
Literature Review and Preliminary Assessment

**Vegetation Challenge Symposium
Sacramento, CA**

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Objectives of Literature Review

- **Collect and summarize literature pertinent to vegetation on levees**
- **Identify data gaps as defined in reviewed literature**



Literature Review

- **Guidance and government documents (Federal, State)**
- **Journal articles**
- **Proceedings/transactions**
- **Newspaper articles**
- **Gray literature (documents not published in accessible format)**
- **Personal communication**

Considerations When Reviewing Literature

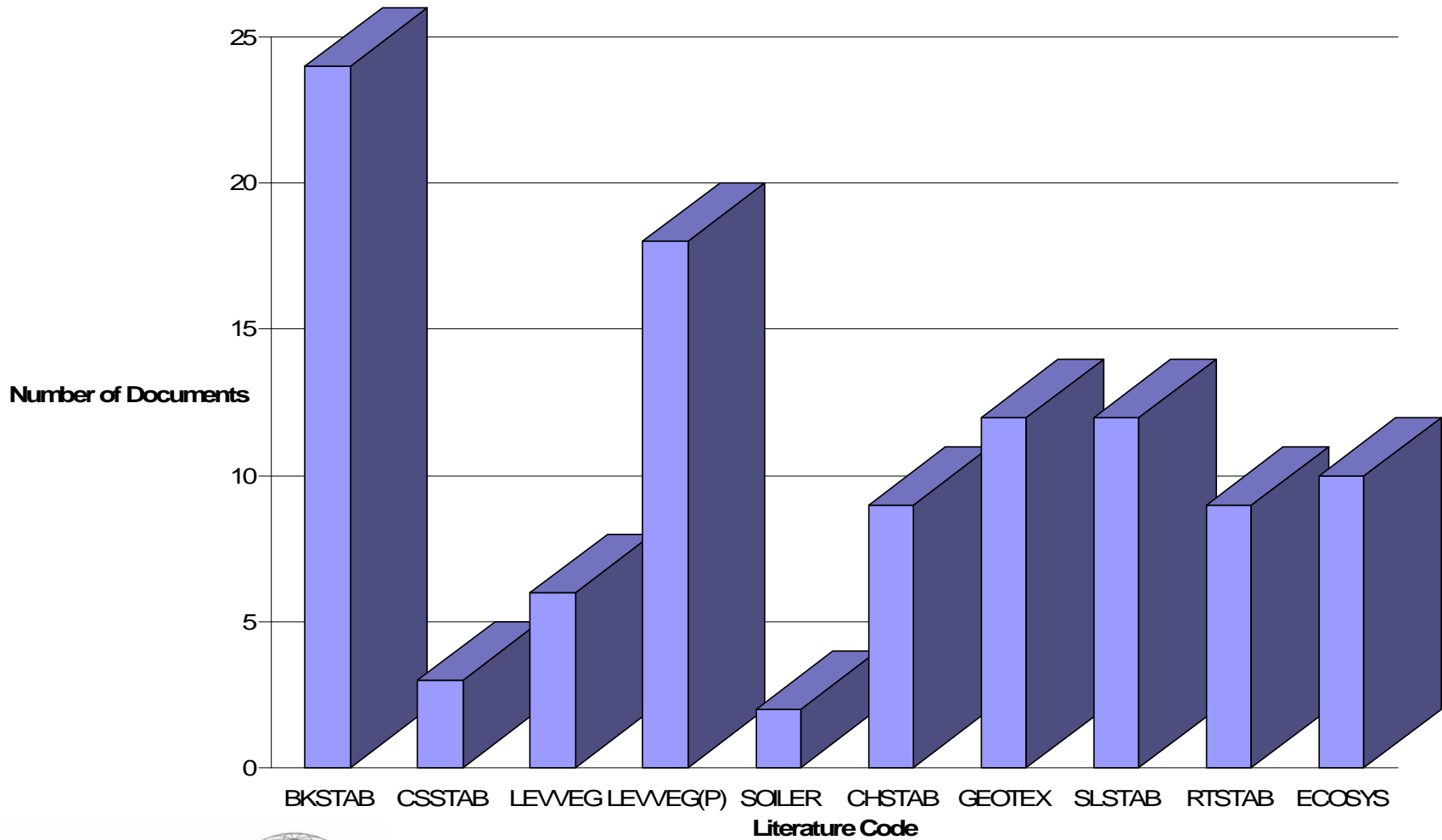
- **Include all types of vegetation (brush, grasses, and trees)**
- **Understand research focus and objectives**
- **Identify vegetation, soil properties, observations, and recommendations of the research**
- **Separate literature that deals directly with vegetation on levees from literature that may offer an insight into the issue, but does not focus on levee vegetation**

