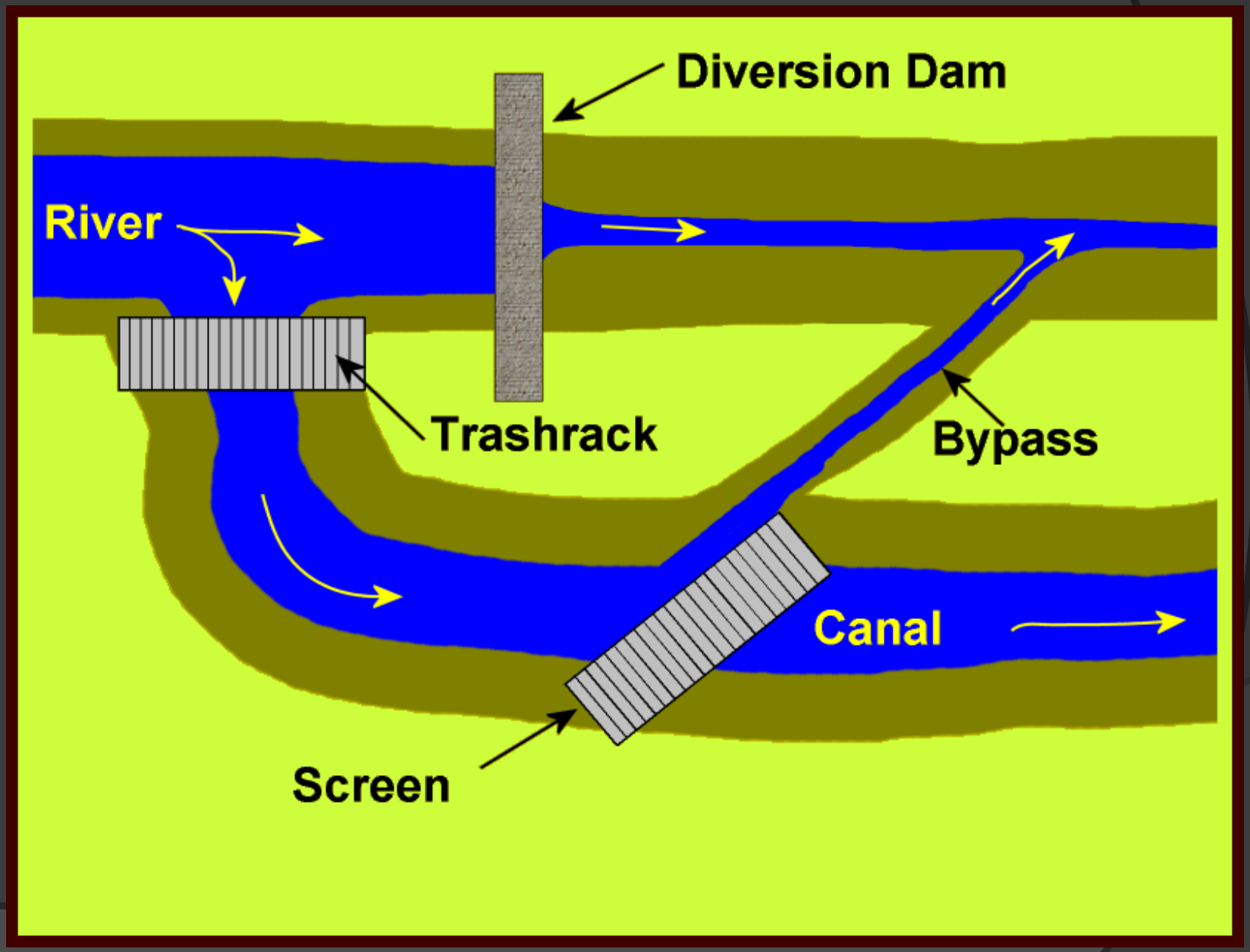
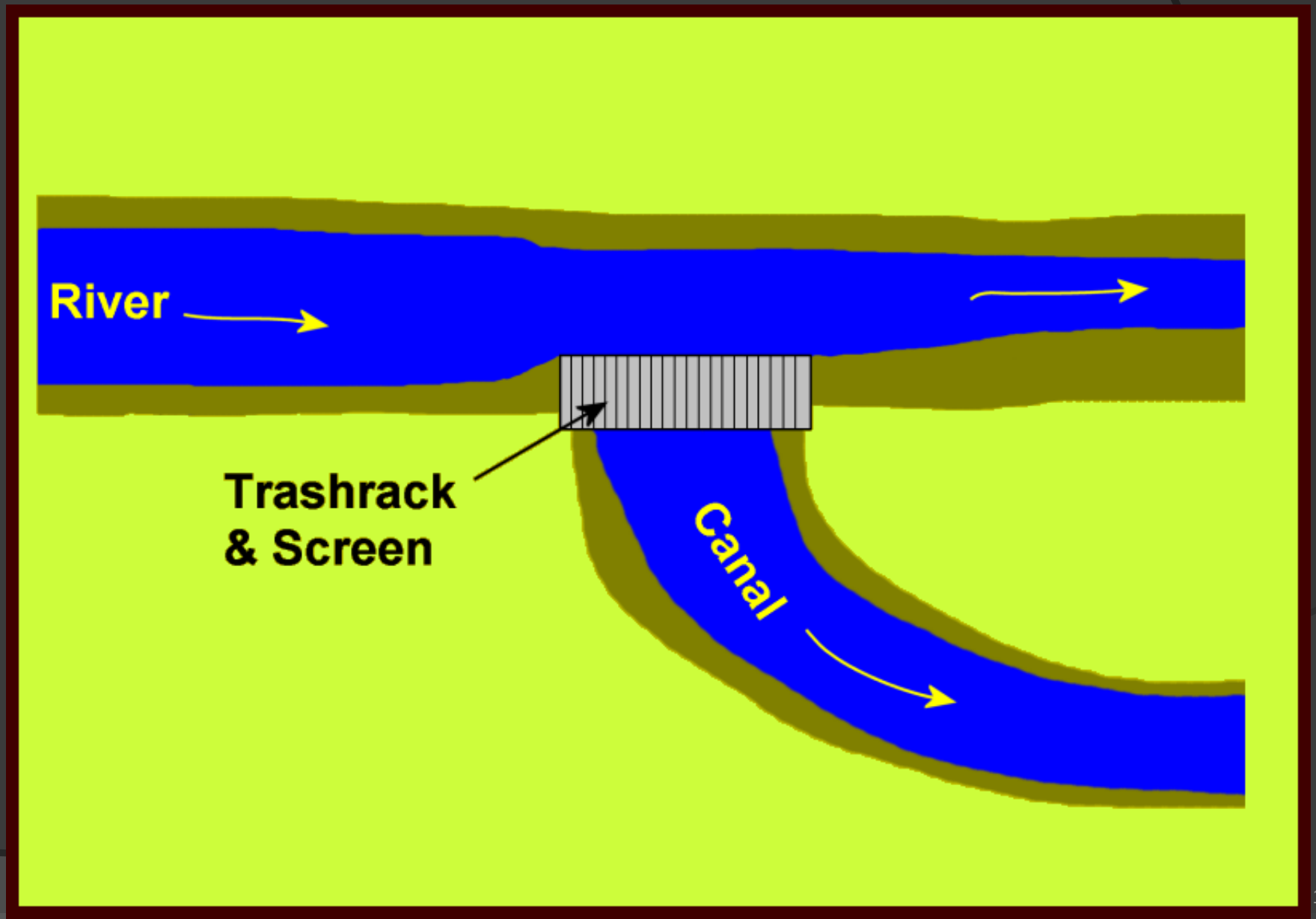
Topics - continued

