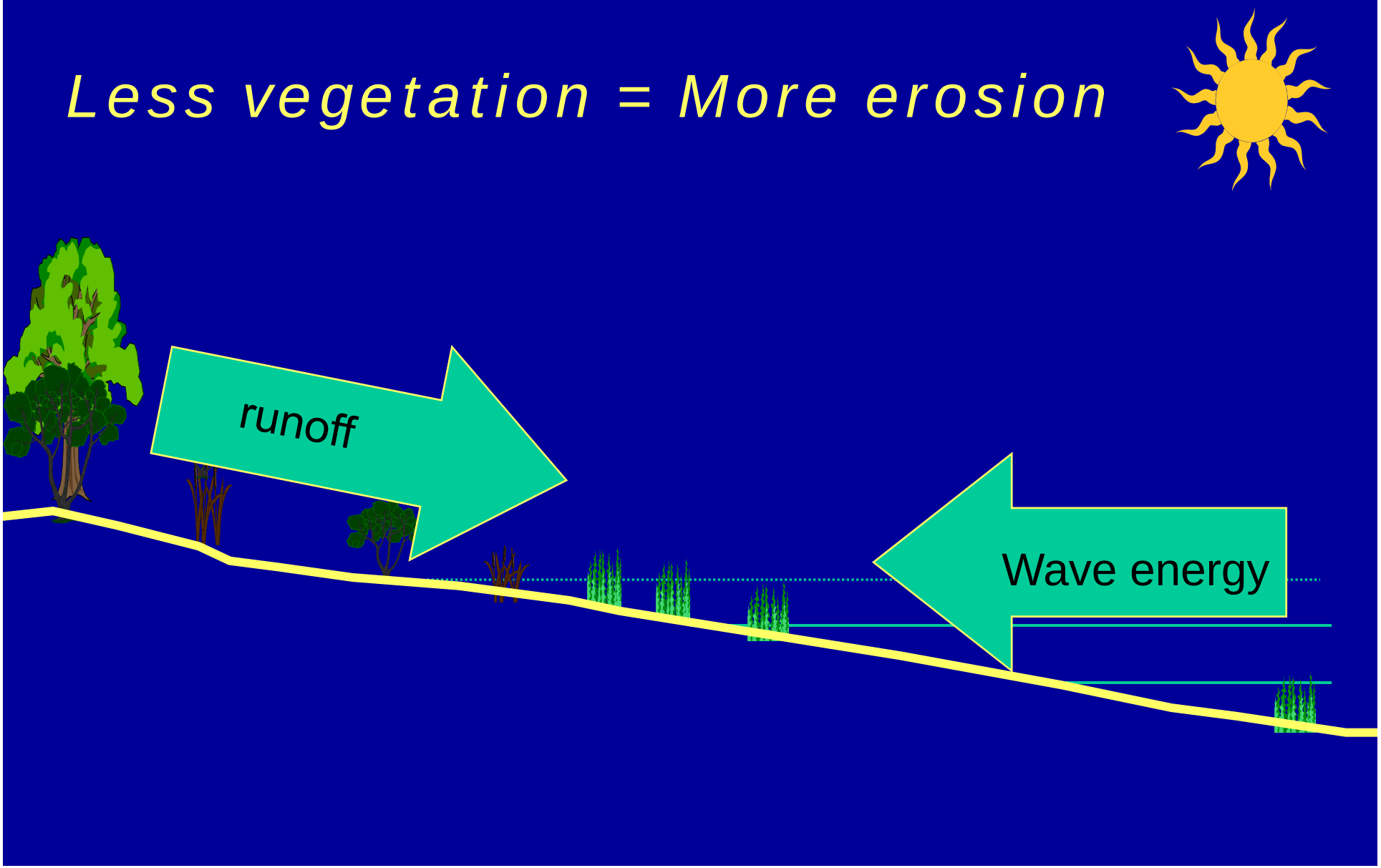
Marsh plants slow incoming waves, reducing their erosive energy.



Marsh reducing wave energy



Less vegetation = More erosion



Beaches & dunes are also important in erosion control/shoreline stabilization.

Dune plants trap wind blown sand, the sand & plants reduce storm energy similar to marshes, especially in winter

Dune plants are adapted to periodic flooding, burial & infertile, dry sand

Ecosystem Services

- Water quality improvement
- Stabilization/Erosion control
- Habitat

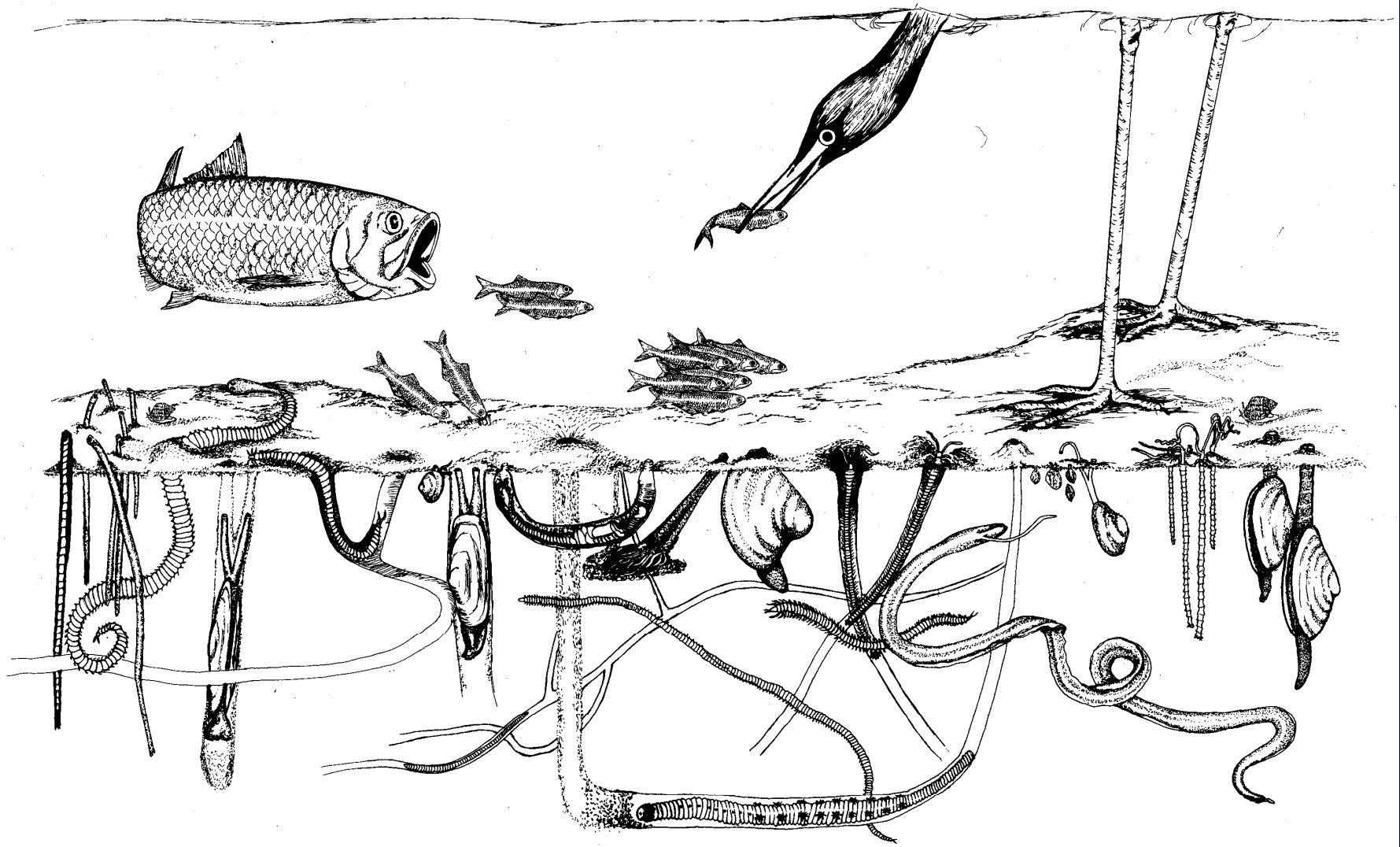
Habitat

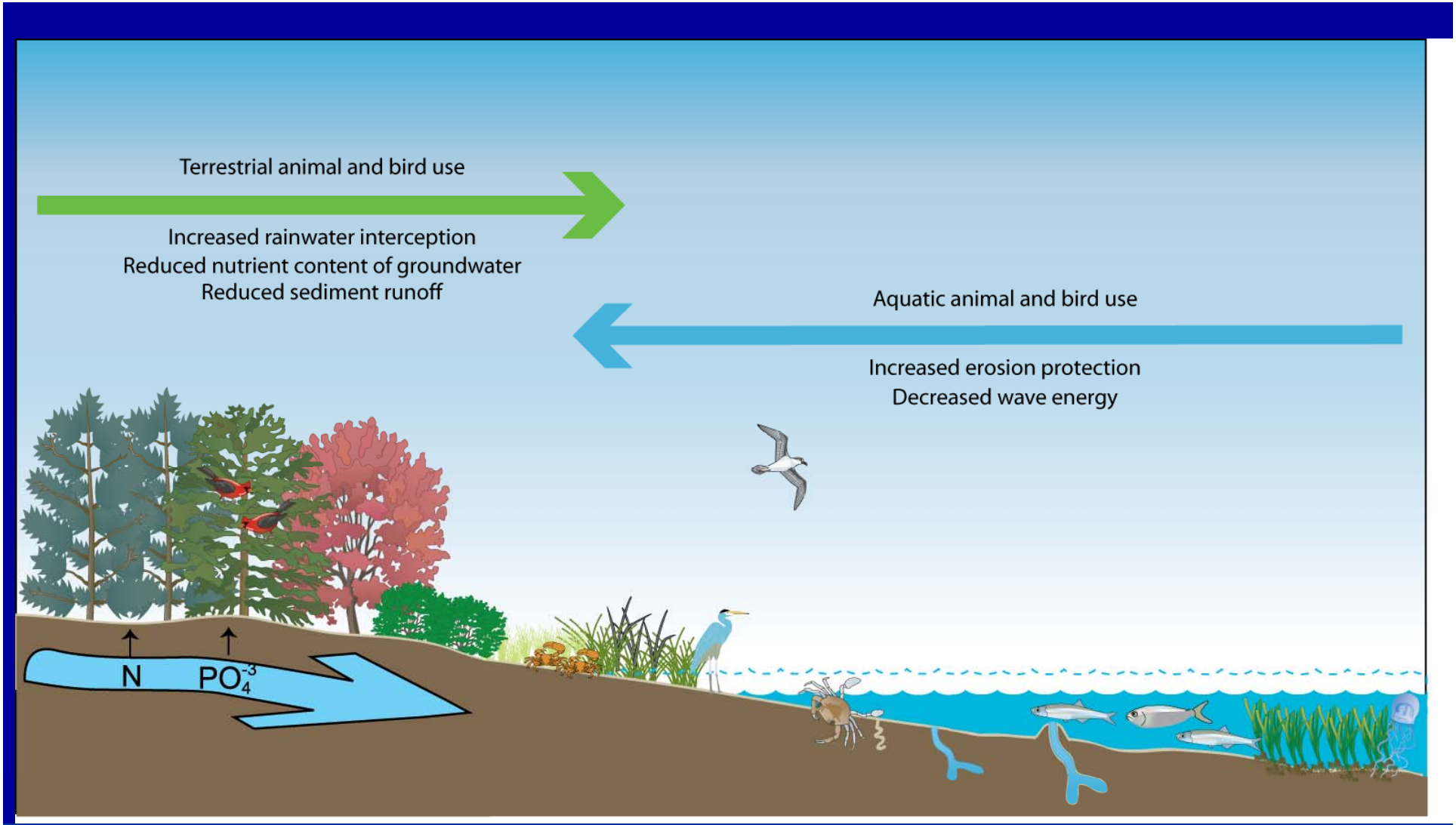
- Spawning Area
- Nursery For Juvenile Fish
- Shelter From Predators
- Food
- Nesting Sites

Tidal shorelines provide habitat for the familiar…

Blue Crab – especially juveniles

…as well as the lesser known substrate dwellers.