Literature Review Format

- **Title, publication information, peer-reviewed**
- **Abstract**
- **Objective(s)**
- **Methodology**
- **Soil Properties**
- **Study Location**
- **Results**
- **Recommendations**

Code System Used in Literature Review

- **ECOSYS (Ecosystem)**
- **LEVVEG (Levee vegetation)**
- **LEVVEG(P) (Levee vegetation – pertinent)**
- **BKSTAB (Bank stabilization)**
- **SLSTAB (Slope stabilitation)**
- **GEOTEX (Geotextiles; includes bioengineering)**
- **RTSTAB (Root stabilization)**



International Guidance Documents

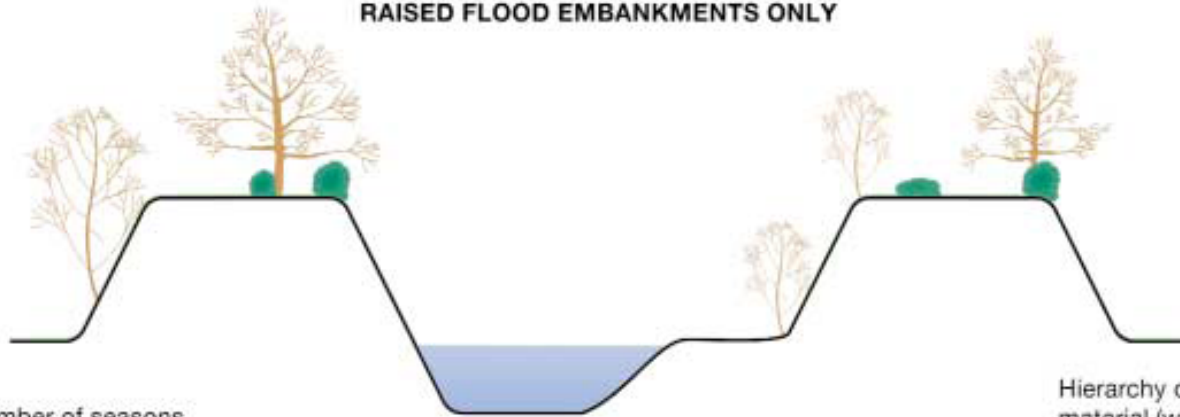
- **United Kingdom** – *Environmental Options for River Maintenance Works (2003)*
- **Japan** – *Manual for River Works in Japan (no date)*
 - **Section 5.2 Afforestation of Rivers**
- **Netherlands** – *Dutch Guidelines on Dike Protection (1987)*
- **Chinese** – not in English

United Kingdom Guidelines

- **Use Environmental Options (EO) to address vegetation and environmental concerns on embankments**
 - **EOs are a series of cross-section and long-section drawings, which provide a visual picture of desired environmental outcome**
- **Balance each EO with the flood defense needs of the watercourse, including health and safety issues**
- **Flood Defense Operations should decide the flood defense standards required and then agree on the appropriate EO to meet these standards with the Fisheries, Recreation, Biodiversity Team (FRB)**

Raised Flood Embankments

RAISED FLOOD EMBANKMENTS ONLY



Phase over a number of seasons

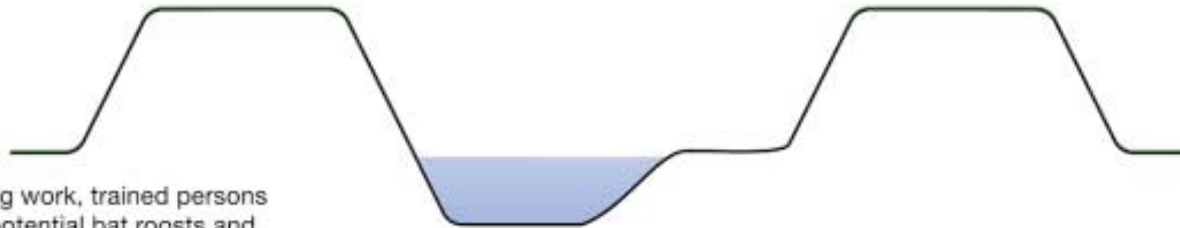
Trees and branches less than 25cm diameter are unlikely to be used by bats