6. Selecting the Screen Structure Site
7. Facility Design
    - Criteria
    - Velocity
    - Screen Materials
8. Types of Positive Barrier Screens
9. Debris
10. Screen Velocity - Balancing

Topic 1. – Generic Water Diversion



On-Channel Diversion



Topic 2. Swimming Capability of Juvenile Fish

- List of references is in Notebook
- University of Washington Fisheries Research Institute study (Smith and Carpenter, 1987) was used to develop fish screen criteria
- USFWS Bull Trout studies

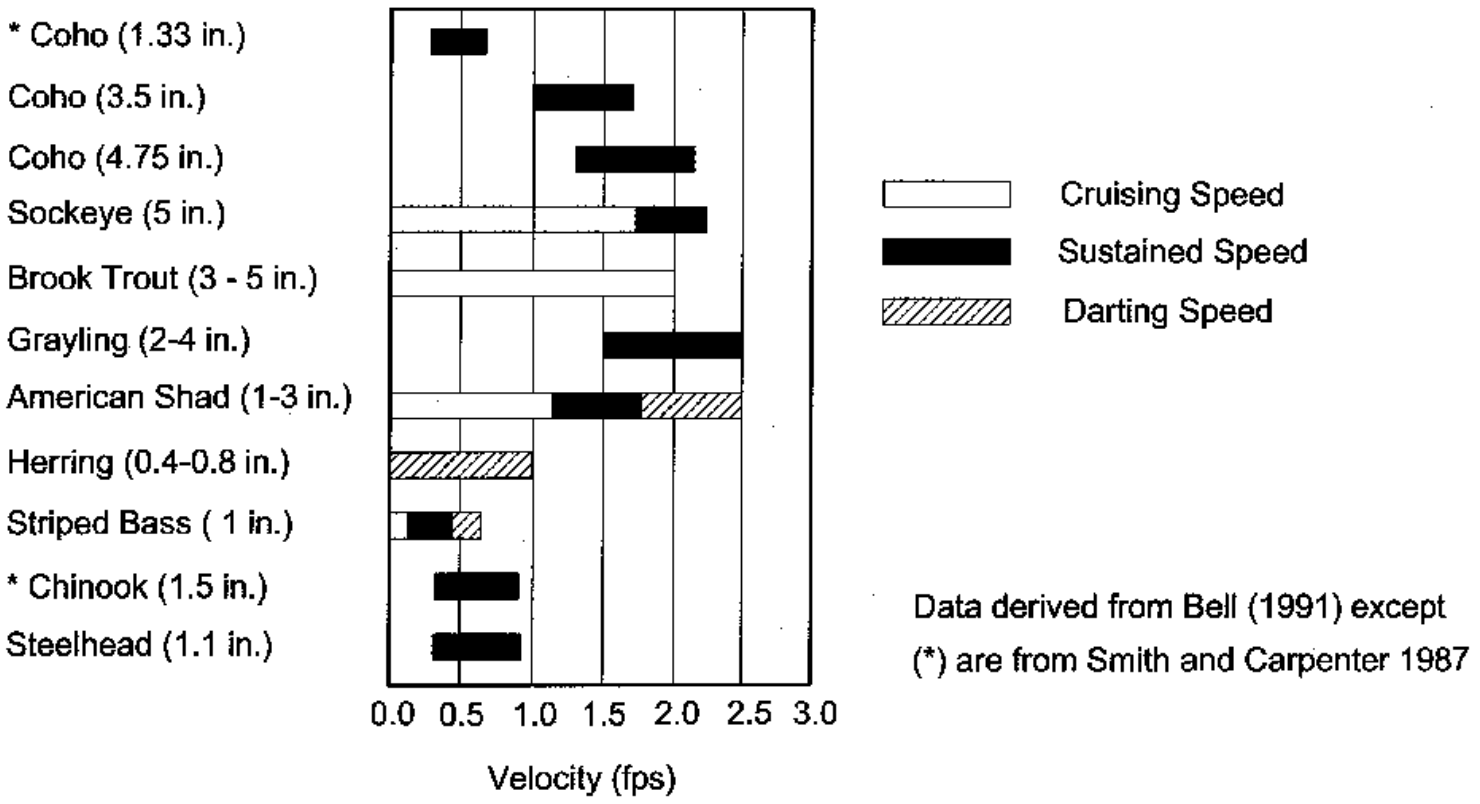
Factors Related to Swimming Capability

- Approach velocity, sweeping velocity, and canal velocity
- Water Temperature
- Fish Size
- Swimming Time Duration
- Dissolved Oxygen Level

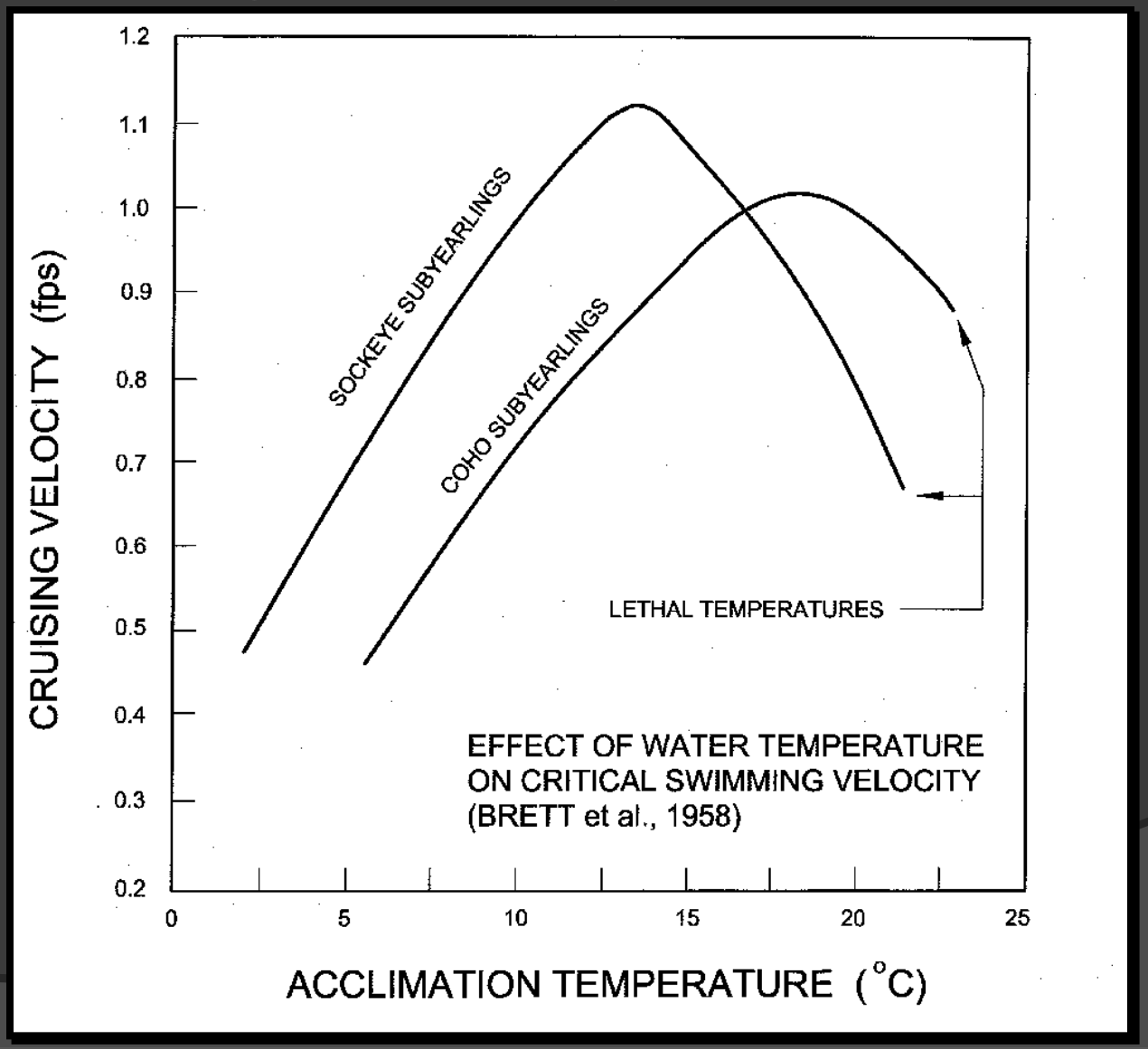
Swimming Speeds Classification

	Cruising Speed	Sustained Speed	Darting Speed
Used for:	Migration	Avoid Obstacles	Escape Predators
Duration of:	Hours	Minutes	Seconds