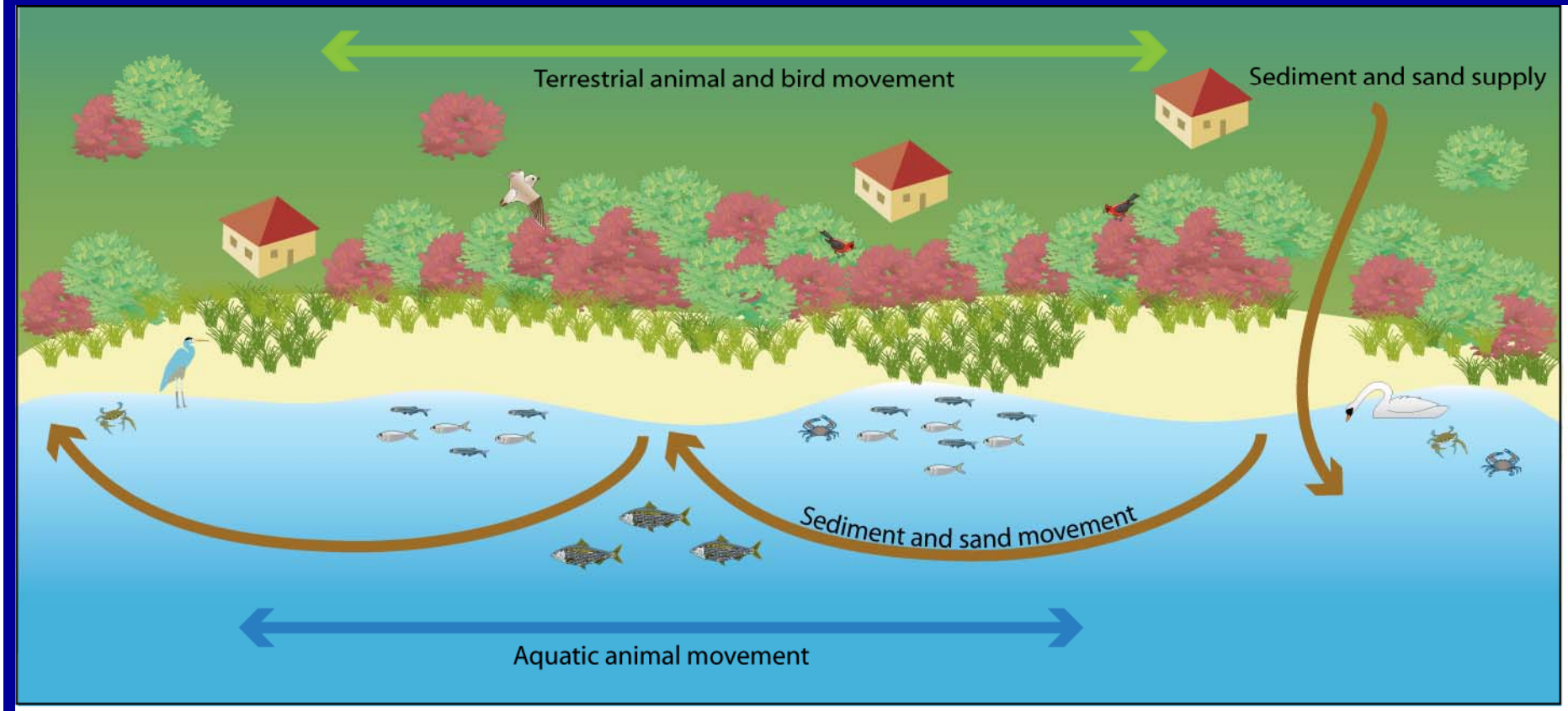


Cross-shore connections

The natural forested riparian buffer provides habitat for a wide variety of animals. Terrestrial, or land-dwelling, animals often make use of the adjacent tidal wetlands, as do aquatic animals.

Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for

Alongshore connections

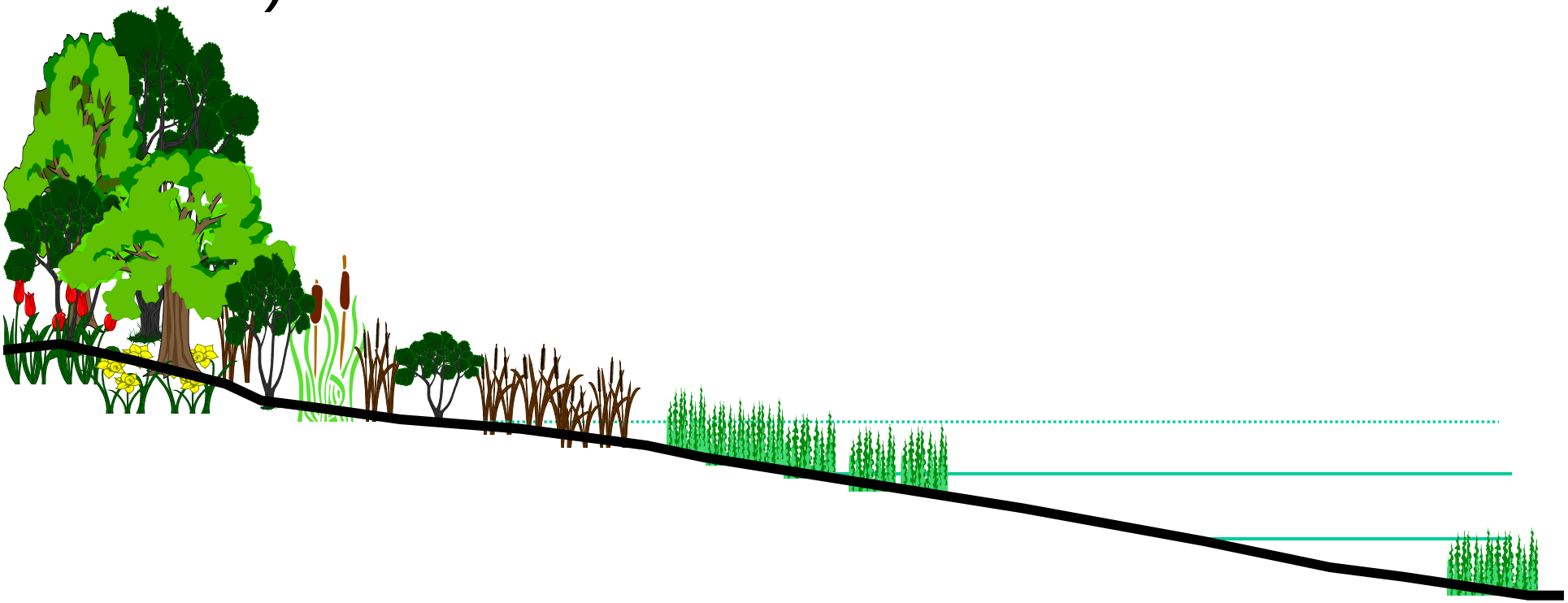


Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science

Ecosystem services such as habitat provision also must be considered from an alongshore perspective, in addition to the cross shore perspective. Each section of shoreline can affect, and is affected by, upstream and downstream shorelines. Aquatic and terrestrial animals move along the shore as well as on and offshore, and riparian and wetland habitats along the shore provide corridors for animal movement up and downstream.

To Maximize Ecosystem Services:

- Gentle, sustainable slope/stable bank
- Densely vegetated with mix of deep-rooted plants (grasses, shrubs, small trees)



Good example of a natural shoreline:

Traditional shoreline stabilization approaches:

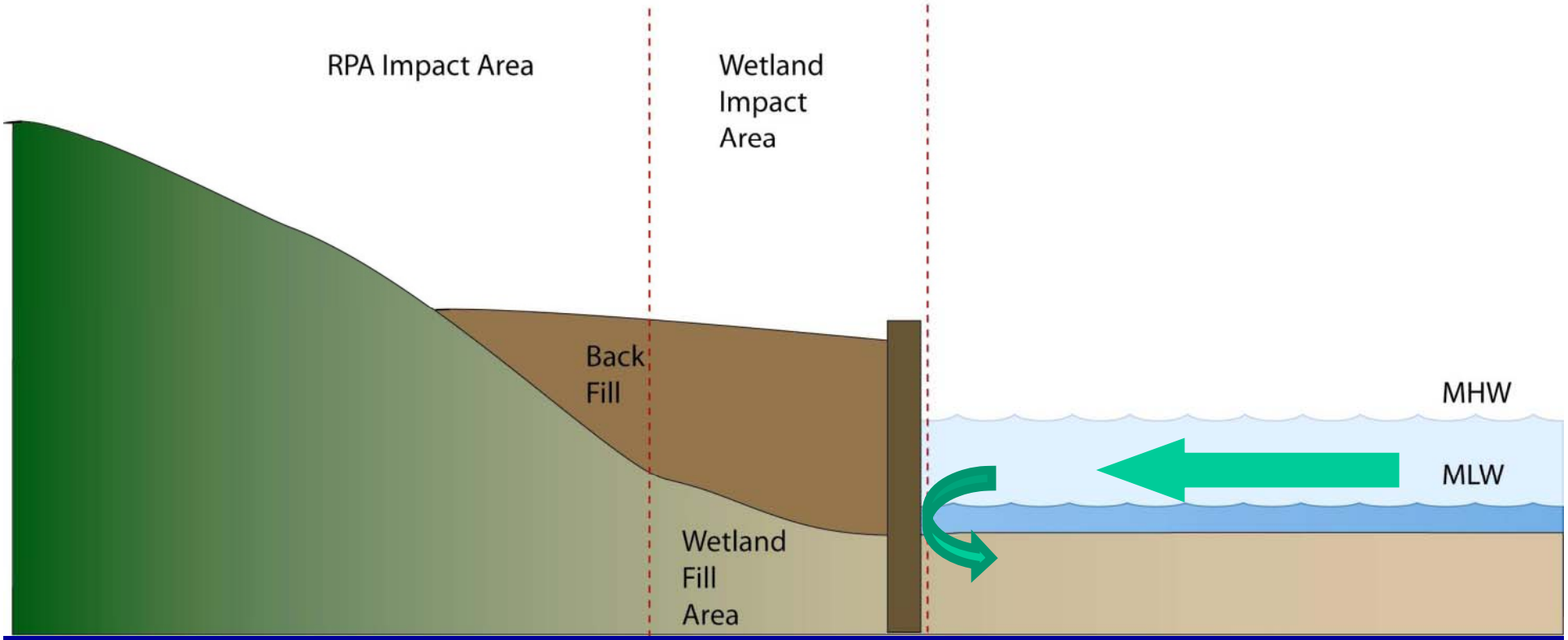
- Bulkheads & Riprap Revetments
- Clearing & Grading
- Lawn establishment & maintenance

How do they impact ecosystem services?


Bulkheads & Riprap Revetments
…sever the natural connection between upland and wetland

Bulkhead Problems
Reflected Wave Energy

Bulkhead cross-section



Incoming wave energy is reflected and scours the bulkhead toe.

