

Grand Is
Georgiana & Staten Is
Grand Is
Jones Tract

Sustainable Delta Levees

Designing with Nature for Flood Protection

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Hartland Nursery

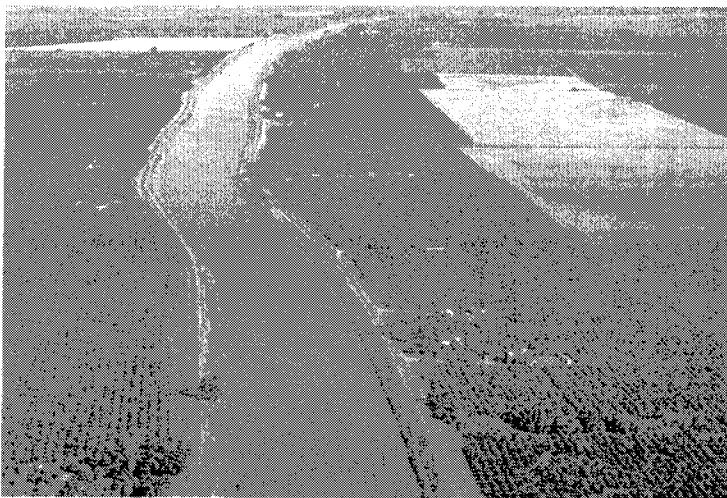
Delta Ecotours

Walnut Grove, CA

Levees...Different Visions?

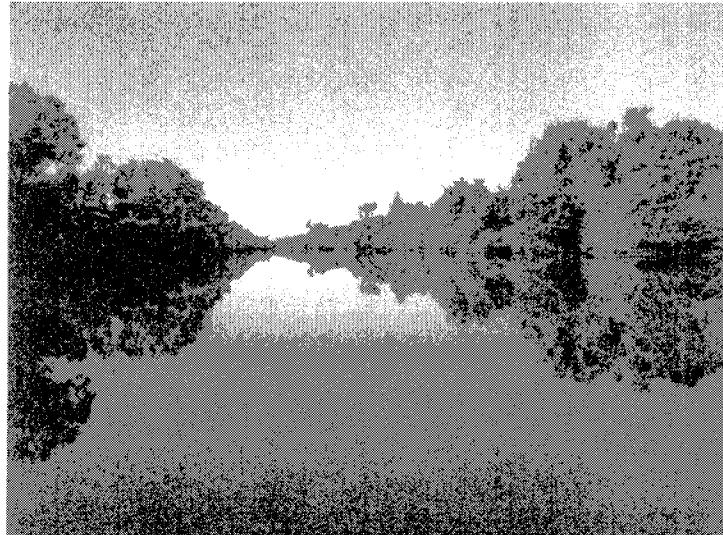


Riparian vegetation can provide protection to levees...and habitat & beauty!



An alternative view is that our levees are sterile, rock conduits for water?

Levees, flood control and riprap



Pristine, riparian habitat

Levee
and
Water
Management



Sterile levee habitat

150 years of reclamation and levee “maintenance” have left many of our levees sterile conduits of our water supply. Are we really safer?

Why Environmentally Green Levees?

❖ Good Engineering

- Plants add strength to levees...can reduce flooding risks
- Habitat restoration can go hand-in-hand with levee improvements

❖ Critical habitat...good for wildlife

- Endangered species...wide range of species...economic and recreational fisheries

❖ Recreational/Cultural Landscape

- People like beautiful landscapes

❖ Encourages wider political support

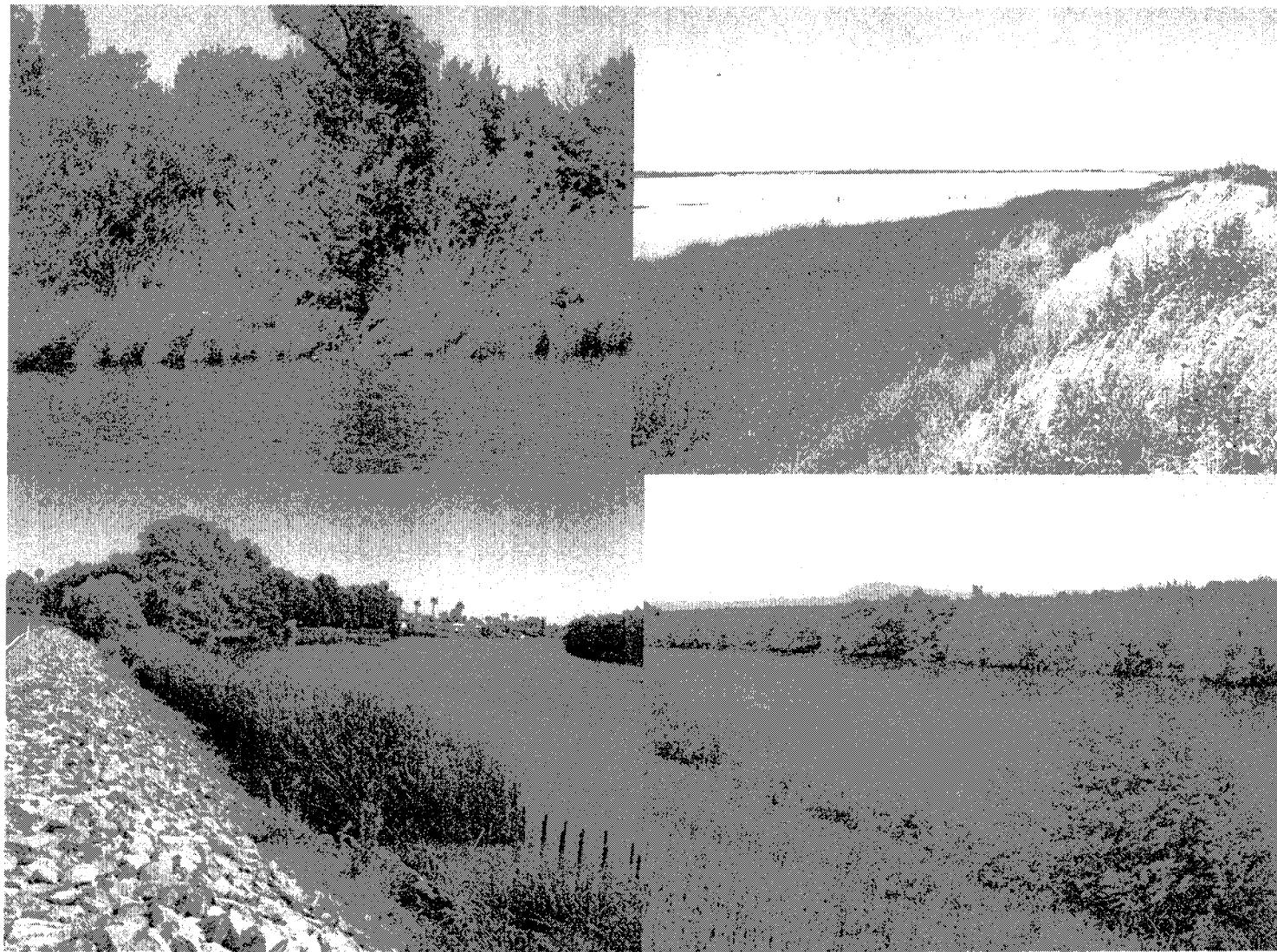
Plants and Levees

Asset or problem?

Plants as engineering agents

- Direct current away from bank, lower velocity and erosive forces
 - Cause deposition...builds up levees with fine materials
 - Poor spaces filled...may reduce water leakage (piping)?
 - Roots and stems bind soil, increase levee stability and reduce erosion (mass wasting)
 - Not all plants are equally effective
 - Perennial, multi-stemmed, deep rooting, small to medium sized plants are the most effective.
 - Annual plants ineffective
 - Single, isolated large trees may cause problems in certain situations (but problem can be managed).

Vegetation can improve levee stability



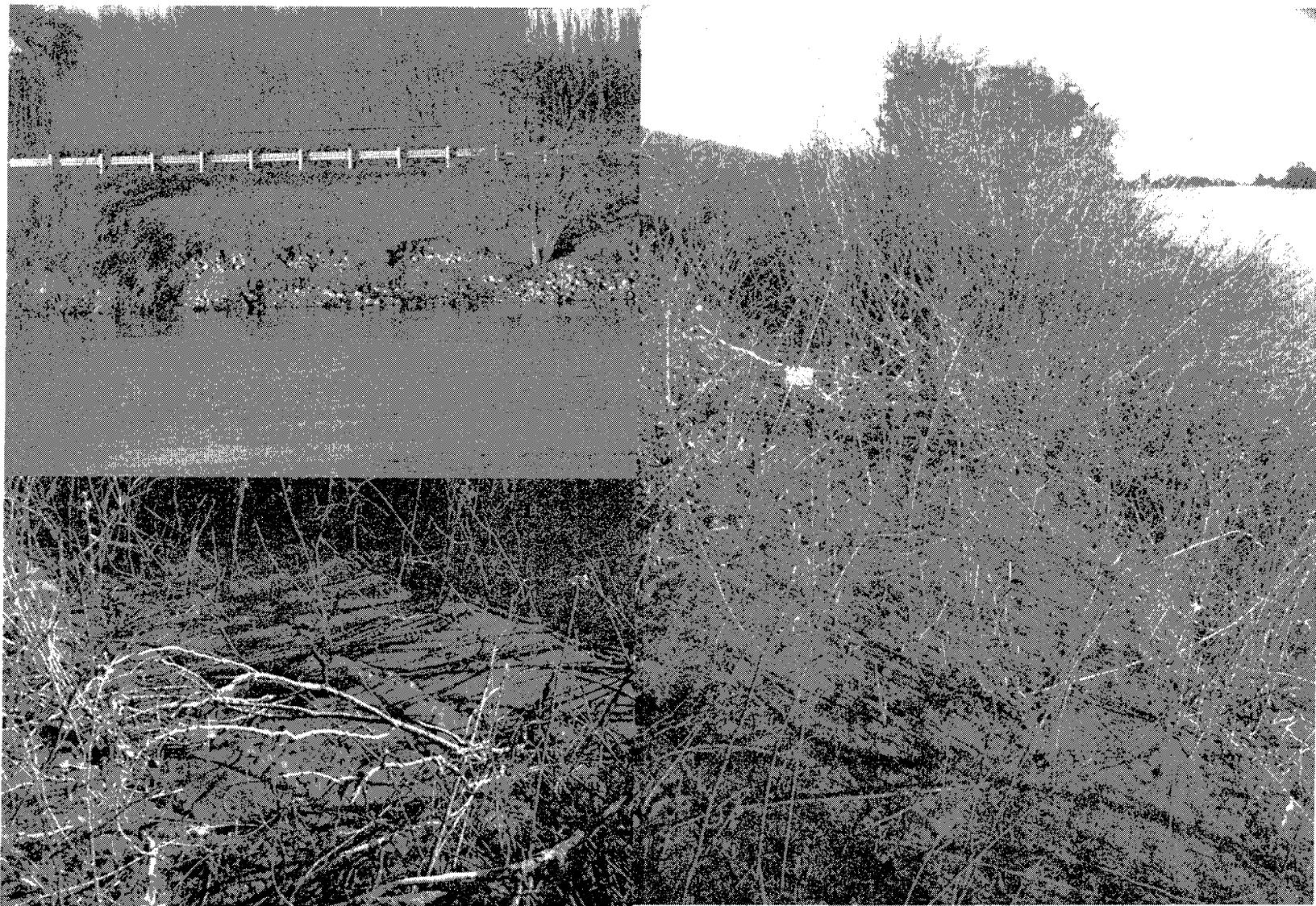
Examples of vegetation and levees co-existing...to the benefit of levee stability!