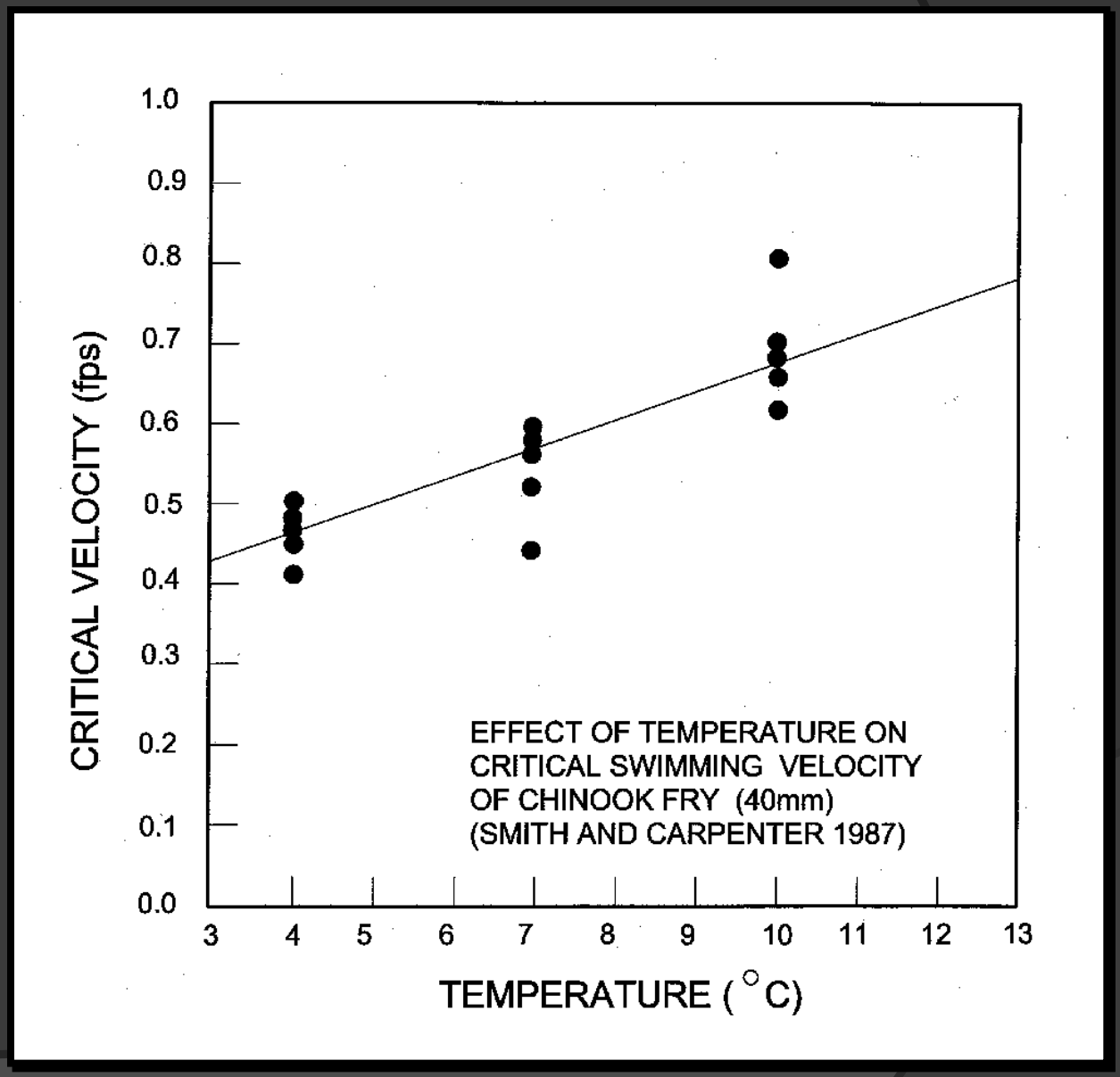
Juvenile Fish Swimming Speeds



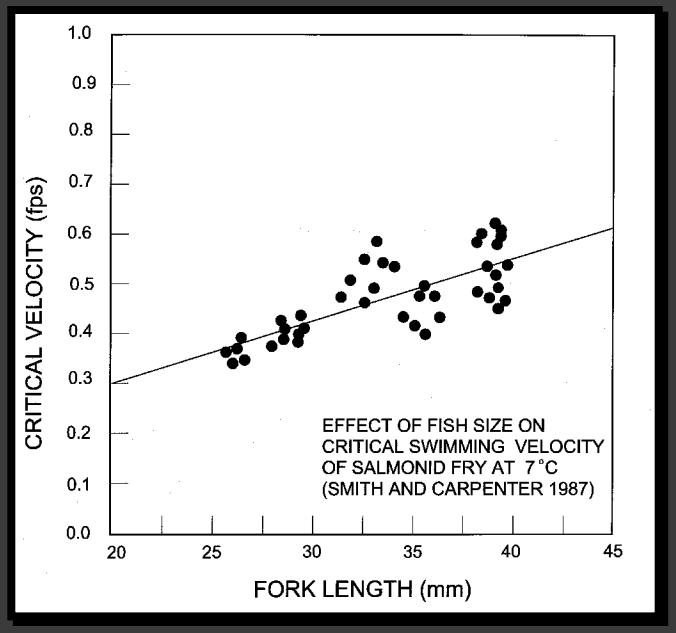
Effect of Water Temperature on Cruising Velocity



Effect of Temperature on Critical Velocity



Effect of Fish Size on Critical Velocity



Topic 3. Behavior of Juvenile Salmonids

- Physiology and Migration
- Design issues
- Dams and Water Diversions
- Reservoir Passage - turbulence
- Guidance in dam forebays
- Routes

Behavior of Juvenile Fish- contd.