Beaches & marshes in front of bulkheads gradually disappear due to reflected wave energy and rising sea level

Revetment Advantages over Bulkheads:

- Long life expectancy 50+ yrs
- Natural material

However, they still sever the cross shore connections

Clearing and Grading

- If not replanted, loss of habitat and ability to improve water quality

Lawn establishment and maintenance

- Lawn not as effective in surface water quality improvement or sediment stabilization
- Not deep-rooted, so not as effective in groundwater quality improvement or in slowing runoff
- Use of fertilizers, pesticides, and herbicides adversely affects water quality

Is there a better approach?

Can we protect the shoreline and retain ecosystem services?

Integrated Shoreline Management

- Preferred approach: preserve, create, enhance the natural system (riparian forest, marsh, beach, dune, subaqueous bottom)
- Each shoreline has a preferred shoreline treatment (or range of treatments), determined by shoreline type & erosion risk.

General order of preference of shoreline treatments

- No Action
- Grading / planting / pruning
- Hybrid
- Structural

Not all erosion is bad

Eroding shorelines and sediment added to the Bay from upland runoff provide the sand for beaches….

…and the sediment that allows marshes to grow in elevation and (hopefully) keep pace with sea level rise.

General order of preference of shoreline treatments

- No Action
- Grading / planting / pruning
- Hybrid
- Structural

Marsh Planting

Use tidal wetland vegetation to reduce wave energy and wave action against the upland bank .

Enhance existing fringe marshes or create new ones where they do not occur naturally.

Bank Grading

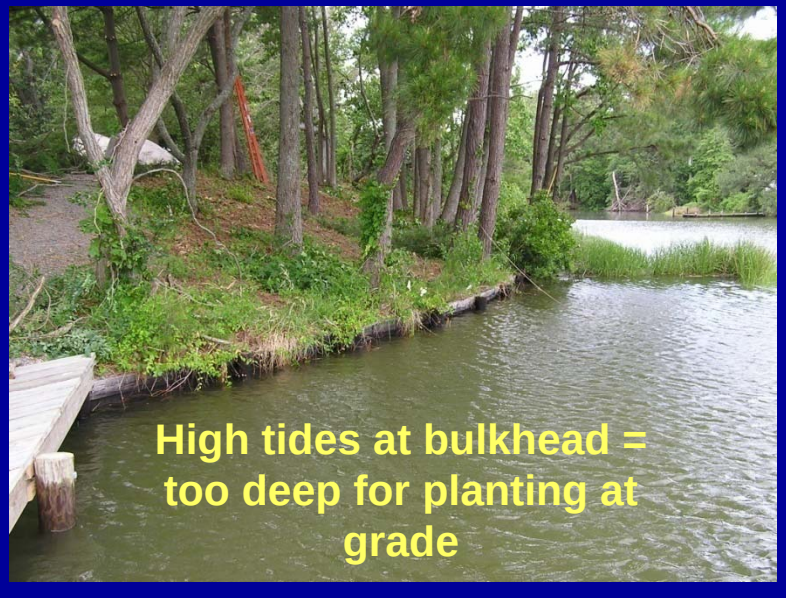
- Changing the slope of the bank to achieve a stable slope
- Not suitable for stable, forested banks
- Can be combined with planted marshes
- Bank vegetation should be restored, not mowed often

Selectively prune limbs that shade intertidal zone

Coir or Fiber Logs

- Manufactured biodegradable logs
- Provide temporary wave reduction for planted marsh vegetation
- Stabilize bank after tree removal or bank grading
- Biodegradable within 3 - 5 yrs

Before – failing timber bulkhead



After - fiber logs + sand fill + plants

Holly Point Nature Park - Deltaville, VA

Wide eroding marsh

Marsh Toe Revetment

Stabilizes the eroding edge of an existing tidal marsh that already provides adequate erosion protection for the upland.

Marsh Sill at Hull Springs Farm

Westmoreland County

January 2007

- Narrow intertidal area
- Patchy wetland vegetation
- Bank grading not possible due to historic tree

Marsh Sill at Hull Springs Farm

August 2008

1. 25 feet of sand fill with gapped sill
2. Planted with saltmarsh cordgrass and saltmeadow hay by volunteers

Marsh Sill at Hull Springs Farm

June 2009

1. Temporary strings to protect planted grasses from grazing mute swans and Canada geese
2. Good plant survival in spite of shading and northeast exposure

Beach Nourishment

- Place clean sand fill on an existing beach shoreline.
- Enhance the width and/or height of the beach profile.

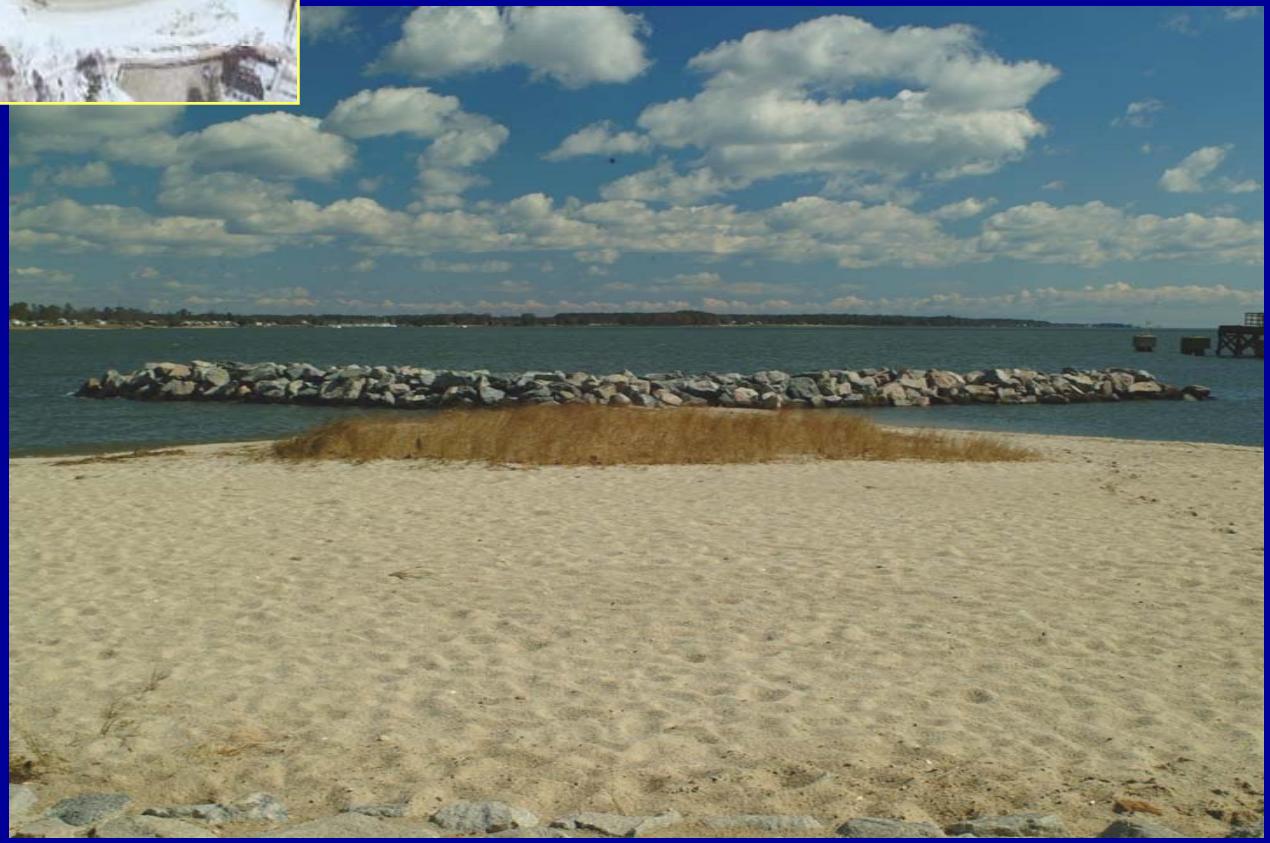
A created beach and dune at VIMS

Planted Dunes

- For additional stabilization.
- Dune vegetation traps wind-blown sand, which increases the beach profile height and provides wave dissipation during storms.