Trees are an important habitat, particularly when in contact with water

Hierarchy of options for cut material (will depend upon site and volume of material)

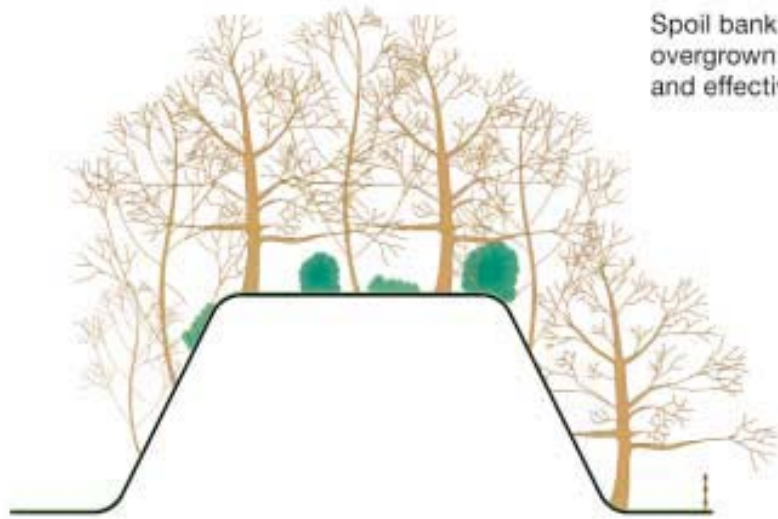
Stack
Burn
Chip
Remove

All trees and bushes removed from embankments



Before and during work, trained persons should look for potential bat roosts and other holts that would be affected by the work. If suspected stop work and contact FRB Team

Spoil Bank or Raised Flood Embankment



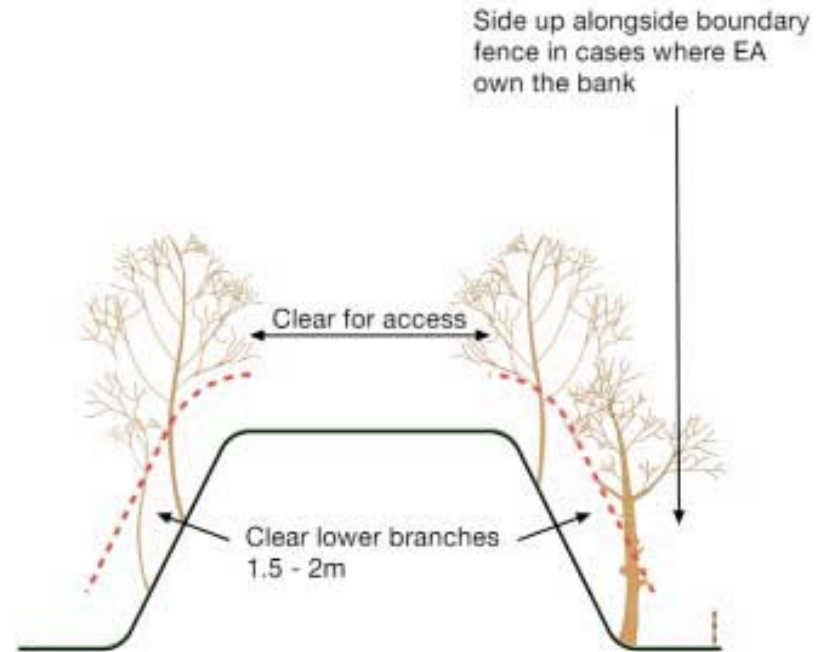
Spoil bank or raised flood embankment overgrown - preventing access for plant and effective vermin control