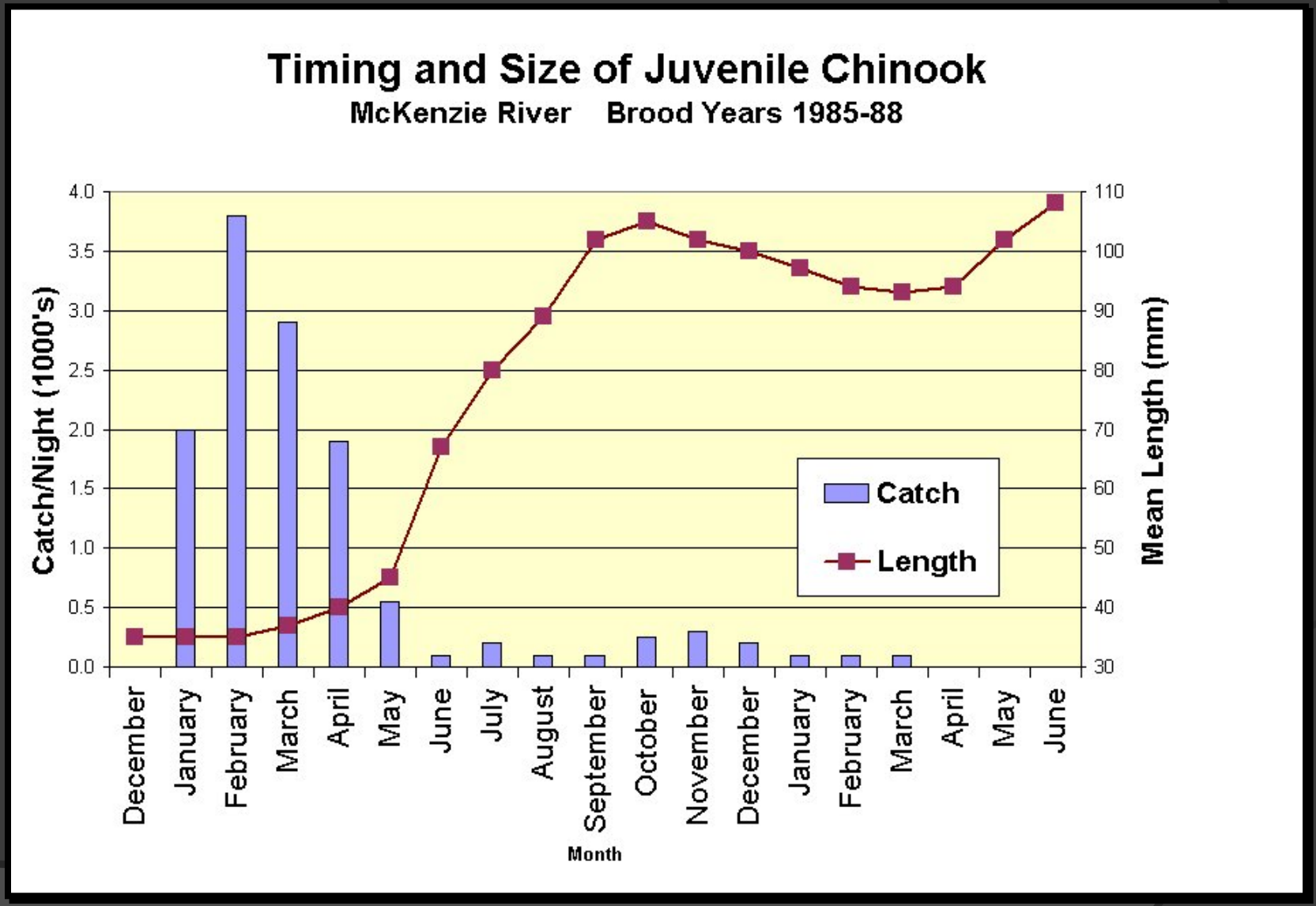
- Reluctance to enter small bypasses
- Preference for day or night migration past screen structures
- Migration corridors in lakes (shoreline? deep?)
- Lateral line function
- Dissolved Oxygen Level

Physiology

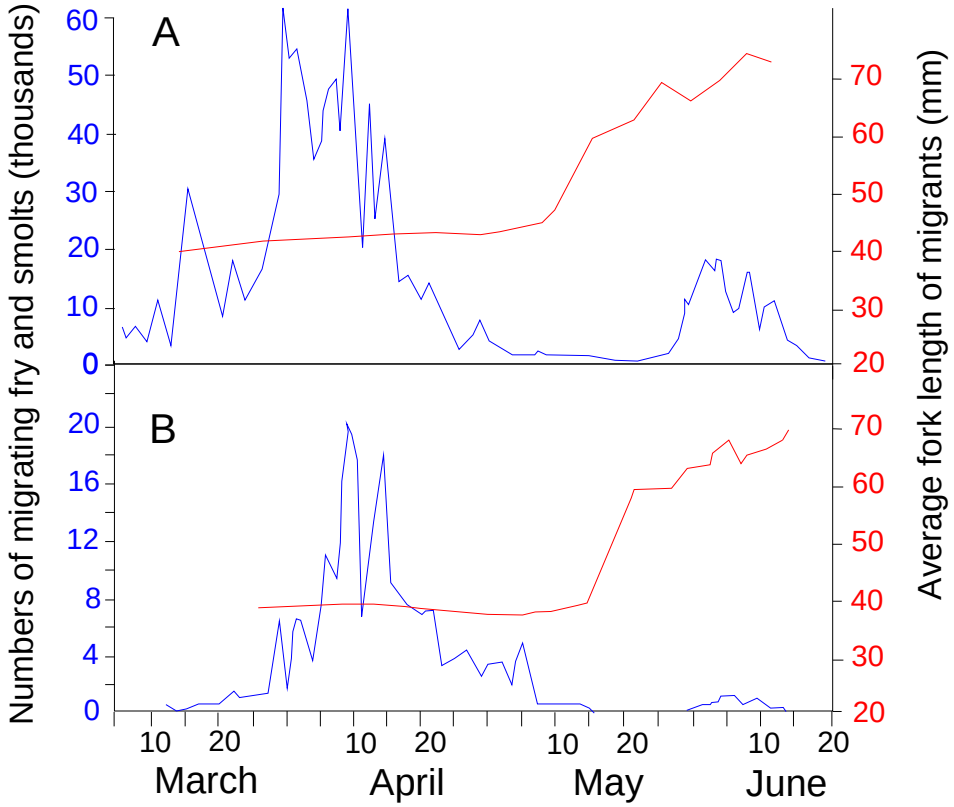
Smolt characteristics compared with parr