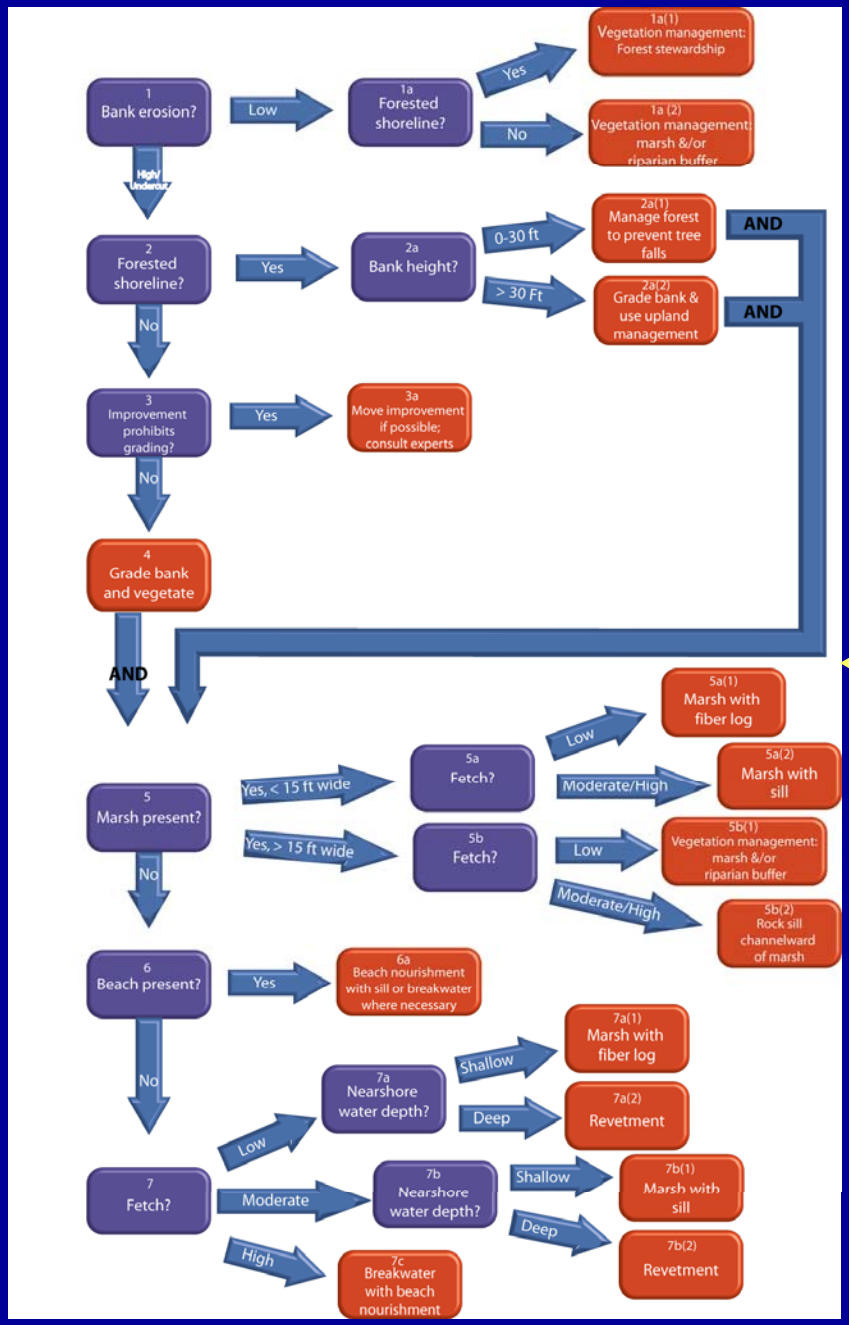
Breakwaters

For higher energy, sandy systems



Choice of shoreline treatment

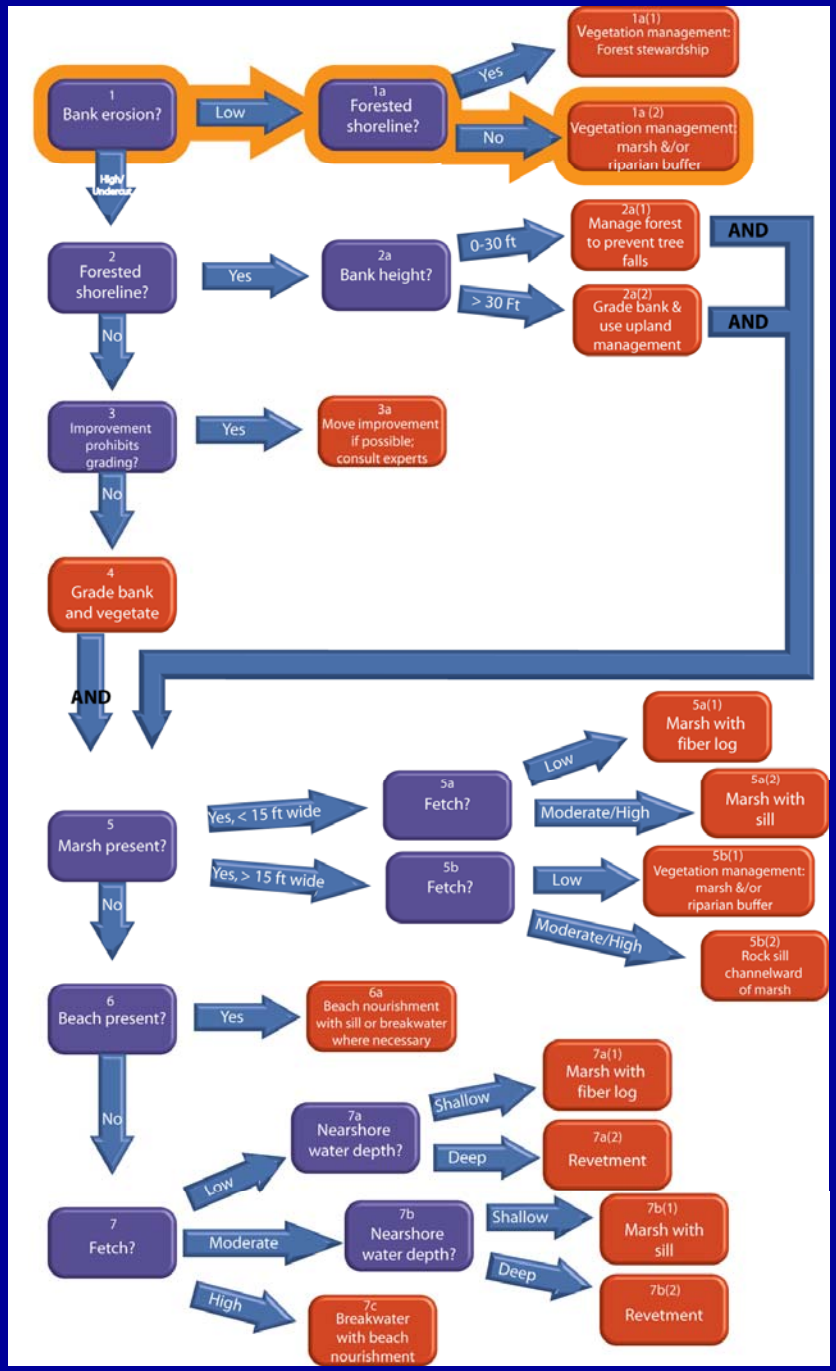
- Depends on shoreline conditions and energy
- The goal is always to enhance/maintain ecosystem services
- Tradeoffs in conversion of one type of shoreline to another



This is the tree

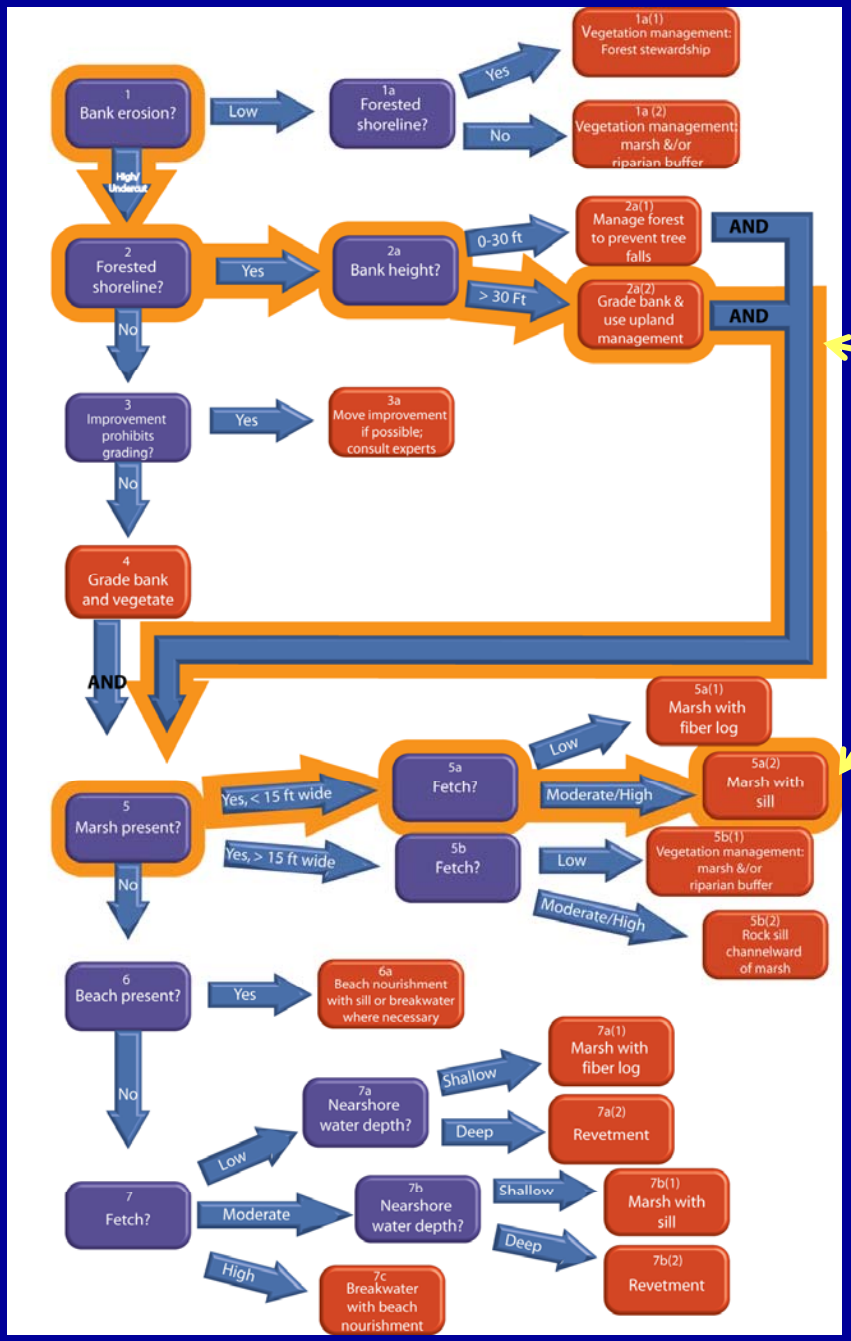
You can download a copy at:

http://ccrm.vims.edu/Spring2010.html



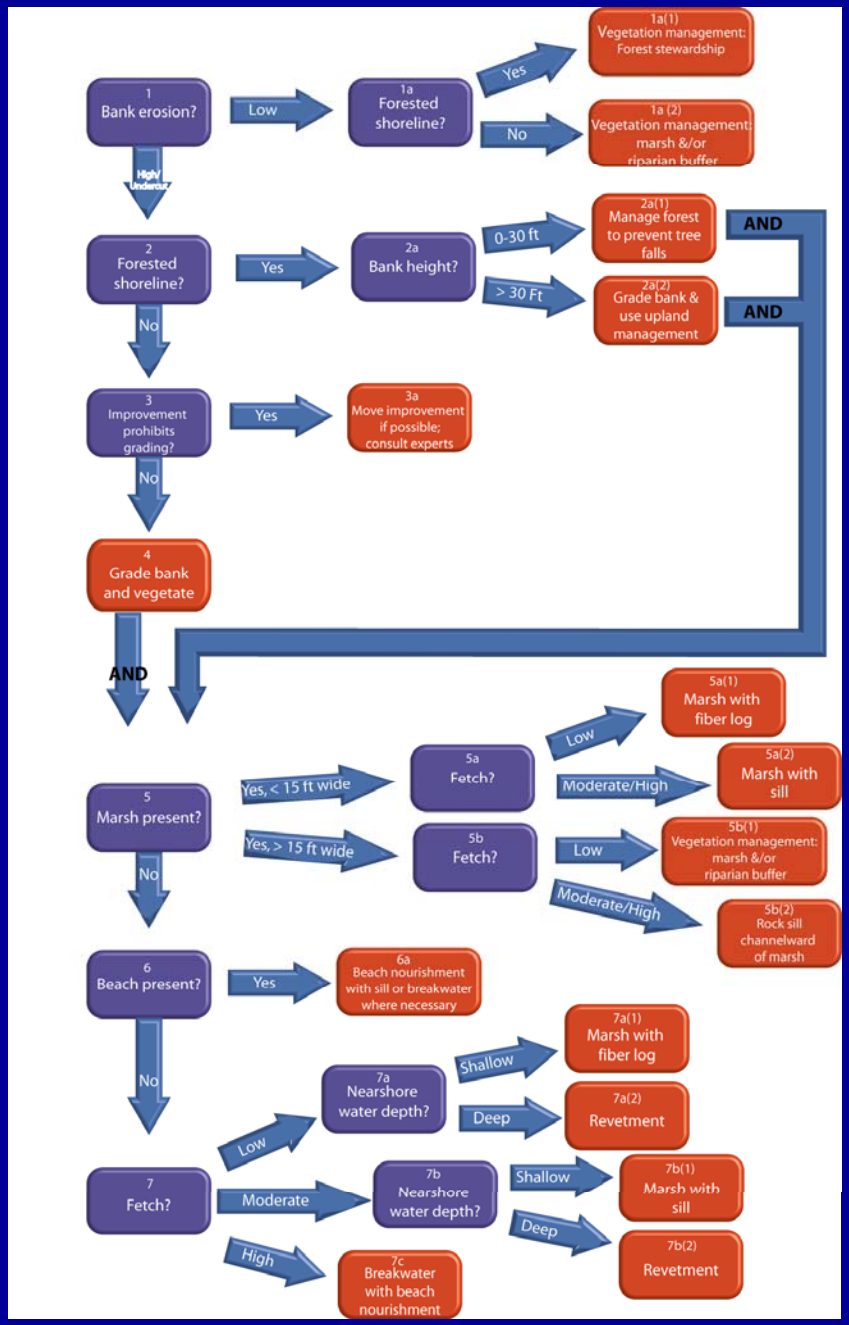
When you use a tree, follow the branches that describe your location.