Plant Roots, Soil Tensile Strength, Stability



Without these tree roots riverbanks and levees would more easily erode...leading to flooding!

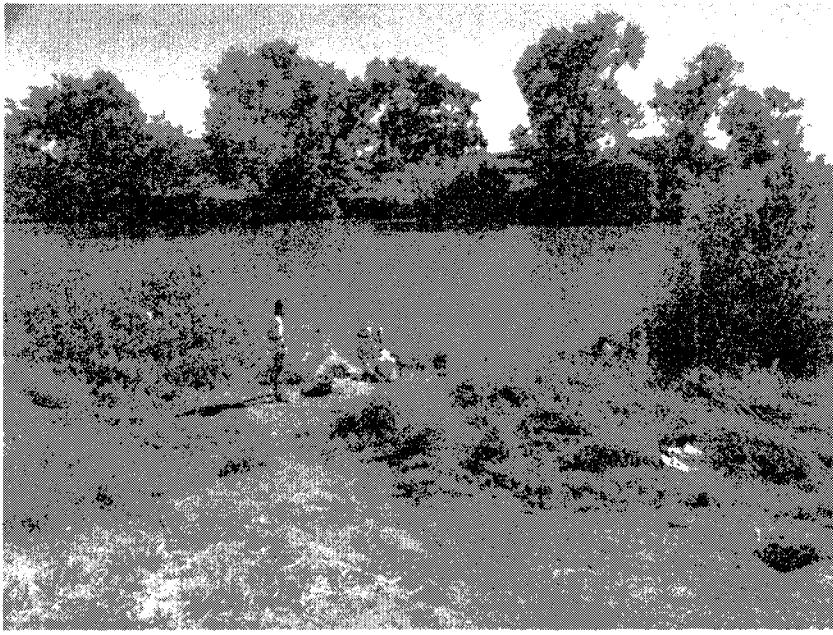
But The Right Kind of Plants are Needed!



Above, left: note annual grasses, after grazing, are insufficient to hold levee together. Other photos demonstrate how multi-stemmed woody plants attract sediment...and build up levees!

Many “maintenance” activities (such as indiscriminate application of herbicide) cause plant loss that lead to erosion.



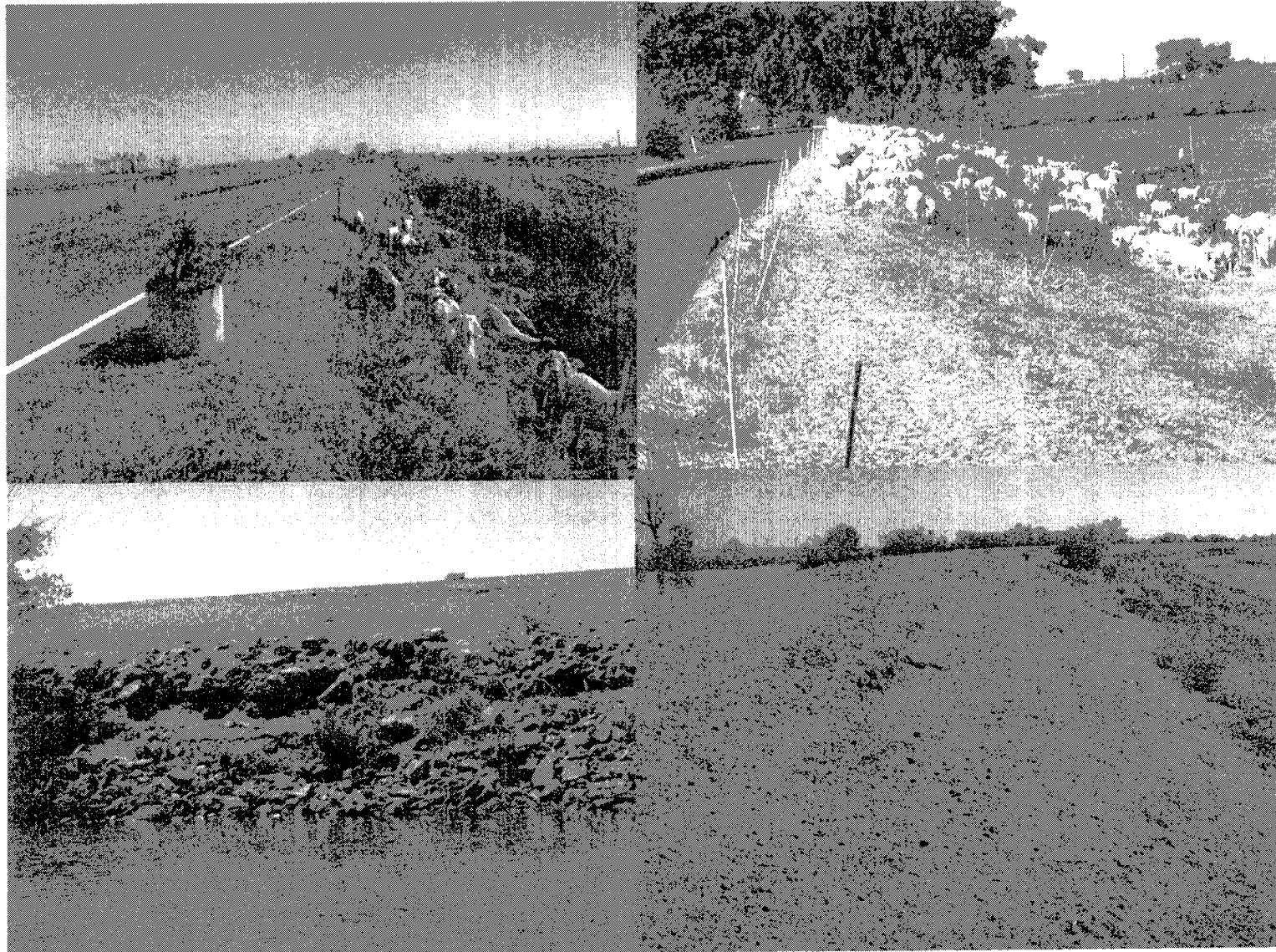


Mowing of plants along this berm and levee reduced plant cover, requiring emergency flood fighting.

Unmanaged recreational access can result in plant removal and erosion.

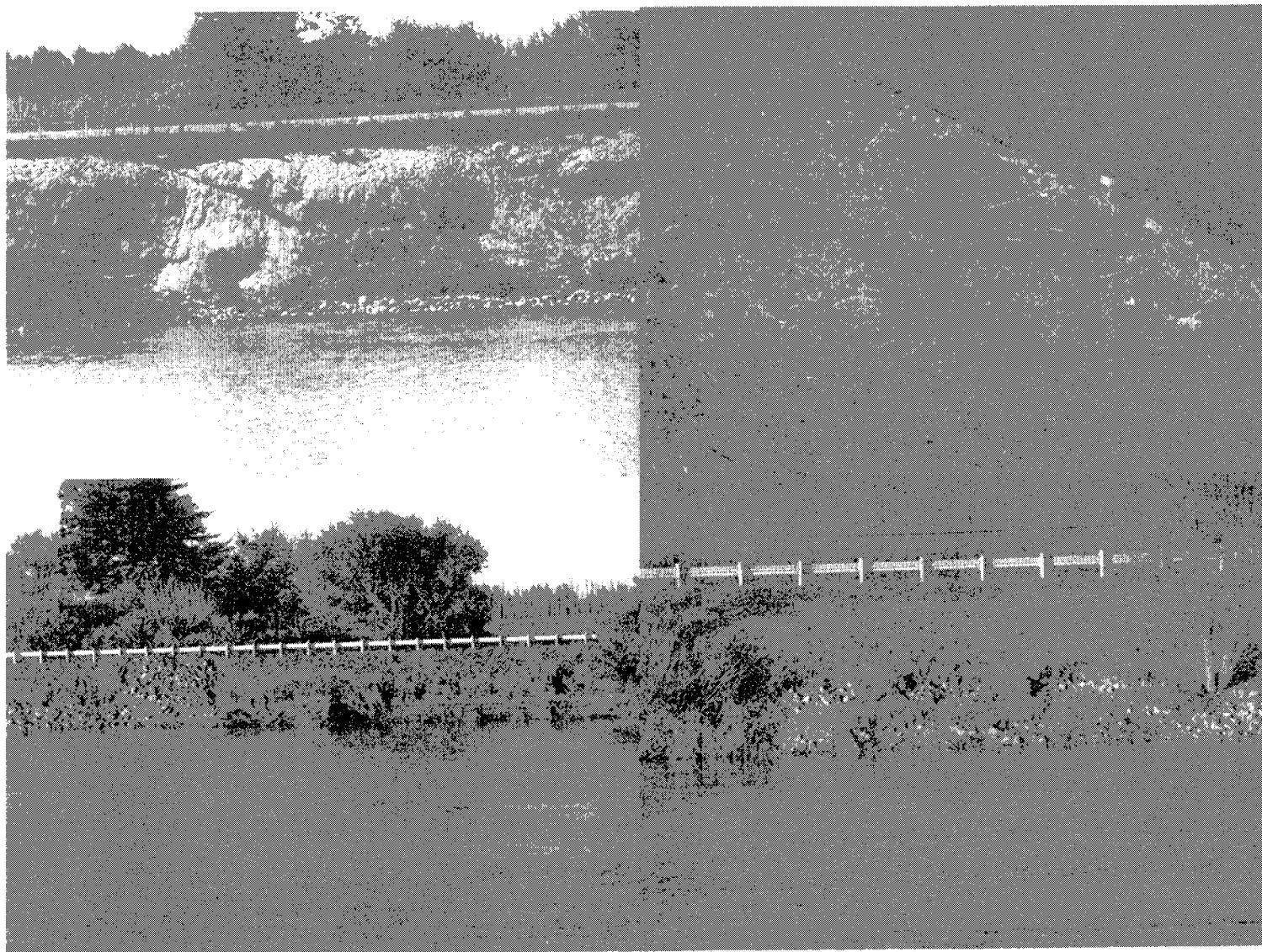


Goat Grazing: Good or Bad Management?