Cut once every 5 - 10 years

Before and during work, trained persons should look for potential bat roosts and other holts that would be affected by the work. If suspected stop work and contact FRB Team

Trees and branches less than 25cm diameter are unlikely to be used by bats

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Japanese Guidance

- **Afforestation of dikes allowed for environmental and planning purposes as long as the afforestation will not obstruct river control measures.**
- **Manual restricts type and position of tree planting**

Literature Review – Vegetation on Levees

- **1967** *Pilot levee maintenance study* (L.C. Davis, S.I. Ito, and P.T. Zwanch): California Dept of Water Resources
- **Objective:** Test alternative methods of levee maintenance that could test alternative methods of levee maintenance that could provide for multiple uses of levees, specifically Sacramento-San Joaquin Delta
 - Trees and shrubs may be allowed on the levee slope in open patterns where berms do not exist on the waterside of the levee
- **Recommendations:** Timely repair of toe erosion of levees and berms can head off major reconstruction work, which involves removal of vegetation

Literature Review – Vegetation on Levees

- **1984** *The role of vegetation in an integrated pest management approach to levee management* (S. Daar, W. Klitz, W. Olkowski): California Riparian Systems
- **Problem Statement:** Practice of yearly vegetation removal and frequent soil disturbance creates and aggravates a series of levee maintenance problems ranging from erosion to ground squirrels
- **Recommendations:**
 - Offers an integrated pest management (IPM) approach to levee vegetation
 - Recognizes the uniqueness of the levee environment and not treating the entire levee system with the same vegetation clearing approach

Literature Review – Vegetation on Levees

- **1987** *Environmental considerations for levees* (N.R. Nunnally, F.D. Shields, J. Hynson). Environmental Management
- **Objective:** Review environmental concepts successfully employed on levee projects in 1980s
- **Methodology:** Data review
- **Recommendations:**
 - More information is needed on vegetal aspects of levee maintenance
 - What types of grasses and maintenance techniques will control erosion on levee slopes, allow periodic inspection, and provide wildlife habitat benefits?
 - Can current levee maintenance standards be revised to allow more woody vegetation without increasing hazard?

Literature Review – Vegetation on Levees

- **1991** The effects of vegetation on the structural integrity of sandy levees (D. Gray, A. MacDonald, T. Thomann, I. Blatz, F.D. Shields, Jr.): WES TR REMR-EI-5
- **Objective:** Investigate the relationship between vegetation and the structural integrity of river levees
 - Determine distribution of roots within levee embankments and how these roots alter soil properties of levee embankments
 - Use data to develop engineering criteria that may allow vegetation (particularly woody) to remain on levees
- **Methodology:** Used root area ratio, botanical information, slope stability analyses
- **Conclusions:** Based on preliminary field studies on a sandy levee, it does not appear woody vegetation adversely affects the structural integrity of a levee; study does not address other issues, such as flood fighting and inspections

Literature Review – Vegetation on Levees

- **1991 REMR (Continued)**
- **Recommendations (General)**
 - **Conduct similar field studies in levees made of cohesive soils and compare results with those obtained for sandy levees**
 - **Conduct studies in regions where climatic conditions are more humid and vegetation spectrum is different from the semi-arid conditions of central California**

Literature Review – Vegetation on Levees

- **2007** *Documentation and analysis of tree root extent and behavior along and in levees and floodwalls in the New Orleans District* (JESCO International)
- **Objective:** Data collection of tree root extension from photographs and root-profile wall mapping
- **Observation:** tree root systems may bind soil together reducing erosion and landslides; overturning trees may exacerbate the loss of levee integrity
- **Questions:** Does root extension change when encountering a levee? Root growth and extension needs to be measured on undisturbed soil for urban conditions
- **Recommendations:** Construction of a physical model to explore effects of root channels on outfall levees

- **Further research to recognize interaction of vegetation with individual components of the levee**
- **Address levees not as an entire unit, but as separate environmental communities and establish specific yet different guidance for these areas**
- **Extend future research to a system-wide approach to better understand the interaction of the environment with different components of the levee system and river community**

Observations and Recommendations

- **Include all aspects of vegetation on levees in future research (i.e. the issue of levee inspection was rarely addressed)**
- **Use scientific and engineering support for guidance that addresses vegetation on levees**