Recommendations are in red boxes



Sometimes you may get multiple answers–

Use both recommendations on the shoreline for improved erosion protection



Let's get started!

We'll work through a few cases

➢1. Is there bank erosion?

This is the first question to be answered. There are 3 types/levels of erosion.

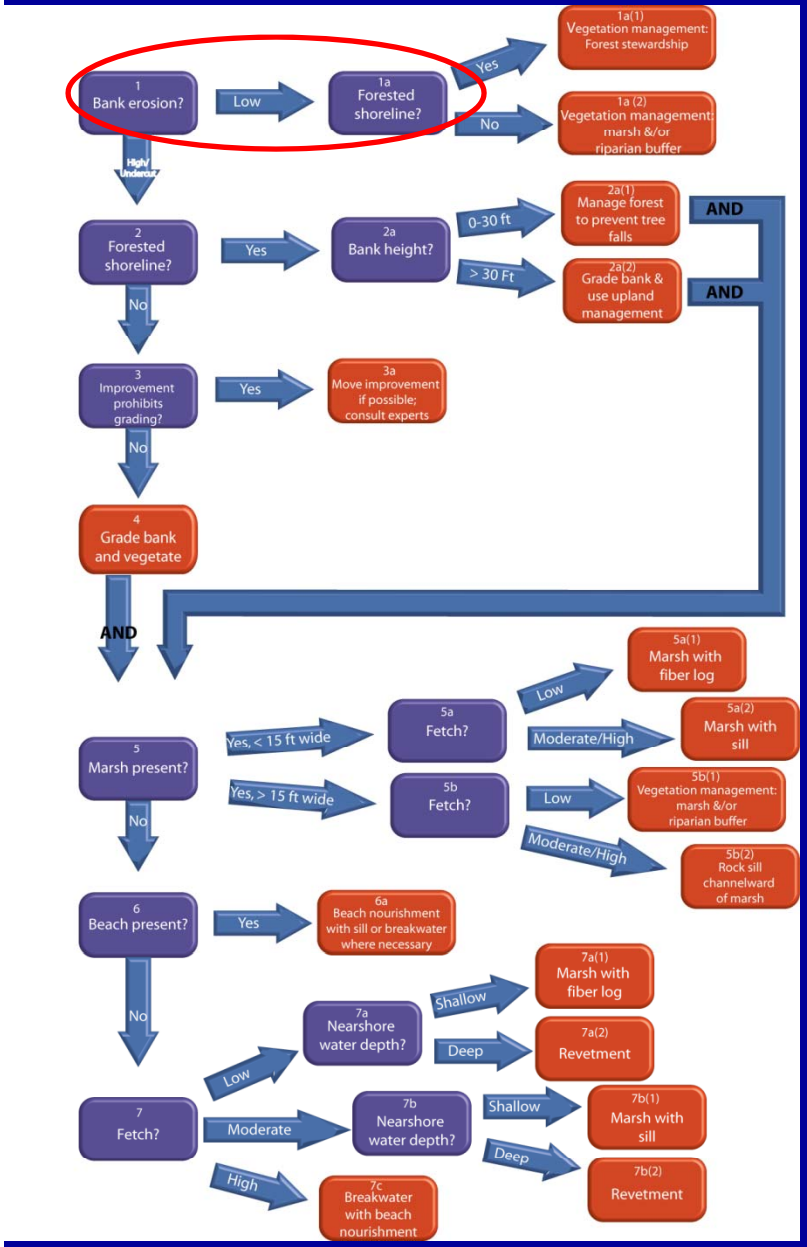
High erosion - Evidence of active soil movement, including bare exposed soil areas, numerous leaning and fallen trees, dead tree stumps in the water and/or bank slumping.

Low erosion - No evidence of active soil movement, indicated by dense wetland and/or upland vegetation, trees growing straight up, trees of different ages, multiple layers of vegetation (canopy, mid-story, groundcover) and a relative absence of exposed soil areas.

Undercut bank - Loss of soil only at bank toe due to tidal action or water currents.

Case 1

- 1. Is there bank erosion?



- ✓ Bank is <u>not</u> eroding or only low erosion
- ➢ 1a. Is the shoreline forested*?

*Dominated by mature canopy trees & other layers such as mid-story trees, shrubs & ground cover.
A single row of trees is not a forest!

Result for Case 1:

- ✓Bank is <u>not</u> eroding or only low erosion
- ✓Shoreline is forested

1a(1) Vegetation Management: Forest Stewardship

Enhance the existing forest condition by selectively removing dead, dying and severely leaning trees, pruning branches with weight bearing load over the water, planting mid-story and ground cover vegetation, controlling invasive upland species introduced by previous clearing.

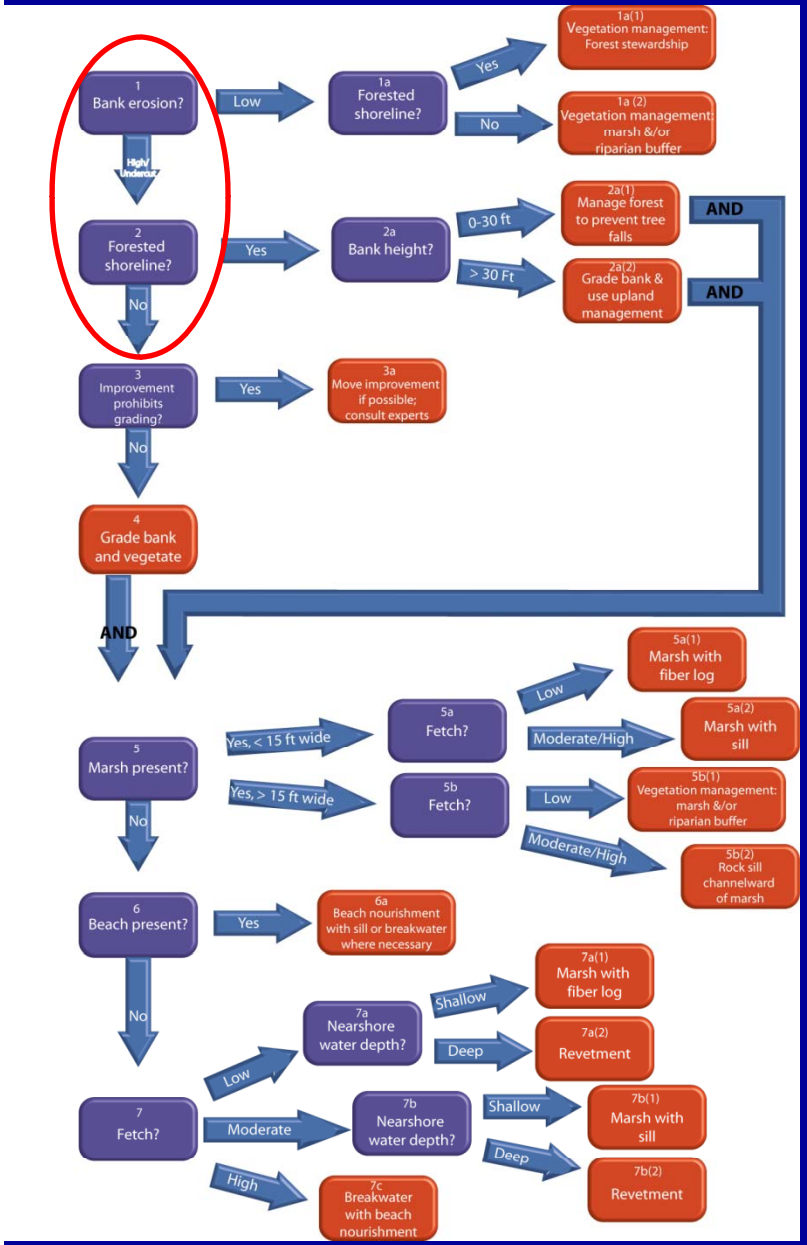
This is the only action recommended by the decision tree.

Case 2

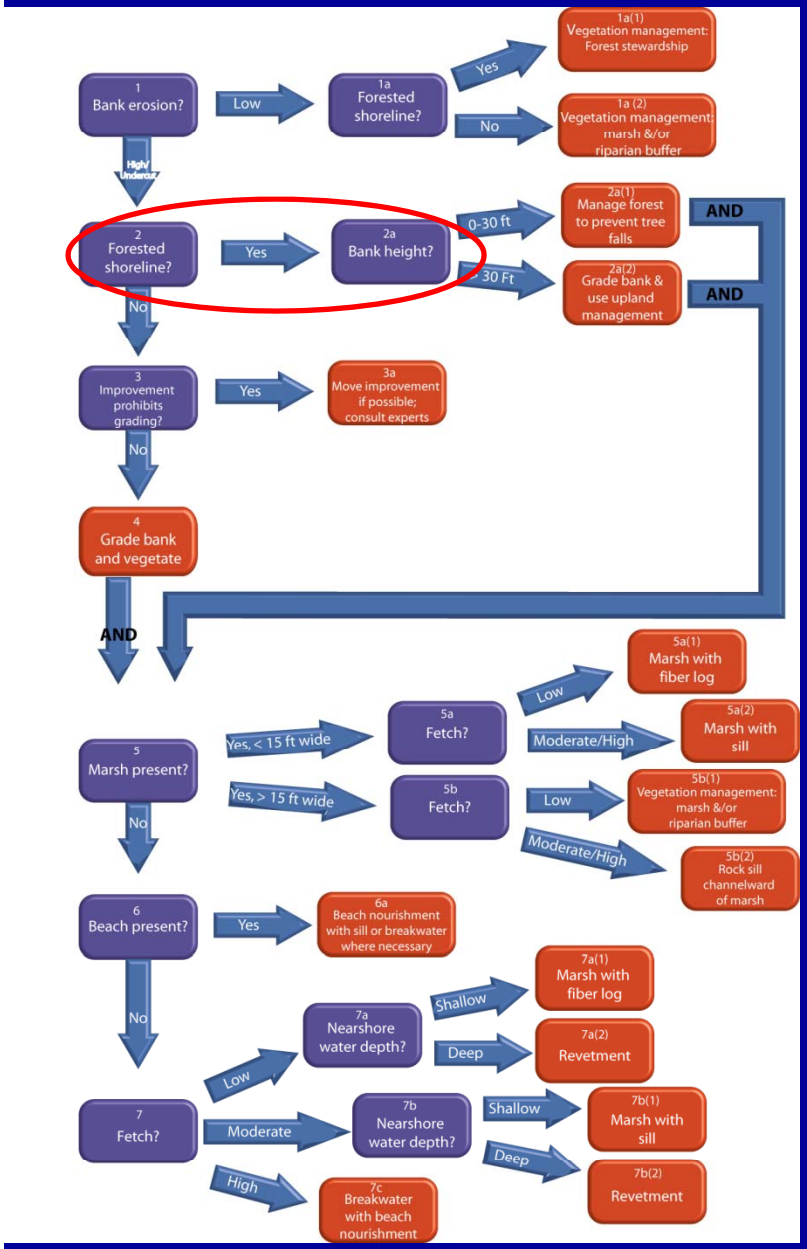
➢1. Is there bank erosion?

January 2007

- Narrow intertidal area
- Patchy wetland vegetation
- Bank grading not possible due to historic tree



- ✓ Bank is actively eroding
- ➢ 2. Is the shoreline forested?