Goat grazing can be an effective tool for occasional early season use that exposes unseen problems. Indiscriminate grazing, especially close to the rainy/flood season is a bad idea.

Effect of Goat Grazing

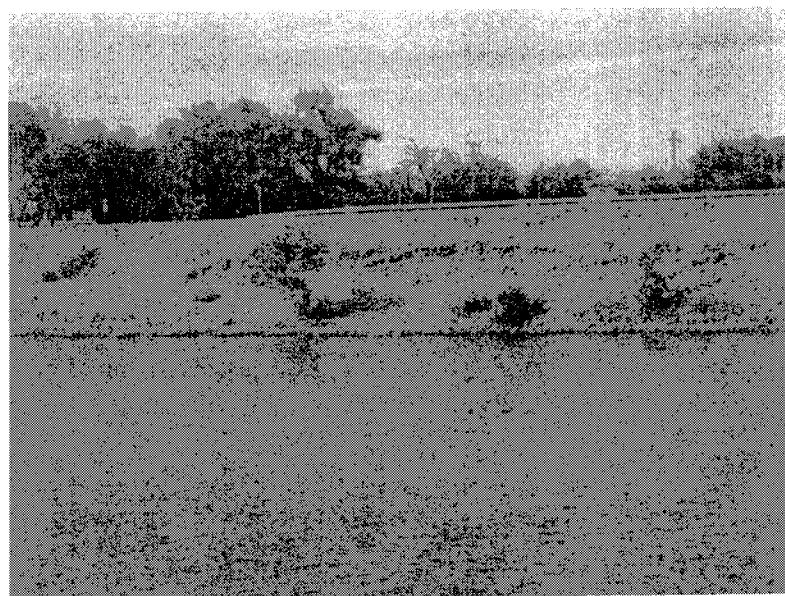


Goat grazing often results in immediate loss of plants, leading to erosion and levee failure!

“Engineering” with poor Soil...resulting in poor vegetation growth

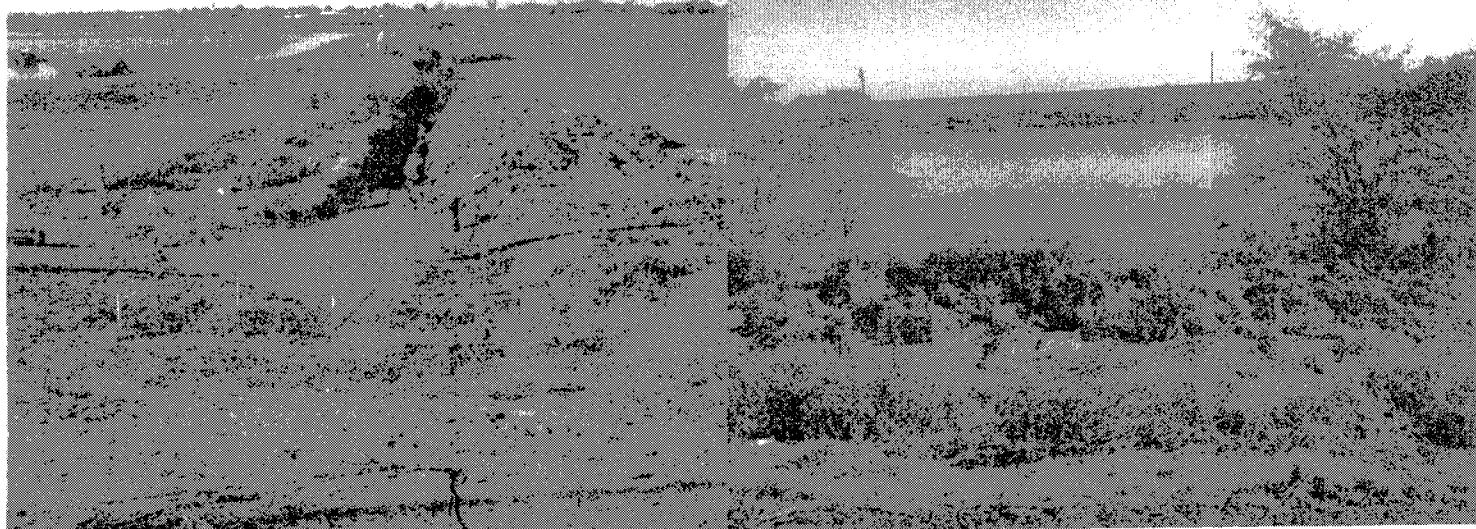
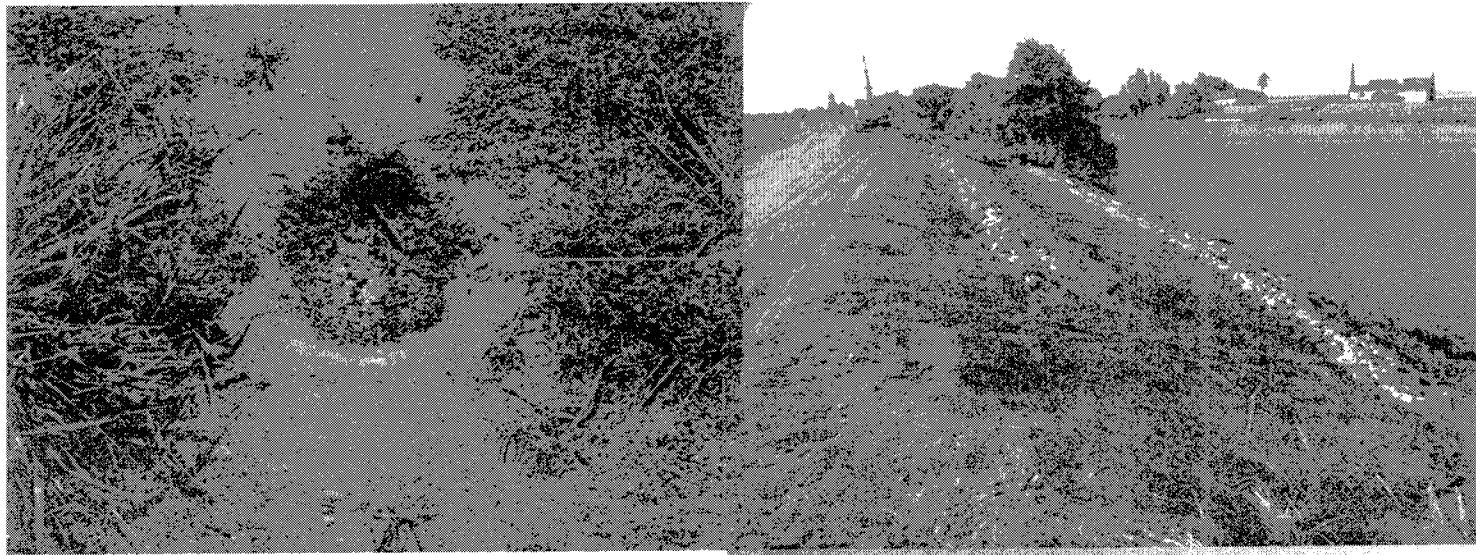


A Corps of Engineers bank protection project used crushed gravel in place of soil...the plants died and the site continues to erode!



Another example of inappropriate rock and road base material...plants can't grow, leading to failure of this “engineered” levee.

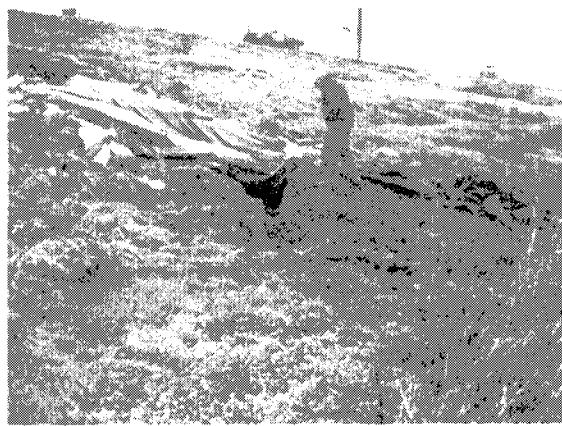
Boils...resulting from water leakage through the levee.



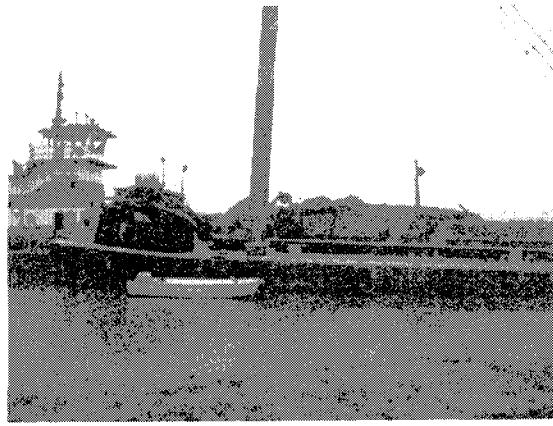
What causes leaky levees, resulting in piping and boil formation and potentially catastrophic conditions. Here are a couple of examples where plants were lacking?