- Body silvering (+)
- Salinity tolerance (+)
- Growth rate (+)
- Weight per unit length (-)
- Body total lipid content (+)
- Blood glucose (+)
- Gill microsome, Na, K, ATPase enzyme activity (+)

Migration Timing and Fish Size



Migration Timing and Fish Size



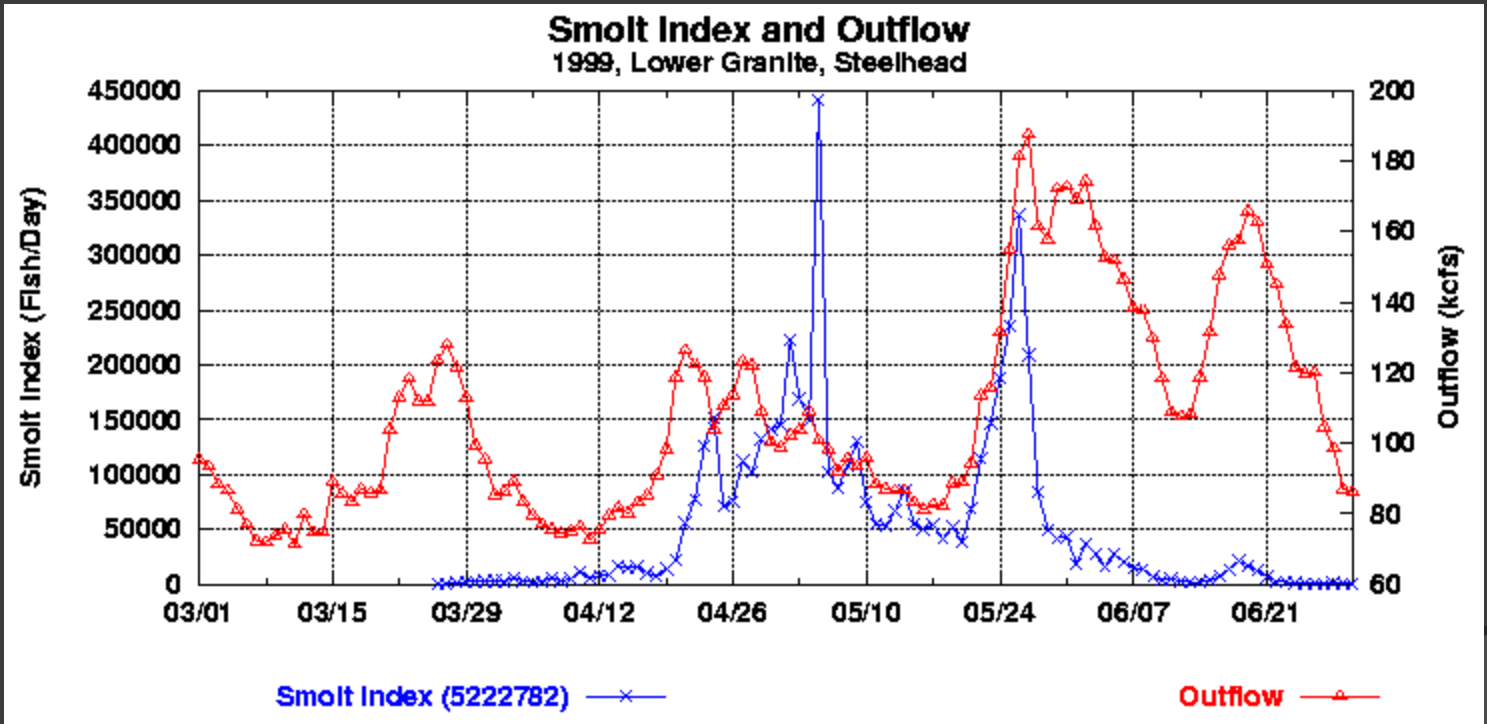
CHINOOK RUN TIMING

Temporal Pattern of Fry and Sub-Yearling Smolts in Two Rivers on Vancouver Island