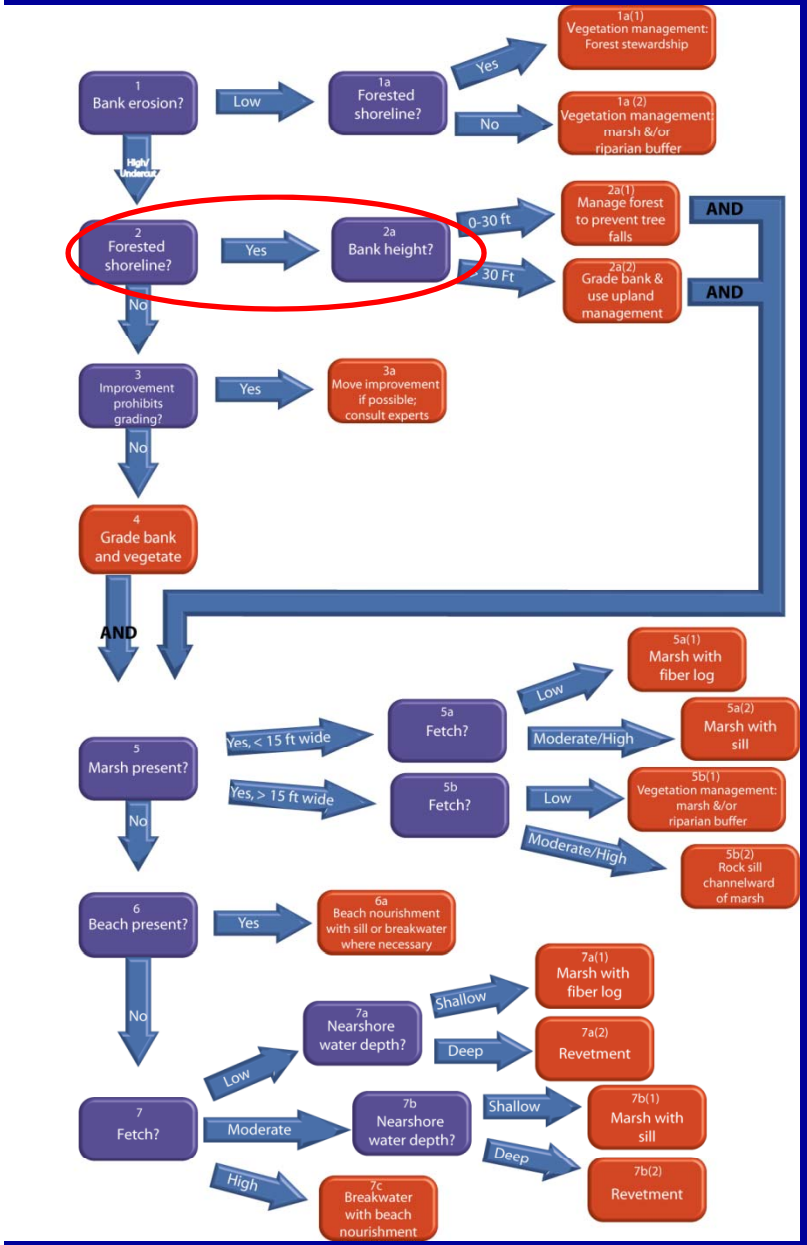
- ✓ Bank is actively eroding
- ✓ The shoreline is forested
- ➢ 2a. How high is the bank?

Measuring Bank Height – approximate vertical height of the upland bank

Why is bank height important?

- Ecological functions – tall forested bank not providing significant water quality benefit

- Bank stability – tree falls

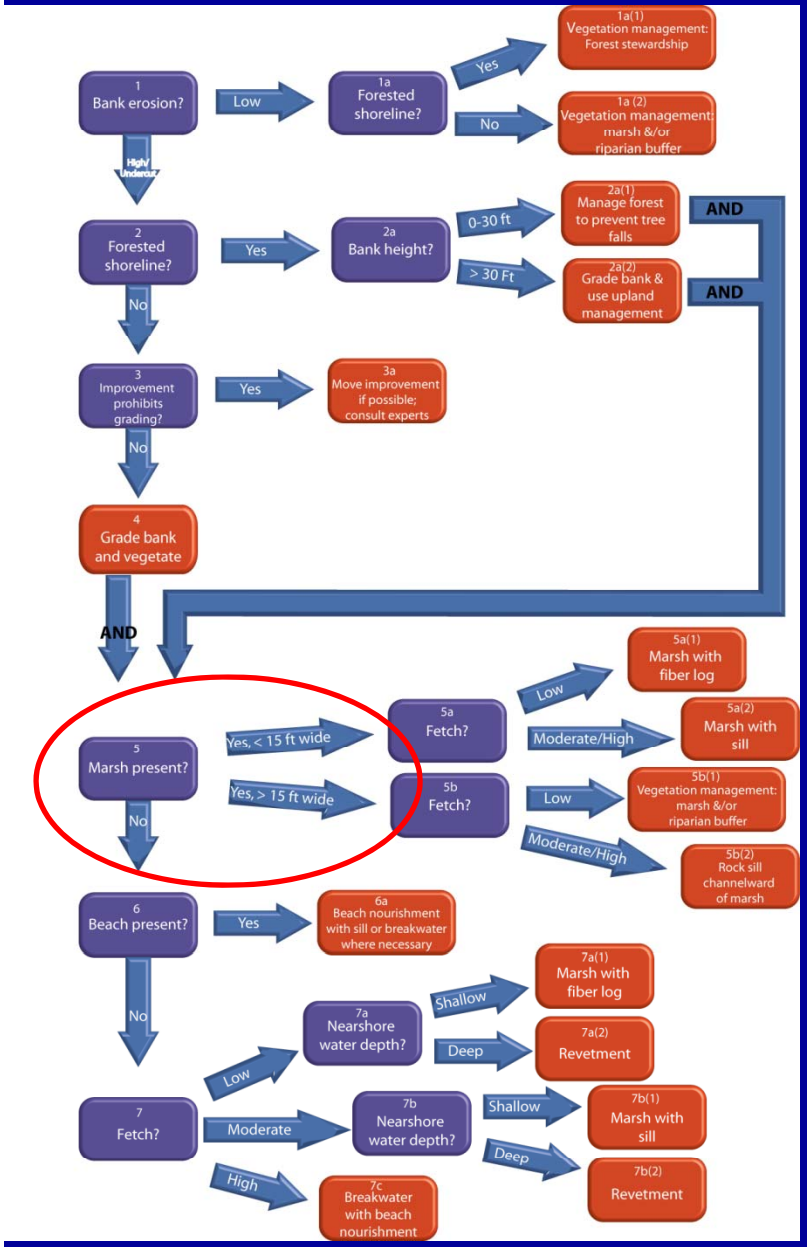


- ✓ Bank is actively eroding
- ✓ The shoreline is forested
- ➢ 2a. How high is the bank? approximately 10 ft.

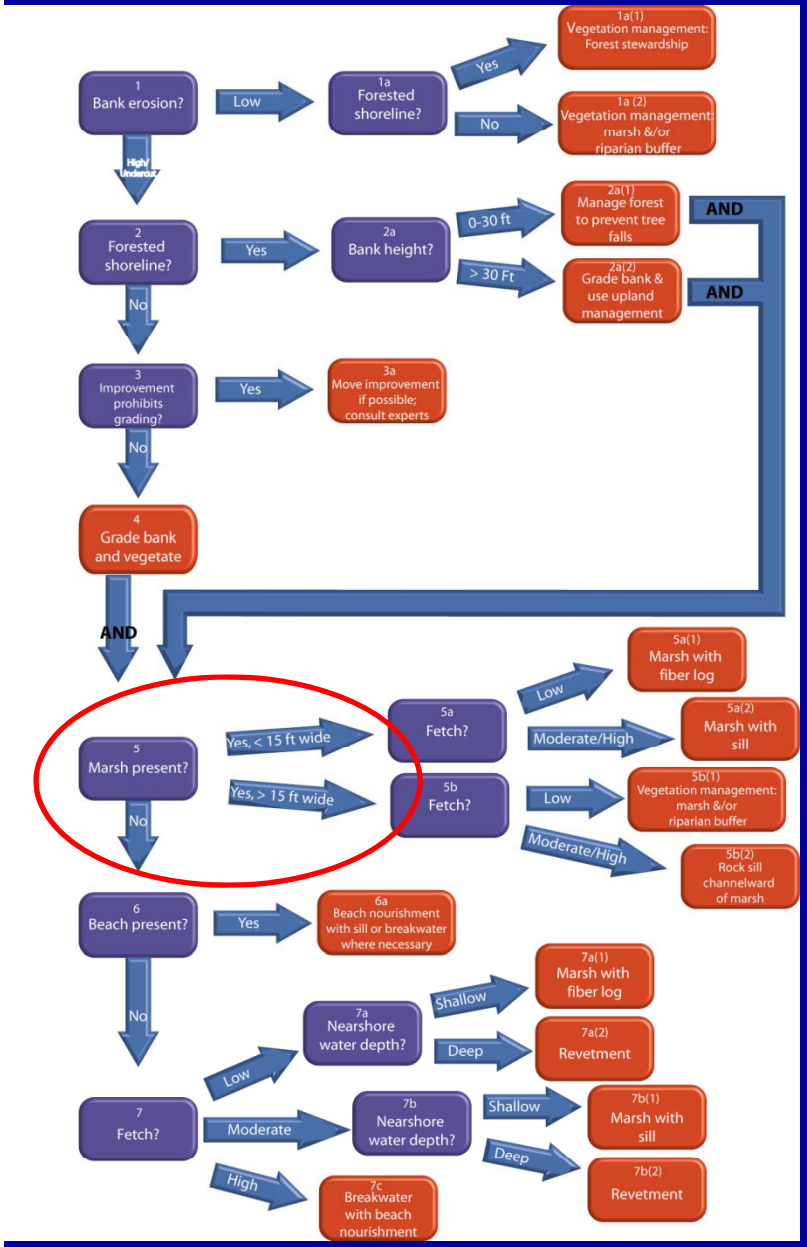
- ✓Bank is actively eroding
- ✓The shoreline is forested
- ✓The bank is less than 30 feet high