Boil on Staten Island, January 06

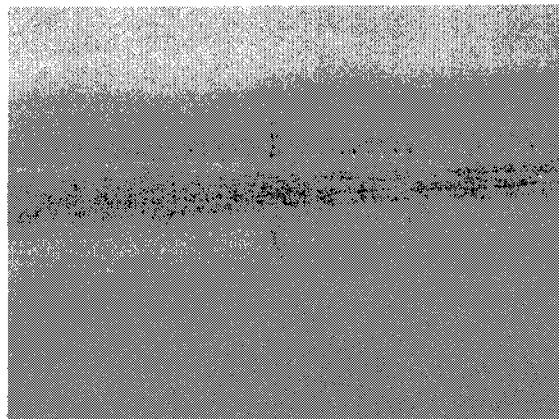
A \$400,000 dollar “fix”



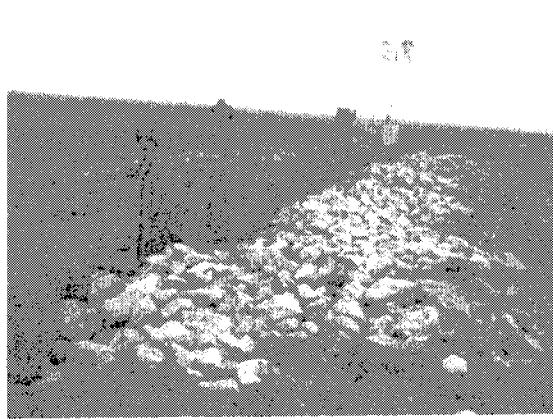
Boil on land side



Emergency repair

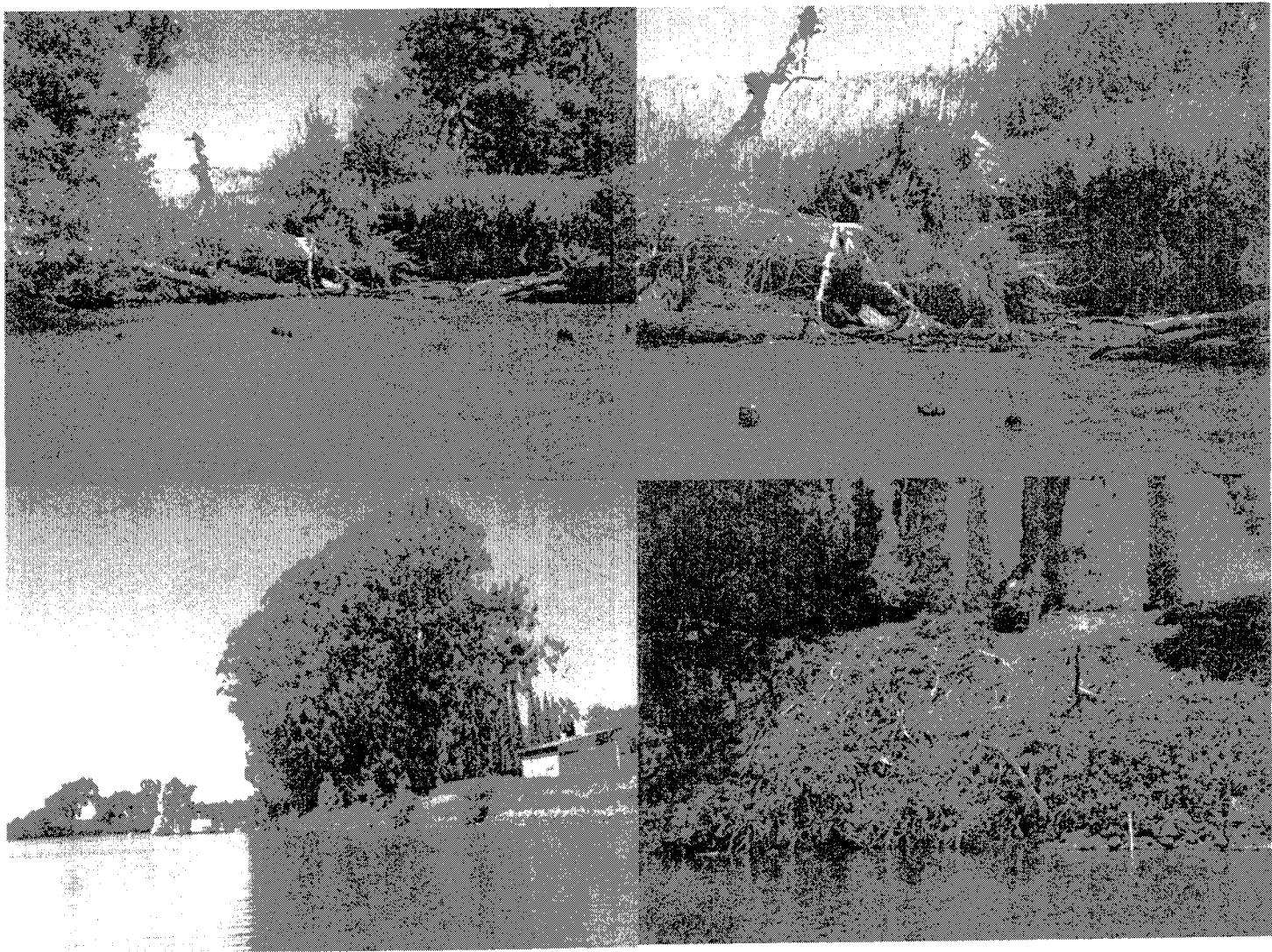


From waterside...note lack
of protective vegetation



Sheet piling and rock on landside.

Large Trees on Small Levees Can Be Problematic



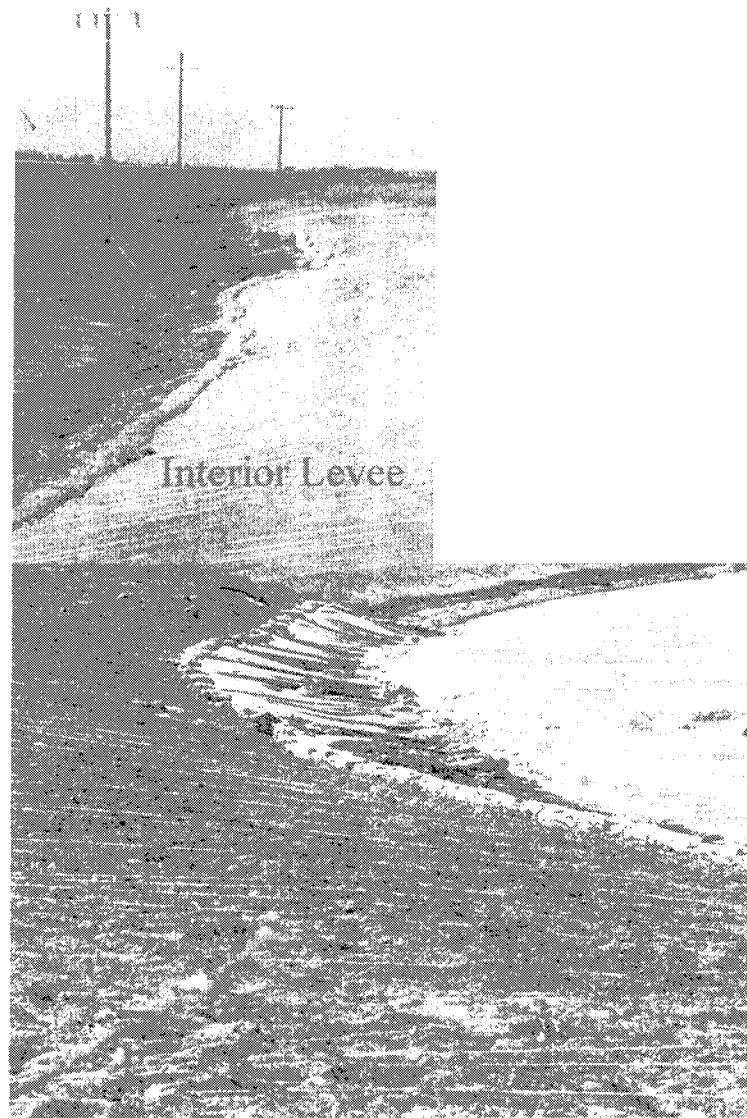
Very large, isolated trees can fall over, jeopardizing levee stability. Pruning or weight reduction may be an appropriate action to take.

Jones Tract: Levees (“properly”) Managed Without Vegetation

Exterior Levee



Interior Levee



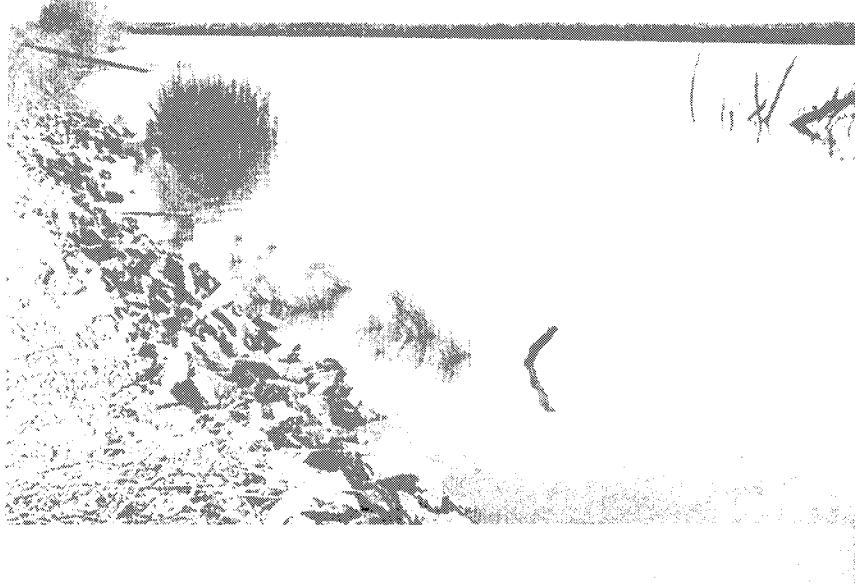
The exterior levees at Jones Tract were “appropriately” managed to exclude vegetation. The interior Levees, with virtually no vegetation, were extremely vulnerable to erosion of wave wash following flooding.