A - Cowichan River - 1967
B - Nanaimo River - 1980

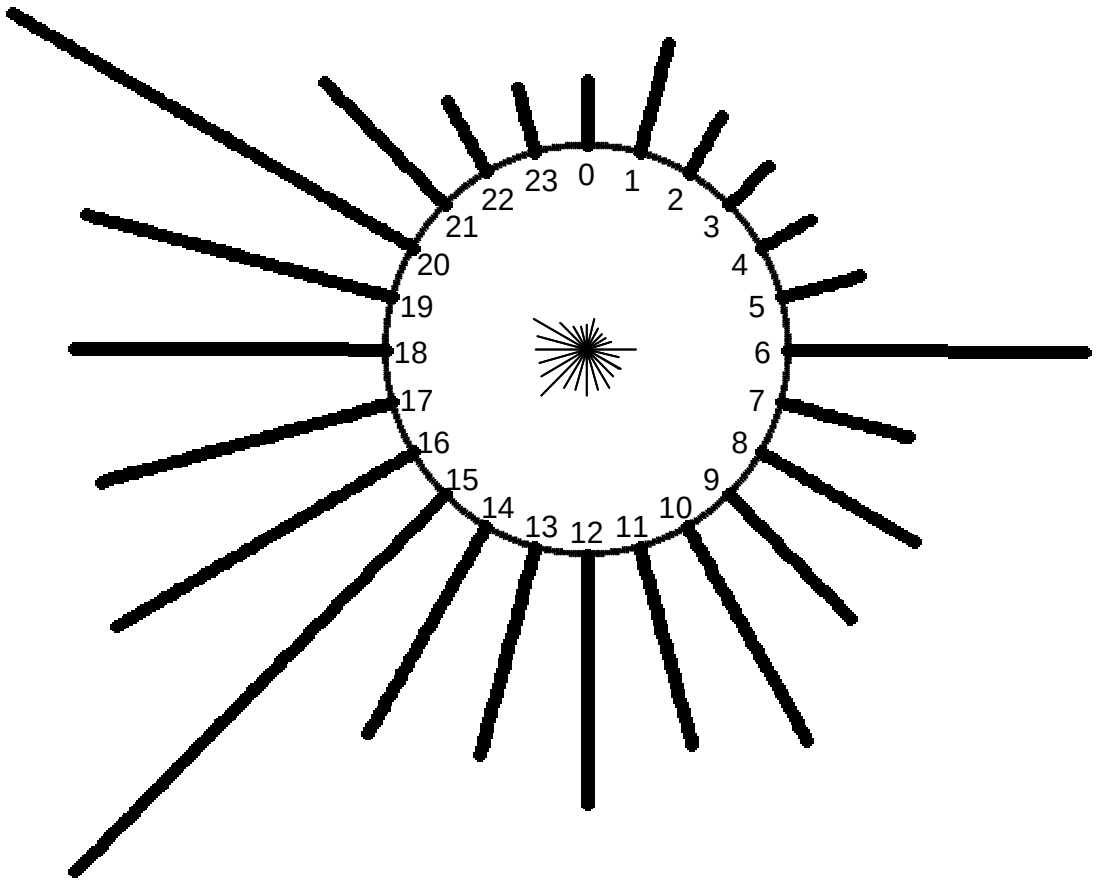
Source: Groot and Margolis 1991

Effect of River Flows



Diurnal migration effect

Arrival of sockeye salmon at Rocky Reach sampler



Topic 4. Basic Methods of Guiding Juvenile Salmonids

- A. Physical Barriers
  - 1. Fish screen or rack to prevent fish entry into diversion
  - 2. Preferred screen design - guide fish to bypass without contacting screen
- B. Behavioral Devices

Examples of Physical Barriers

- Vertical and Non-Vertical Fixed-Plate Screens
- Traveling Screens
- Cylindrical Screens
  - Rotating Drum Screens
  - Fixed Cylindrical Screen
- Eicher Screens and Modular Inclined Screens
- Pump Intake Screens
- Cone Screens