2a(1) Manage Forest to Prevent Tree Falls
AND

Continue on in the tree to question 5 for other management options



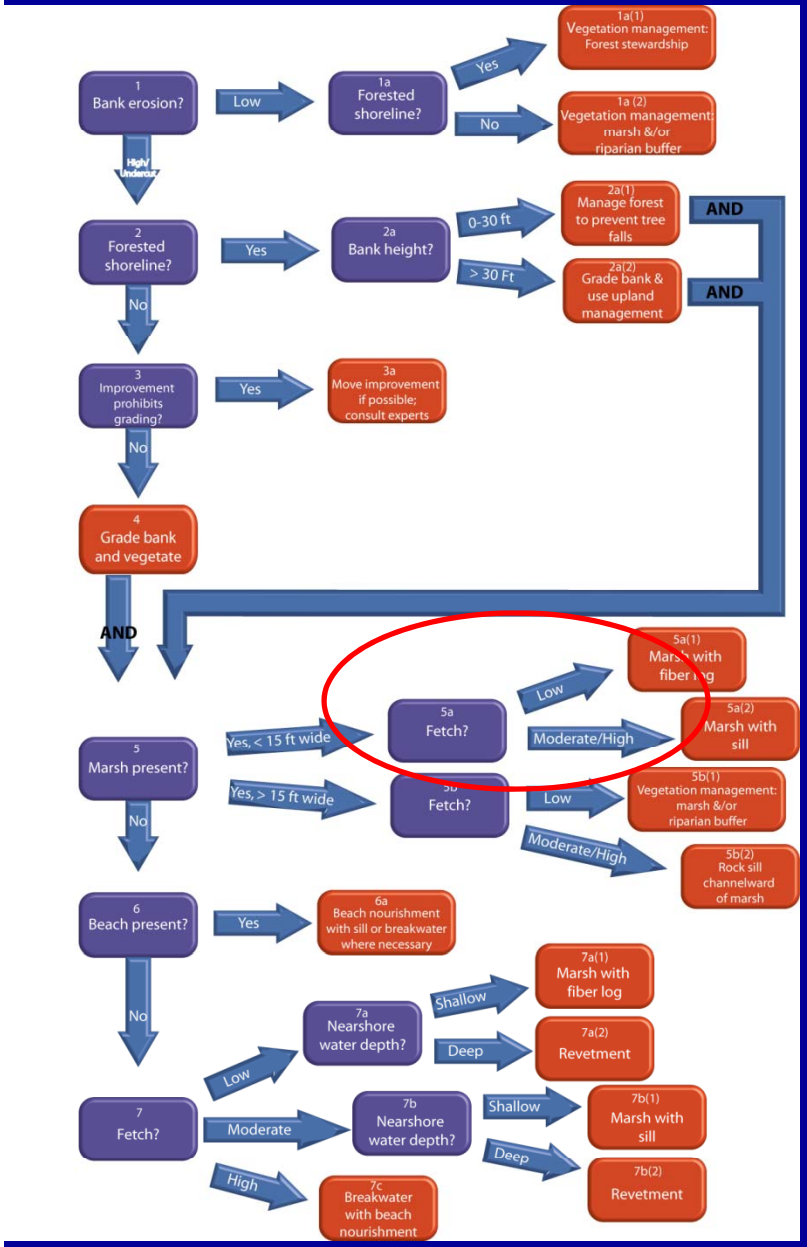
➢5. Is there a marsh on site?



- 5. Is there a marsh on site? Yes

Marsh width is a horizontal measurement from landward to channelward edges.

Marshes at least 15 ft. wide have been shown to significantly reduce incoming wave energy.

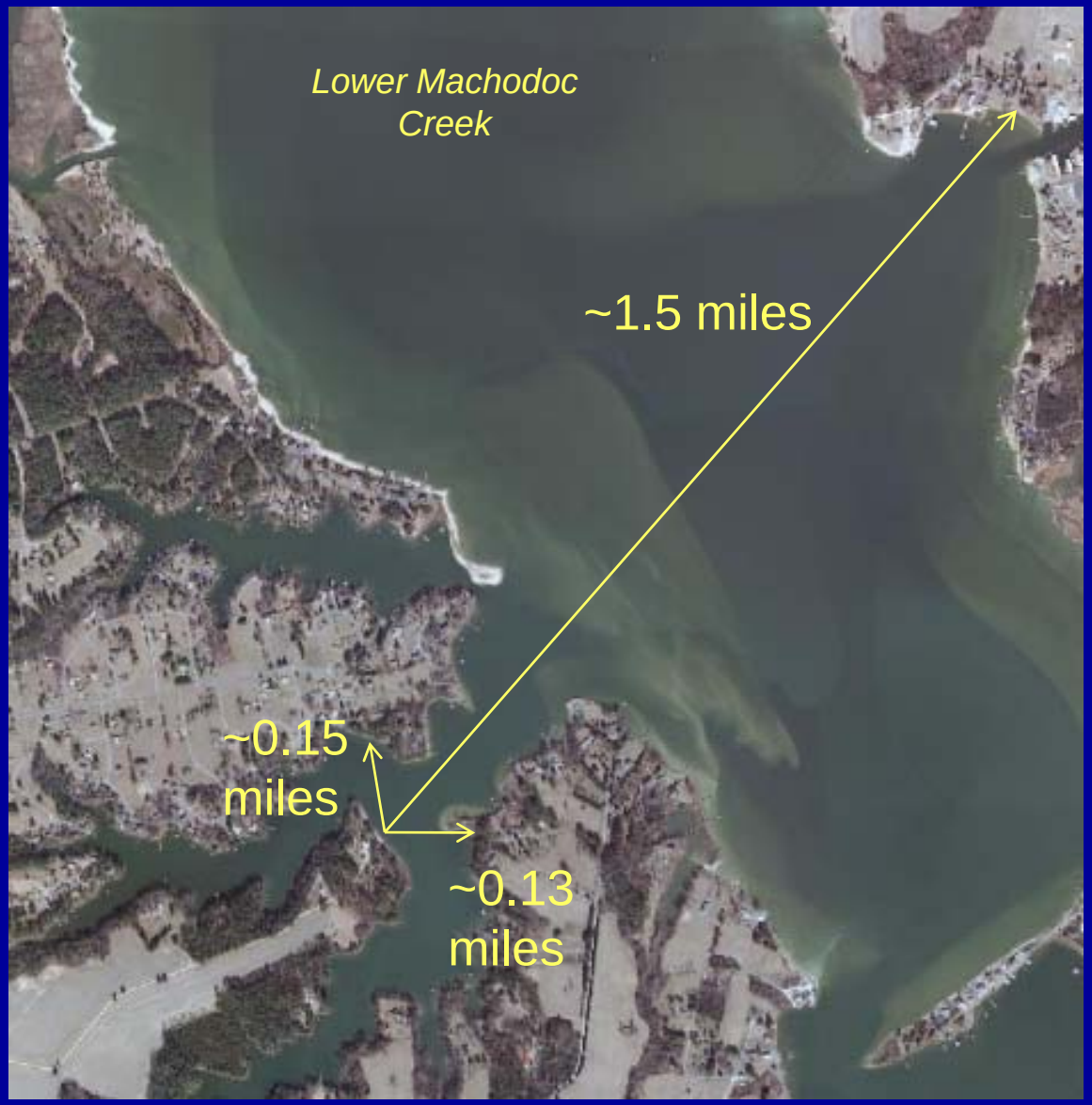


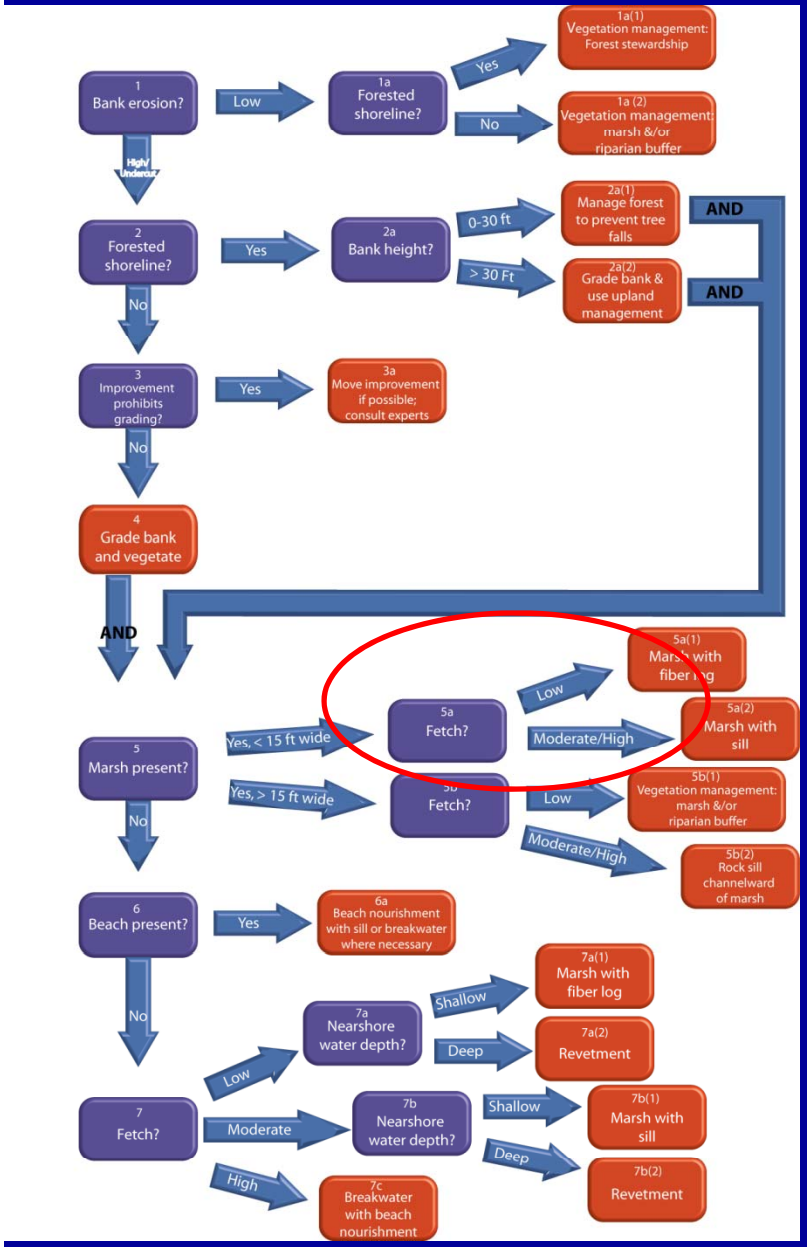
- ✓There is narrow marsh (less than 15 feet wide)
- ➢5a.What is the fetch?

Fetch - The distance across open water over which wind blows and waves are generated. This distance is measured at all angles from the shoreline. For the purposes of the decision tree, use the longest distance.

Fetch categories:

Low: 0 – ½ mile; Moderate: ½ - 2 miles; High: > 2 miles



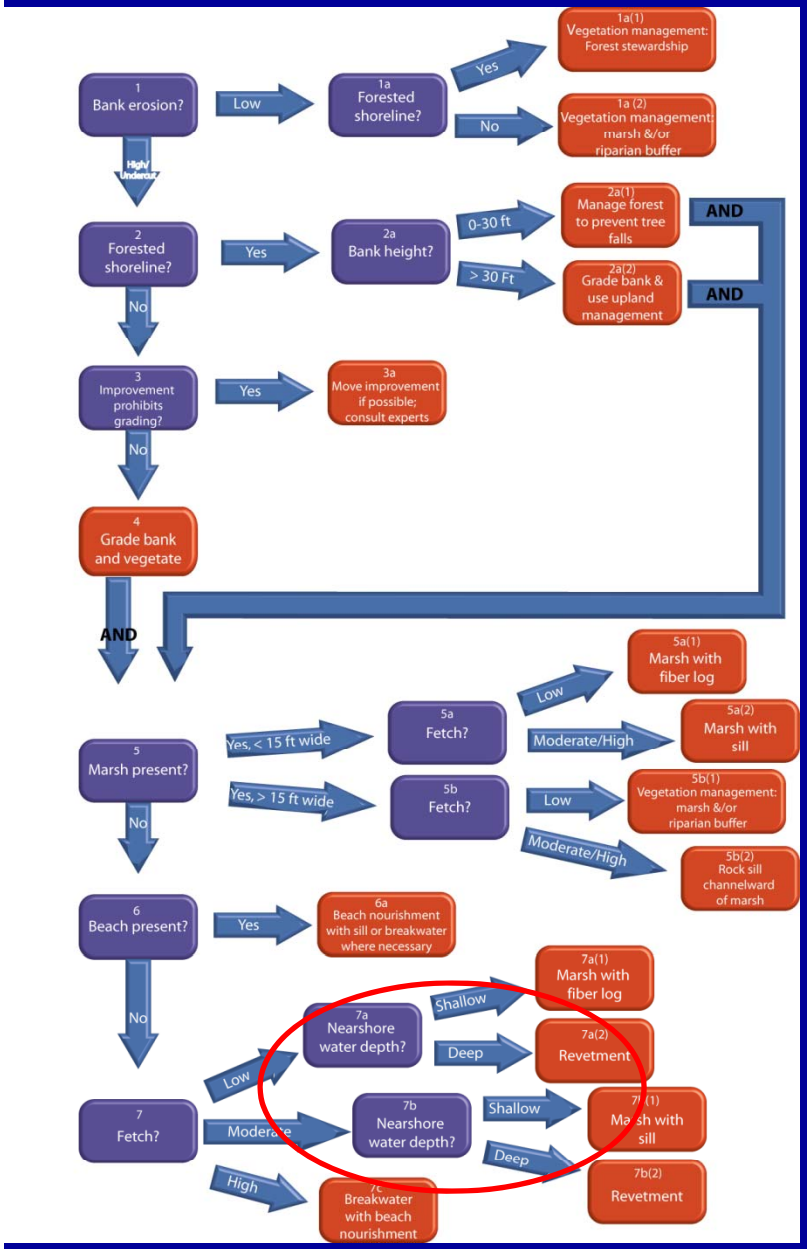


- ✓There is narrow marsh (less than 15 feet wide)
- ➢5a.What is the fetch?