Examples of Levee Restoration Projects

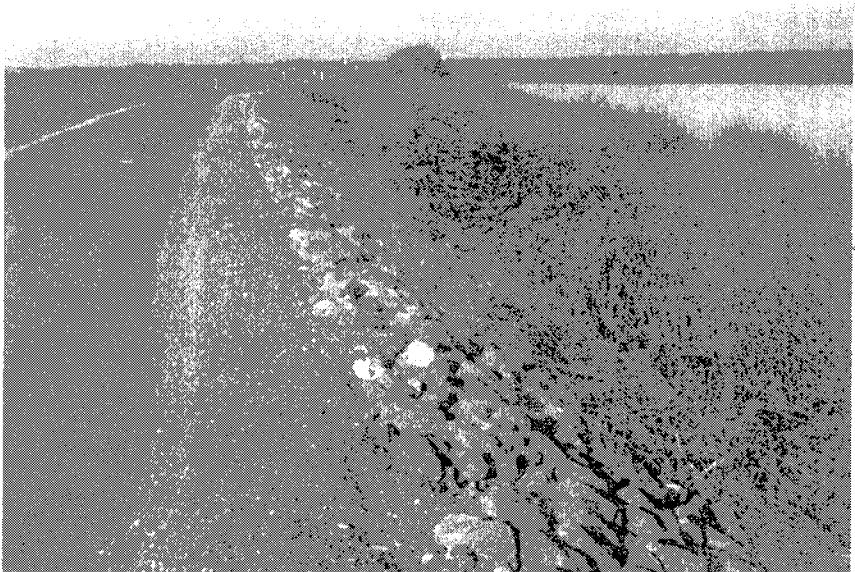
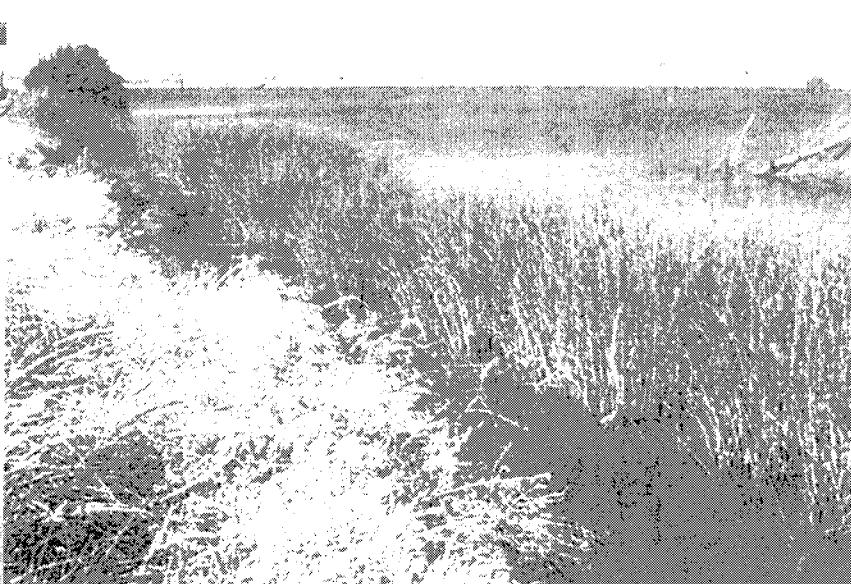
- ❖ Tidal mudflat restoration (tules)
- ❖ Bank planting
- ❖ Berm Protection/Rehabilitation
 - Brush boxes
 - Tree planting
- ❖ Levee planting

North Fork Mokelumne River Tidal Mudflat Berms

Immediately after tule planting



Two years after tule planting



Five years after planting...after big 06 January storm

Tules provide critical protection to levees from storm
And boat induced wave wash.

Riverbank toe planting: Lower American River



1999



2002



2004



2004

Levee (“Oversized”) Planting (Grand Island)



Protection and Creation of Berms

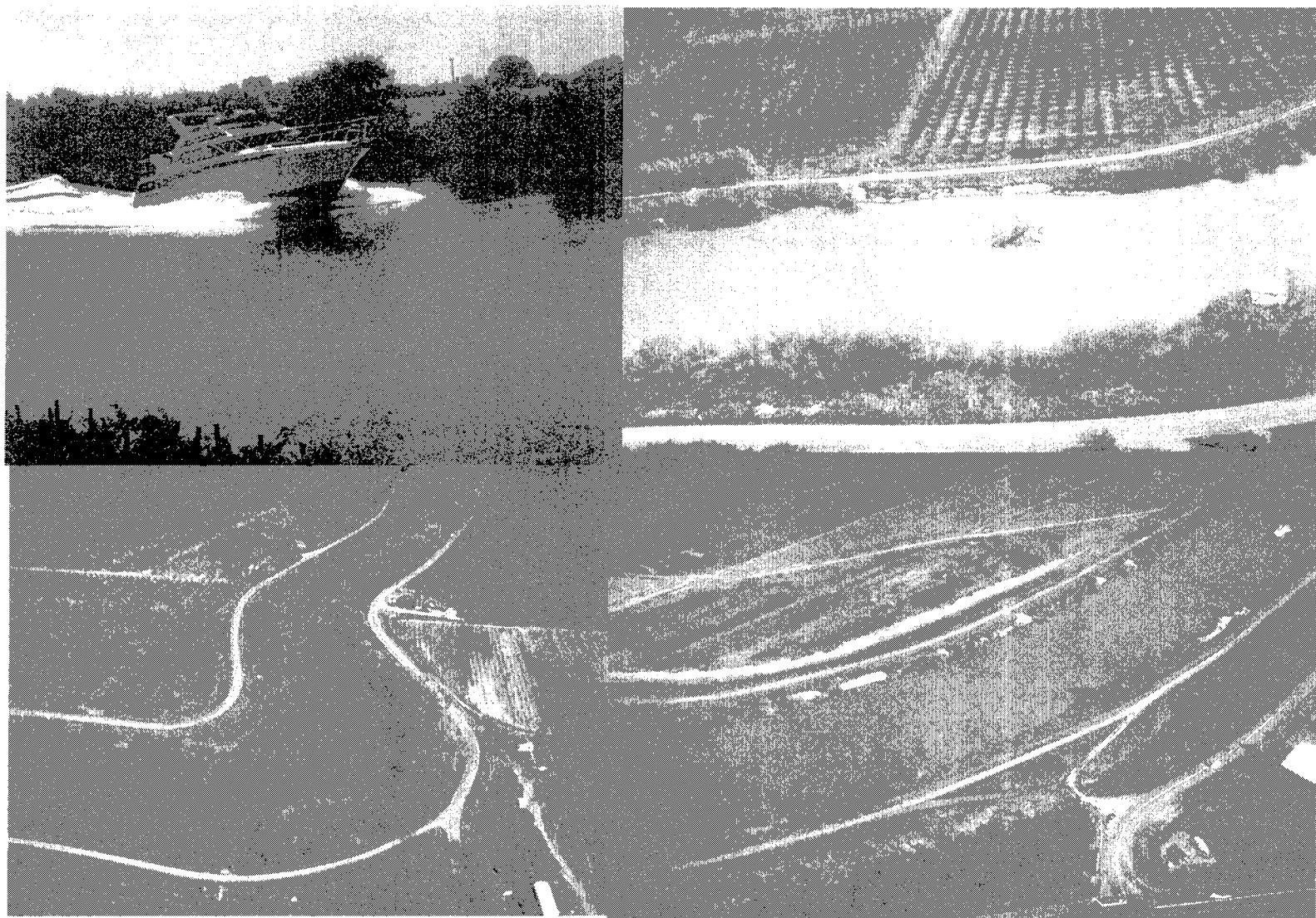
❖ Protection of existing berms

- Brush boxes/natural sedimentation
- Tree planting
- Vegetation management

❖ Creation of new berms through bioengineering and natural deposition

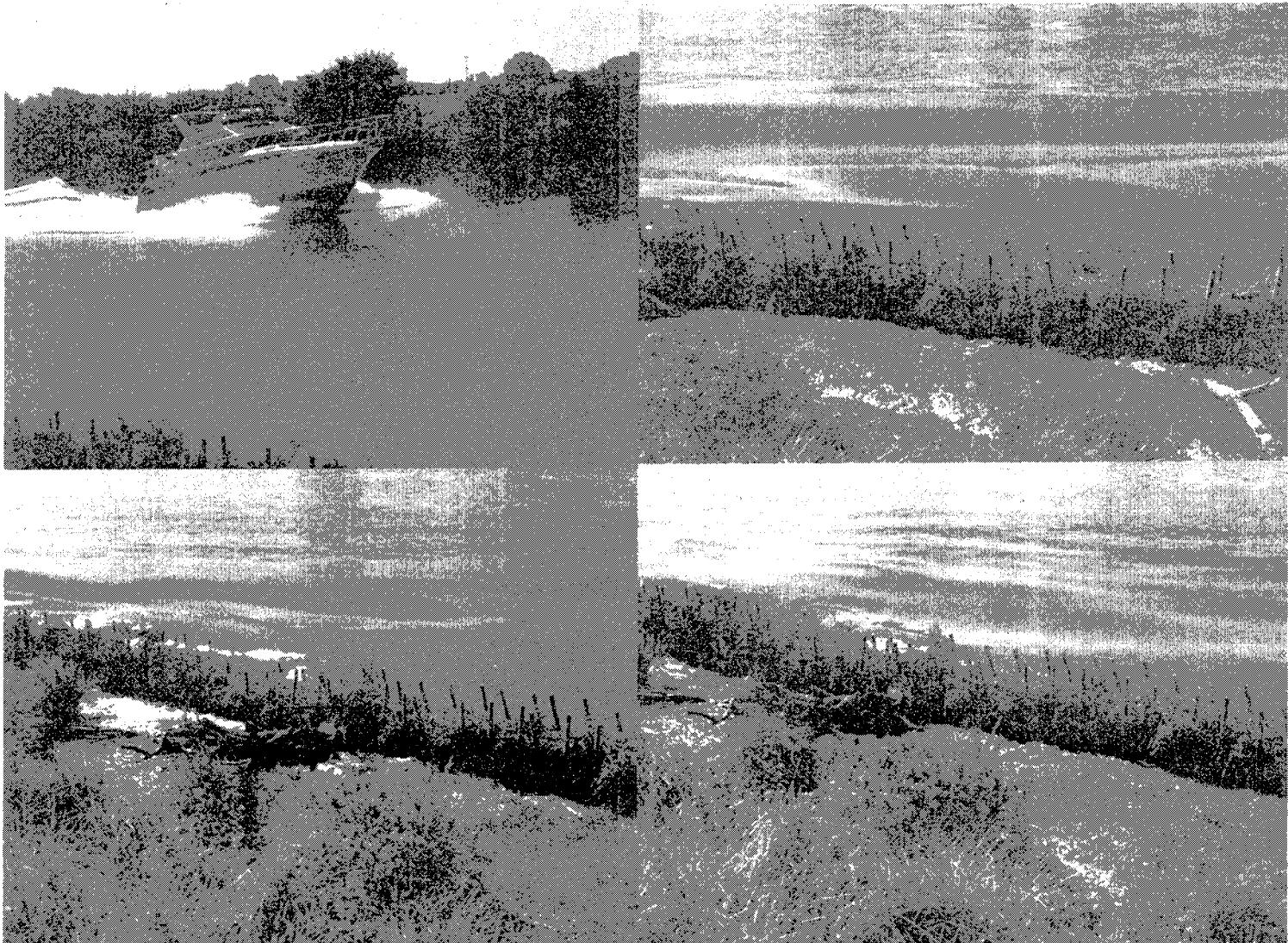
❖ Engineered creation of berms

Protection of Existing Berms



Boating induced erosion along Georgiana Slough...results in loss of protective berm and valuable habitat. Typically these eroded scallops are filled with riprap.