- ✓Bank is actively eroding
- ✓Marsh is present but less than 15 feet wide
- ✓Fetch is greater than ½ mile

5a(2). Expand the marsh, use a sill to protect the marsh

5a(2). Expand the marsh, use a sill to protect the marsh



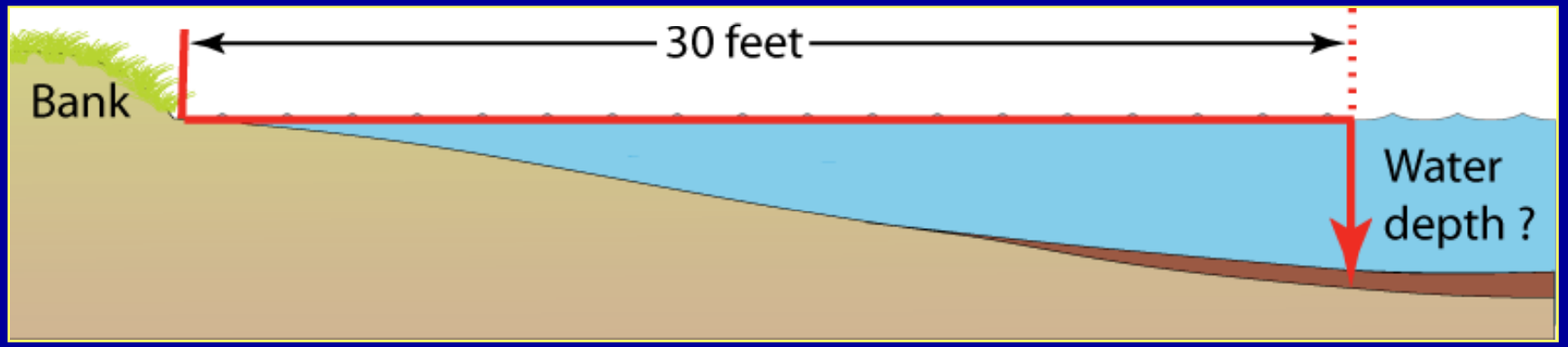
Another section of the decision tree asks about "nearshore water depth," in order to evaluate whether constructing an offshore sill is appropriate.

- 7a. What is the nearshore water depth?

Nearshore water depth – at 30 ft. channelward of MLW…

Shallow: depth ≤ 3 ft.

Deep: depth > 3ft.



Caveats & Exceptions

- Shoreline sections
- Flooding
- Upland erosion
- Groins
- Bulkheads – restricted navigation

If different sections of the shoreline have different characteristics, apply decision tree separately to each section

Flooding, not erosion.

Erosion control structures will not resolve flooding problems

Exceptions

Areas of upland erosion – shoreline erosion control structures will not resolve upland erosion problems

Shoreline structures are not an effective method for dealing with upland erosion because they are placed channelward of where the erosion is occurring. Reducing the slope, increasing vegetative stabilization and managing the quantity and rate of runoff in the upland are the most effective methods for preventing continued erosion.

Exceptions

Groin in existing successful groin field

2002 2007 2009

Exceptions

Groin in existing successful groin field

There are few situations for which groins are the preferred approach for a shoreline because they can have significant adverse impacts on adjacent shorelines. This decision tree does not lead to a recommendation for groin construction in any situation. However, there are some situations in which groin construction is an appropriate option/alternative. Specifically, a groin may be appropriate if the property is within or adjacent to an existing groin field that is very successful, based on filled groin cells and a resulting beach that is providing adequate shoreline protection. A significant and adequate sand supply must exist. In most cases, new groins must be artificially nourished and must be of a low-profile design in which the elevation of the channelward end of the groin is no greater than the mean low water elevation, in order to lessen the interruption of sand movement along the shoreline.

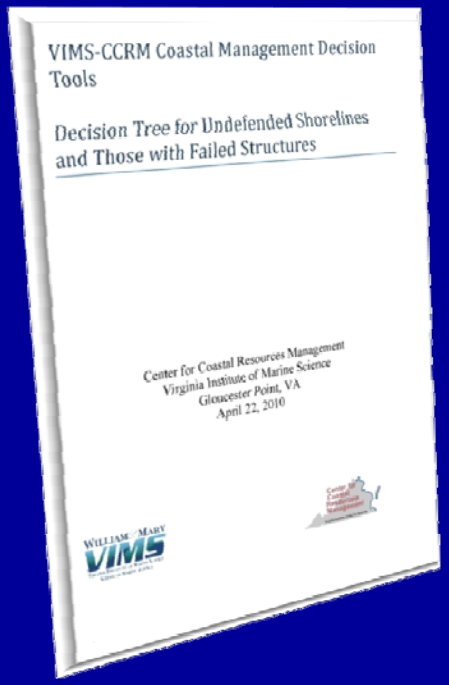
Exceptions

Areas of restricted navigation

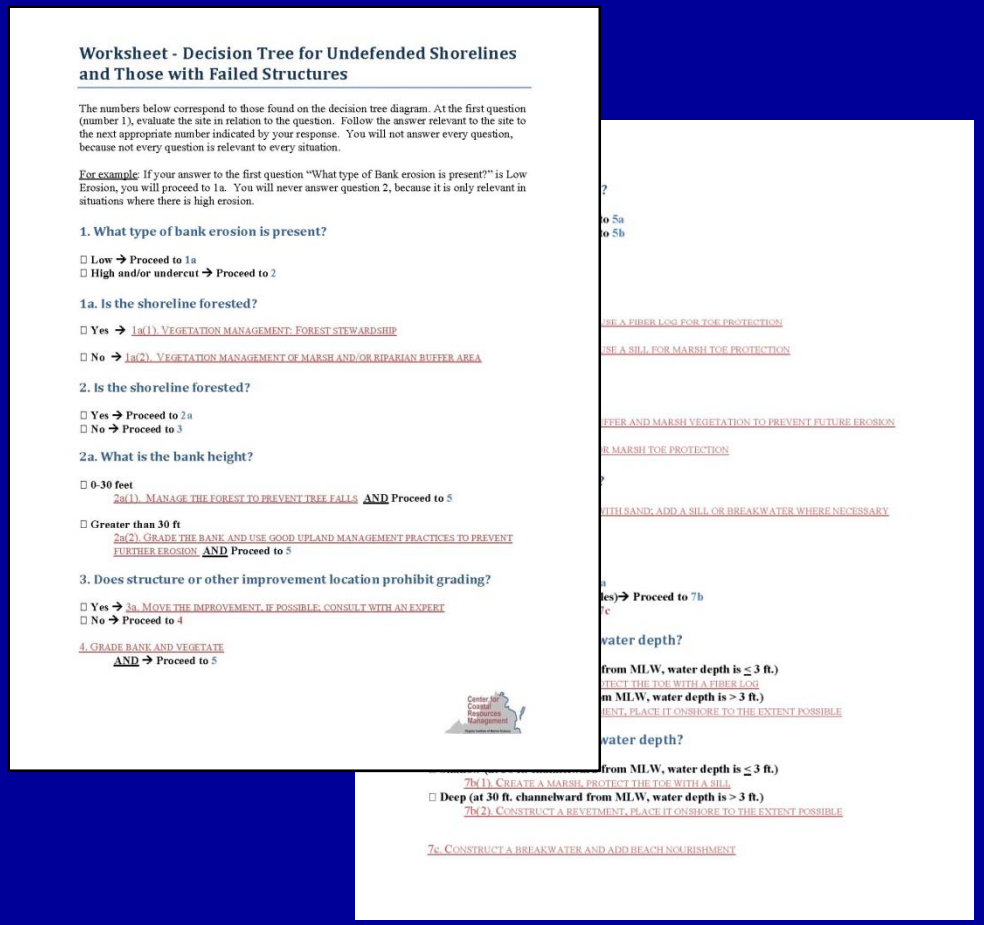
Exceptions

Areas of restricted navigation

This decision tree does not lead to a recommendation for bulkhead construction in any situation. However, there are some situations for which bulkhead construction is an appropriate option/alternative. Specifically, in areas where the environmentally preferred structure or shoreline treatment would impair navigation, then a bulkhead may be an appropriate option/alternative. This situation may occur in dredged canal areas and in industrial areas with deep water.



Decision Tree Manual – on CD that was distributed at workshop; also available at http://ccrm.vims.edu/Spring2010.html



Worksheet - Decision Tree for Undefended Shorelines and Those with Failed Structures

The numbers below correspond to those found on the decision tree diagram. At the first question (number 1), evaluate the site in relation to the question. Follow the answer relevant to the site to the next appropriate number indicated by your response. You will not answer every question, because not every question is relevant to every situation.

For example: If your answer to the first question "What type of Bank erosion is present?" is Low Erosion, you will proceed to 1a. You will never answer question 2, because it is only relevant in situations where there is high erosion.

1. What type of bank erosion is present?

☐ **Low → Proceed to** 1a
☐ **High and/or undercut → Proceed to** 2

1a. Is the shoreline forested?

☐ **Yes →** 1a(1). VEGETATION MANAGEMENT: FOREST STEWARDSHIP

☐ **No →** 1a(2). VEGETATION MANAGEMENT OF MARSH AND/OR RIPARIAN BUFFER AREA

2. Is the shoreline forested?

☐ **Yes → Proceed to** 2a
☐ **No → Proceed to** 3

2a. What is the bank height?

☐ **0-30 feet**
2a(1). MANAGE THE FOREST TO PREVENT TREE FALLS **AND Proceed to** 5

☐ **Greater than 30 ft**
2a(2). GRADE THE BANK AND USE GOOD UPLAND MANAGEMENT PRACTICES TO PREVENT FURTHER EROSION **AND Proceed to** 5

3. Does structure or other improvement location prohibit grading?

☐ **Yes →** 3a. MOVE THE IMPROVEMENT, IF POSSIBLE; CONSULT WITH AN EXPERT
☐ **No → Proceed to** 4

4. GRADE BANK AND VEGETATE
AND → Proceed to 5

Decision Tree Worksheet – distributed as handout at workshop & also an appendix in manual

Decision Tree Hands-on Session:

- Cooperative Learning Activity
- Small Groups
- Work through decision tree for 4 shoreline cases

Enhancing our technical guidance to help promote and support integrated management decision-making.

Thanks!

Center for Coastal Resources Management

Virginia Institute of Marine Science