Alternative Bank Protection: Brush Boxes



Brush box structures reduce wave energy by 60-80%, allowing the site to accumulate sediment and protective vegetation.

Georgiana Slough

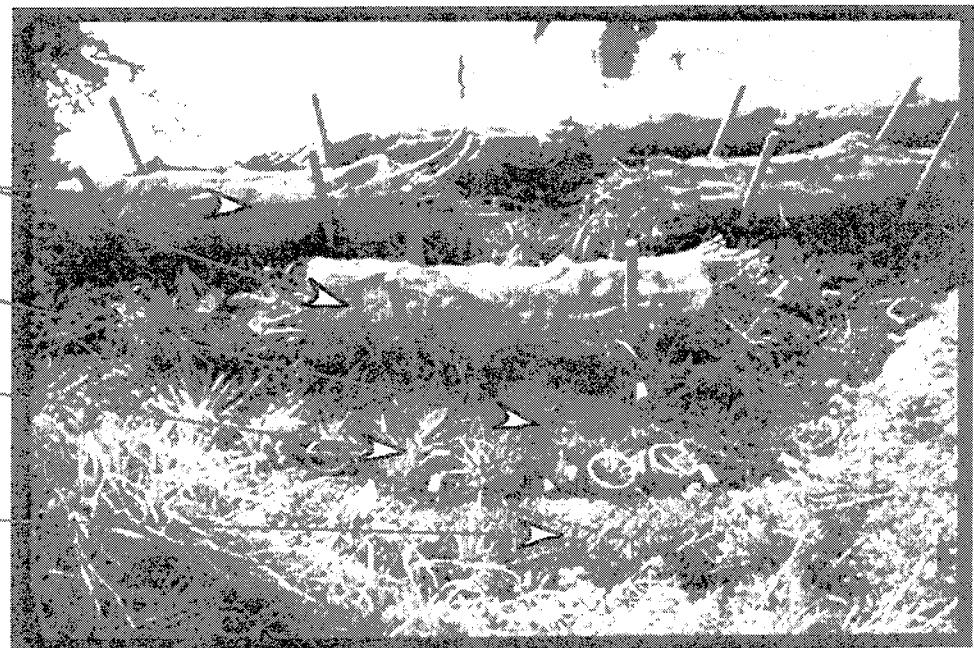


Brush boxes

Brush bundles

Ballast buckets

Coir biologs

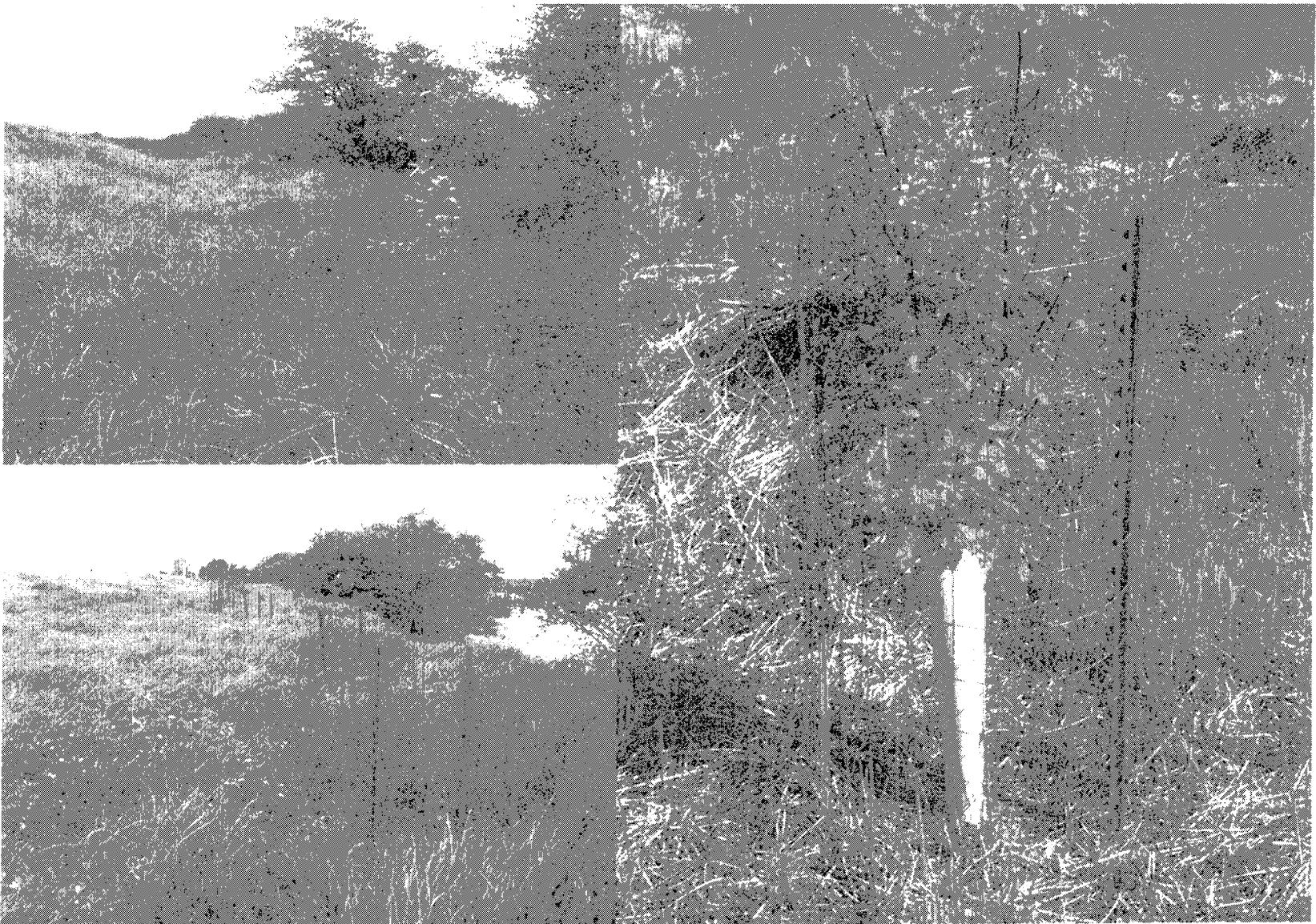


Upper left photo: eroding scallop, prior to treatment.

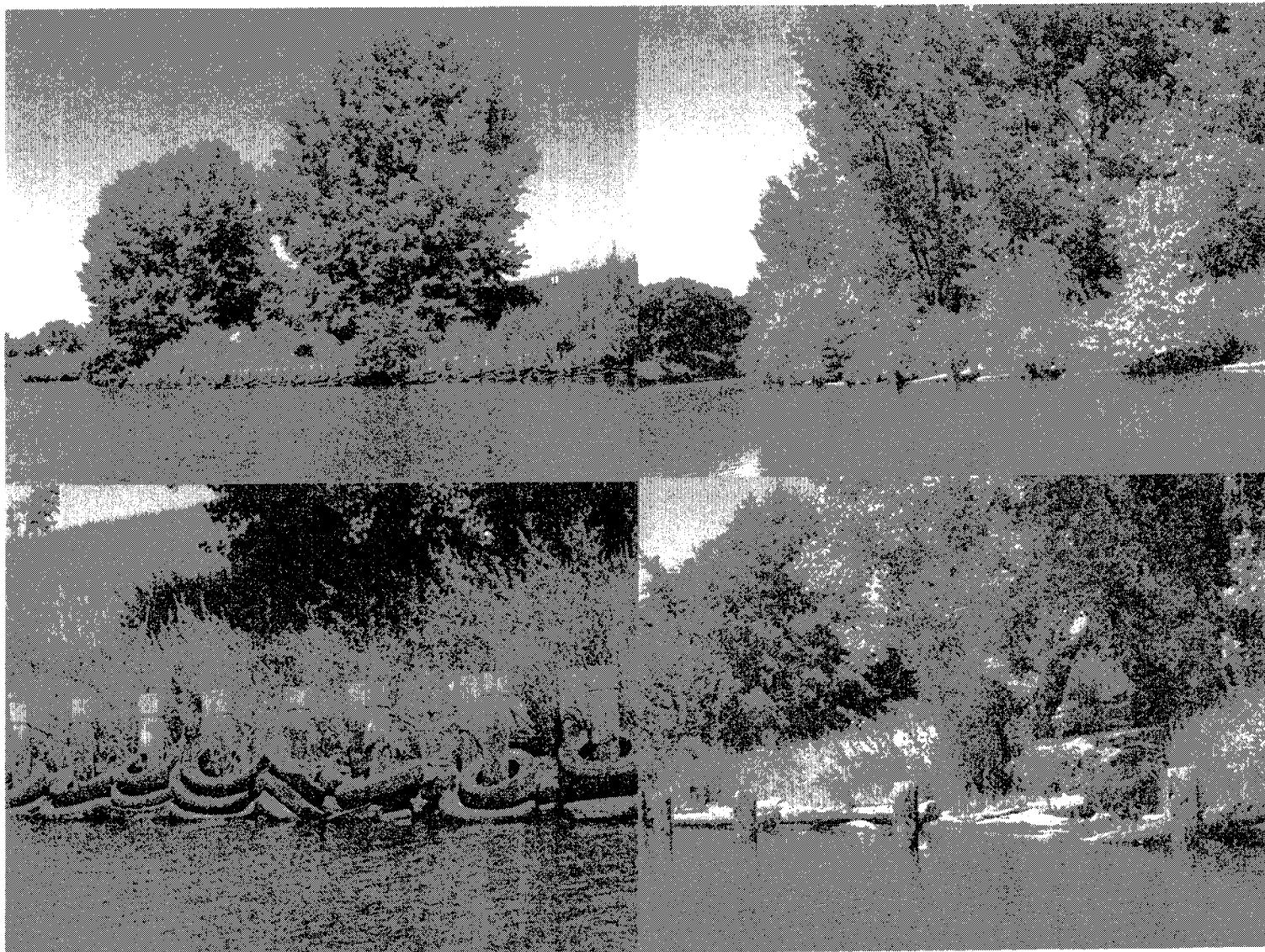
Upper right photo: treated site, first year (1998)

Lower left photo: developing site, 2002.

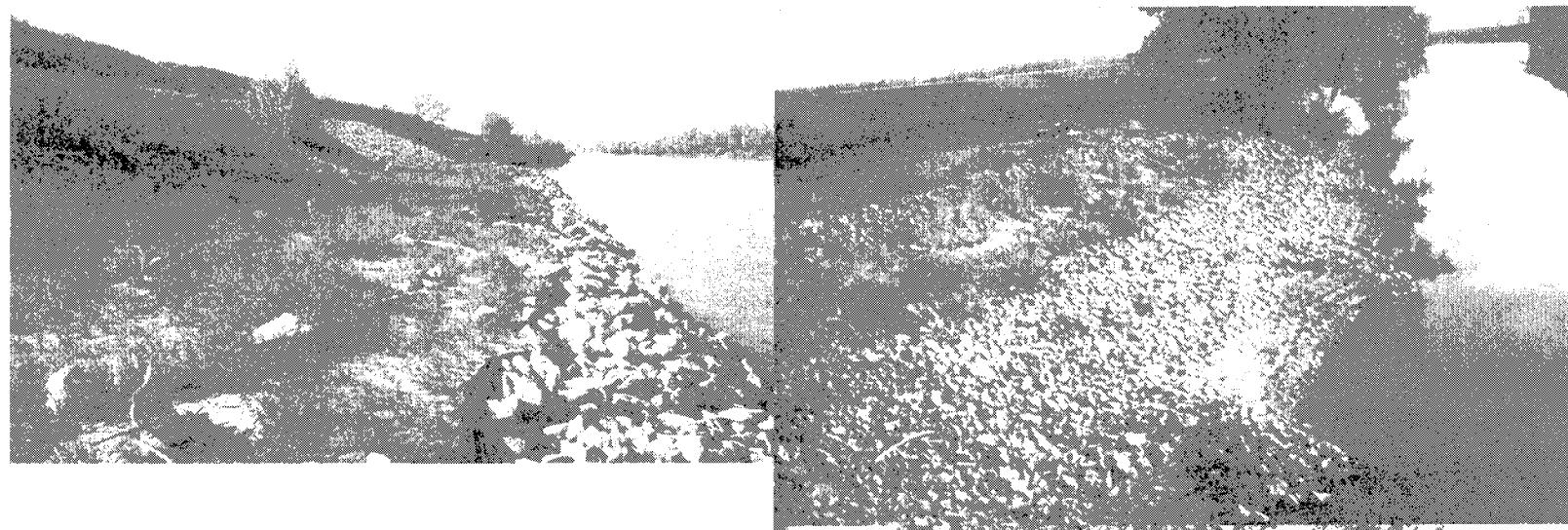
Protection of Berms: Tree Planting



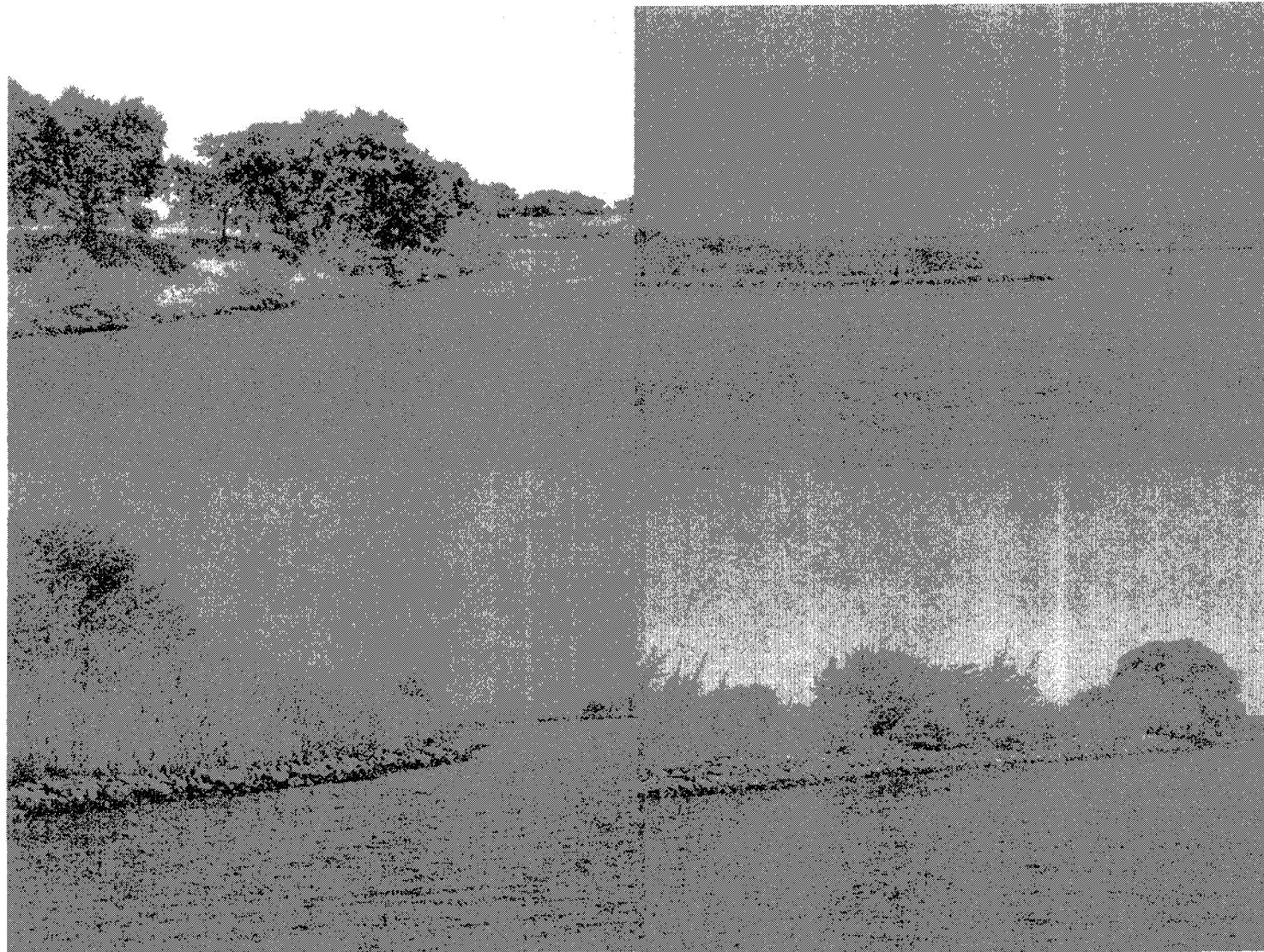
Alternative Berm Creation



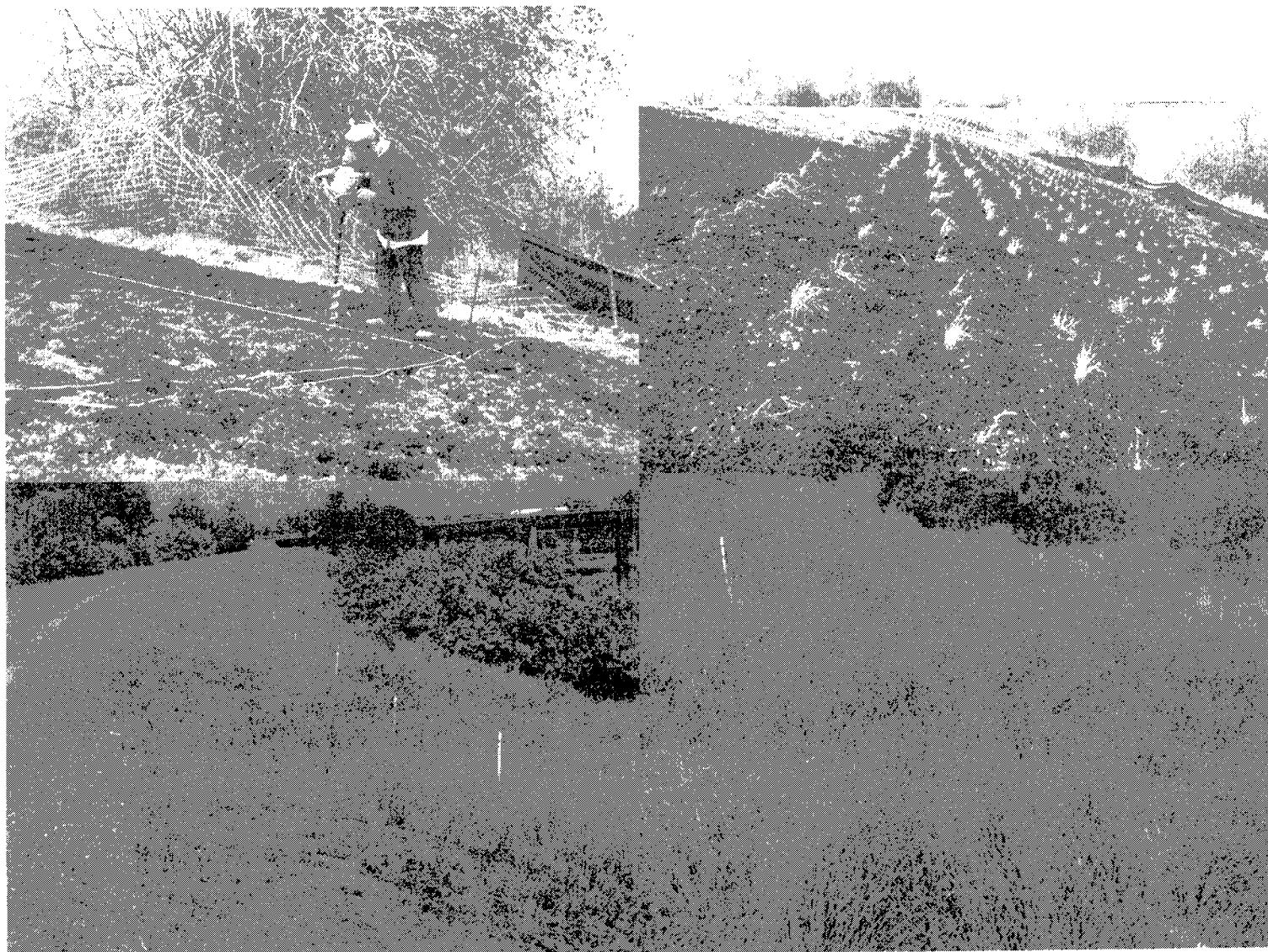
Creation of New Levee Berms Using Rock, Soil and Plants



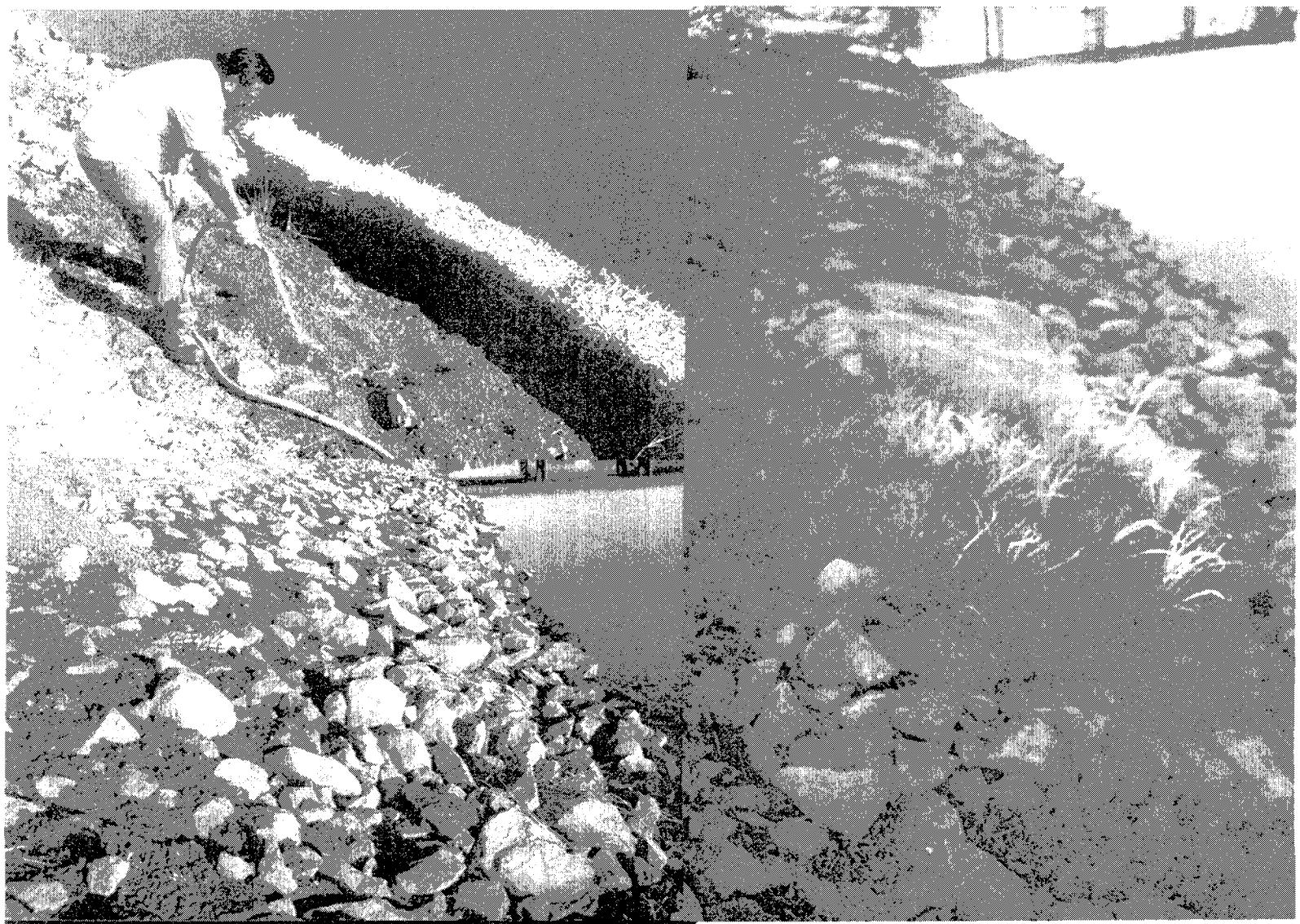
Rock Levee Berms



Grassy Levee Slopes



Levee Planting: Mixing Soil in Rock, Then planting



Green Levees:



Stronger, less flood prone

(especially if combined with other engineering techniques (including rock!))

Habitat for wildlife

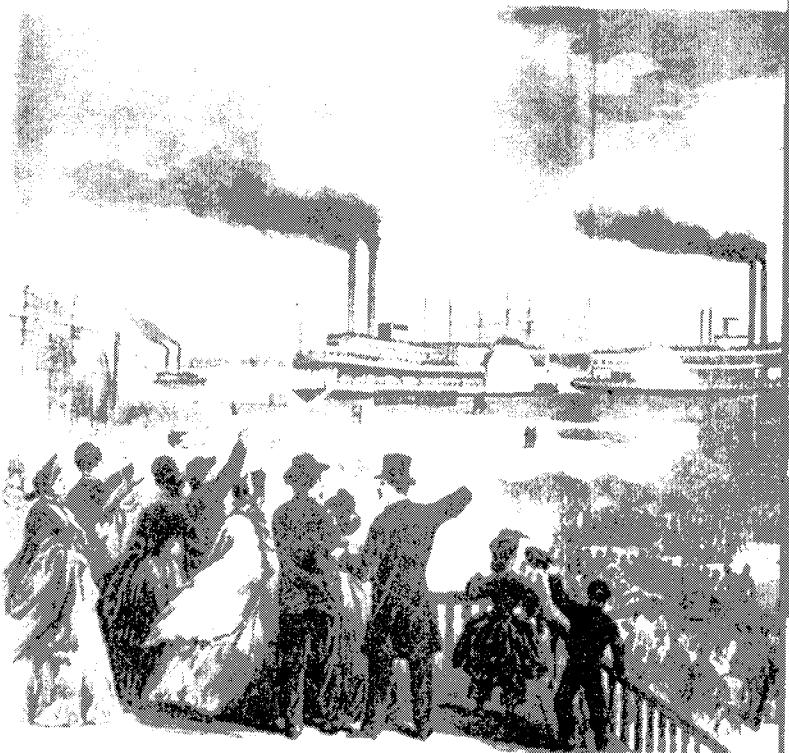


Beauty for recreation and public benefits

Public support leads to political support, funding

Engineered New Orleans Levees (Nature Lacking Here!)

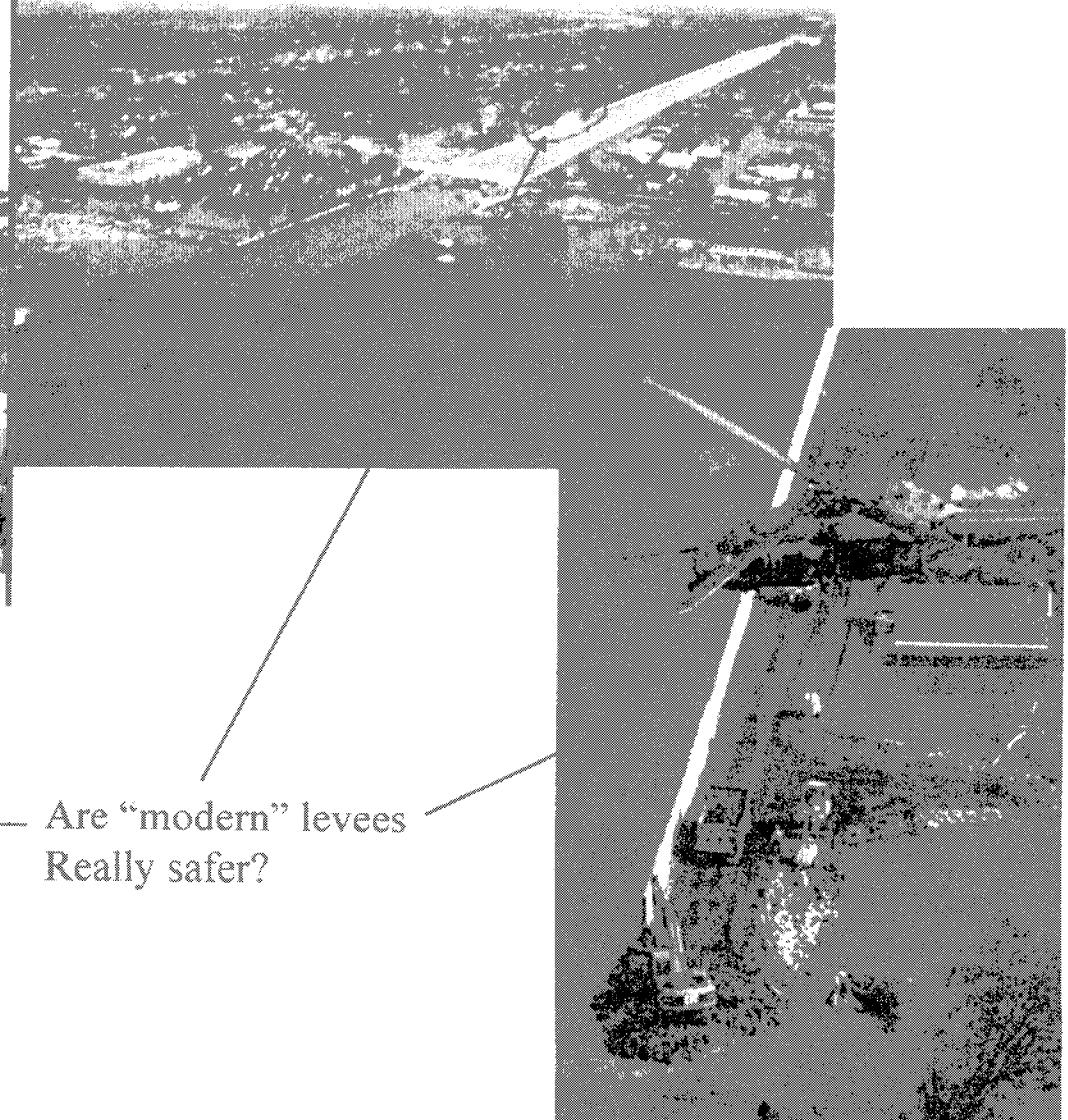
150 Years of Progress?



Original broad, vegetated levees



Are “modern” levees
Really safer?



Towards Sustainable Delta Levees

- ❖ Stable landform

- Oversized, gradual slope

- ❖ Tule/wetland plants on tidal mudflat

- ❖ Base of levee/bank:

- Perennial, herbaceous cover
 - Small to medium sized trees
 - Recreate berm...armor with rock if necessary

- ❖ Vegetation Management on waterside

- Seasonal remove vegetation for inspection
 - Selective spray
 - Goat or sheep grazing...don't overgraze!
 - Mowing may be best method, since root system stays intact