Examples of Behavioral Devices

- Sound
- Light
- Electric Fields
- Hydraulic Action

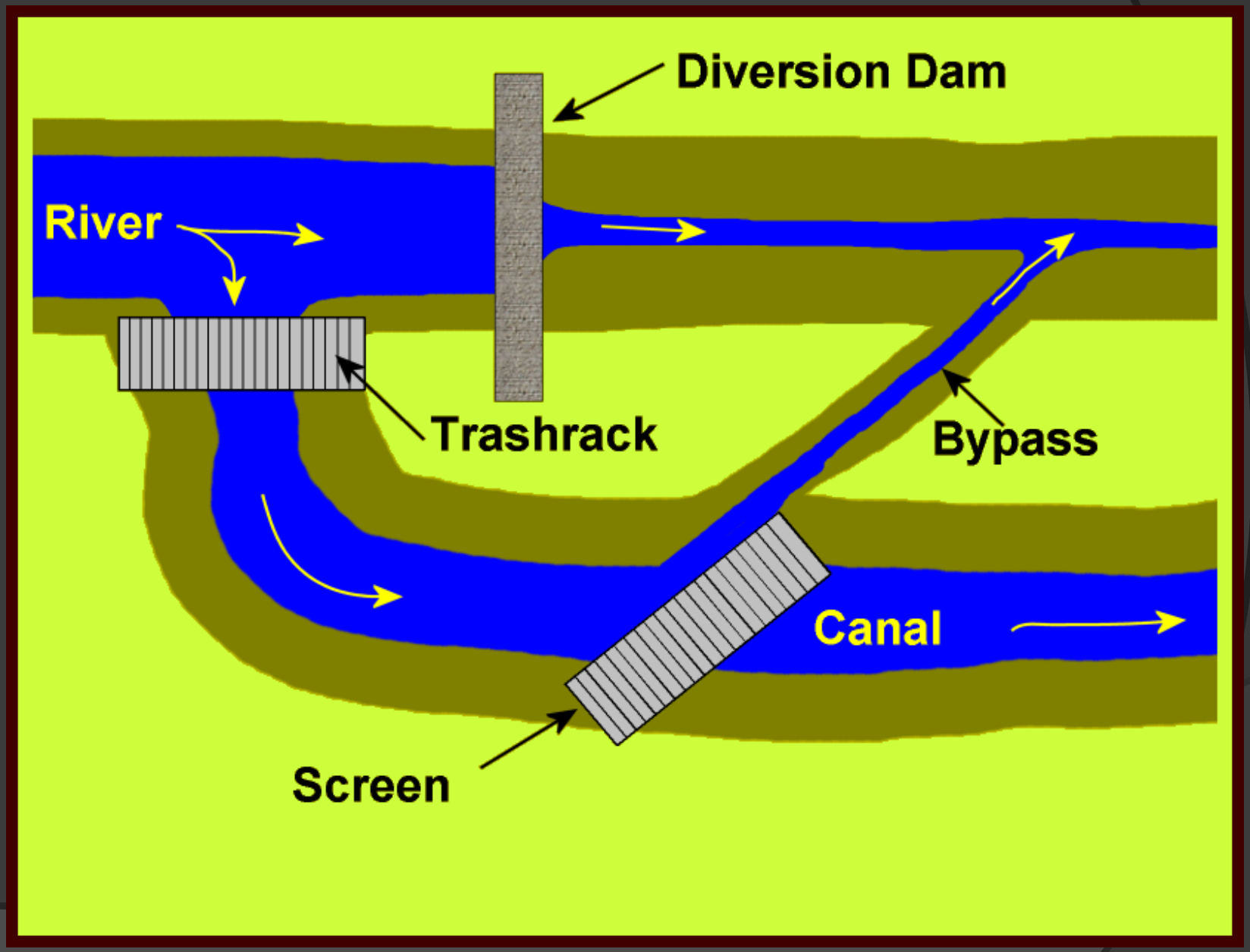
Topic 5. Design Objectives

- **Guide Fish Past Screens:**
  - **Without contacting screen - impingement**
  - **Without entrainment through seals, mesh, other gaps**
  - **Without delay - guidance**
  - **Without injury or mortality**
  - **Minimizing stress to fish**
  - **Minimizing predation**

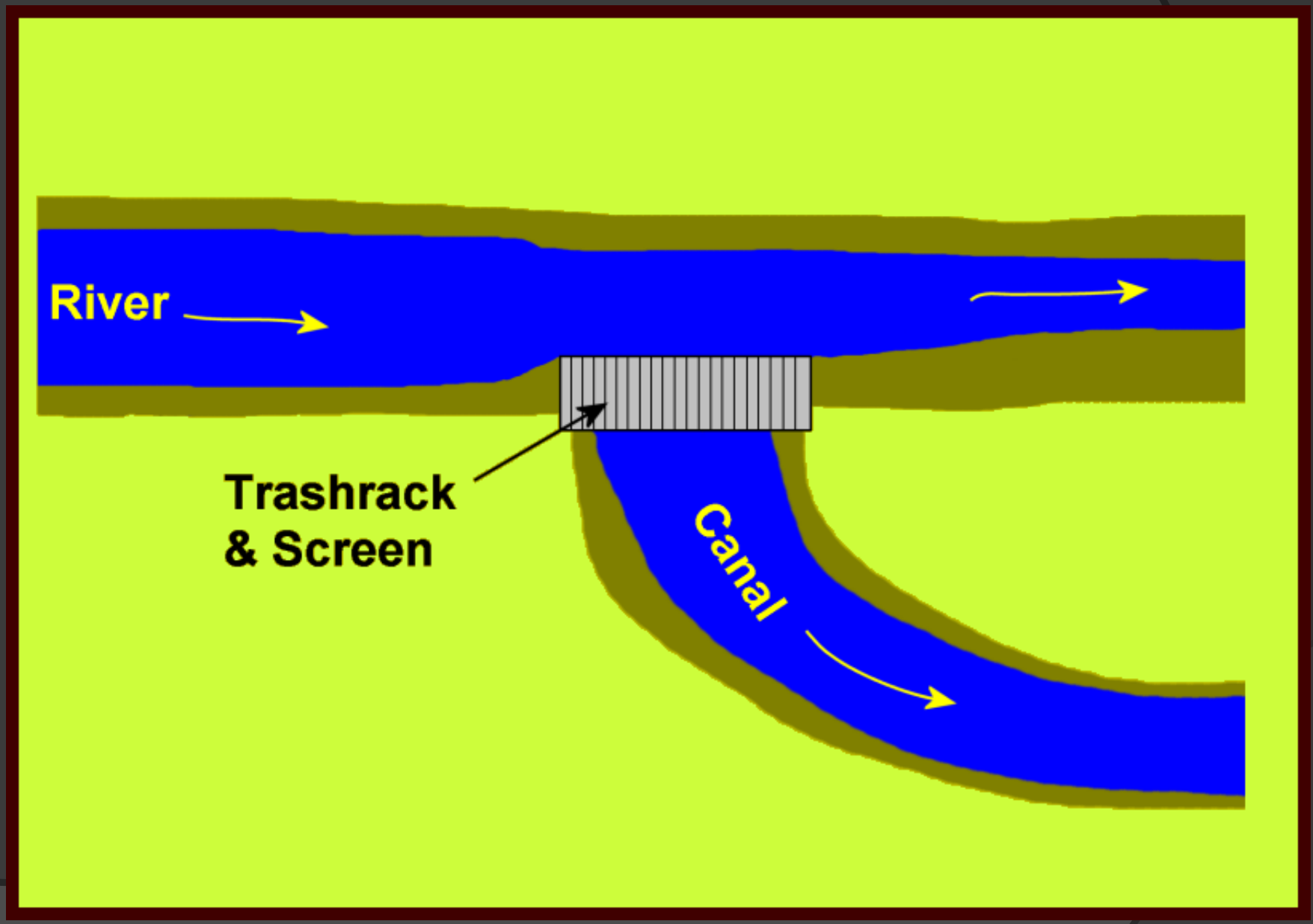
Topic 6. Selecting the Screen Structure Site

- Minimizing delay
- O&M
- On-River site
- Off-River site
- Hydraulics, Hydrology
- Head
- Bank characteristics
- Data Collection – See Notebook

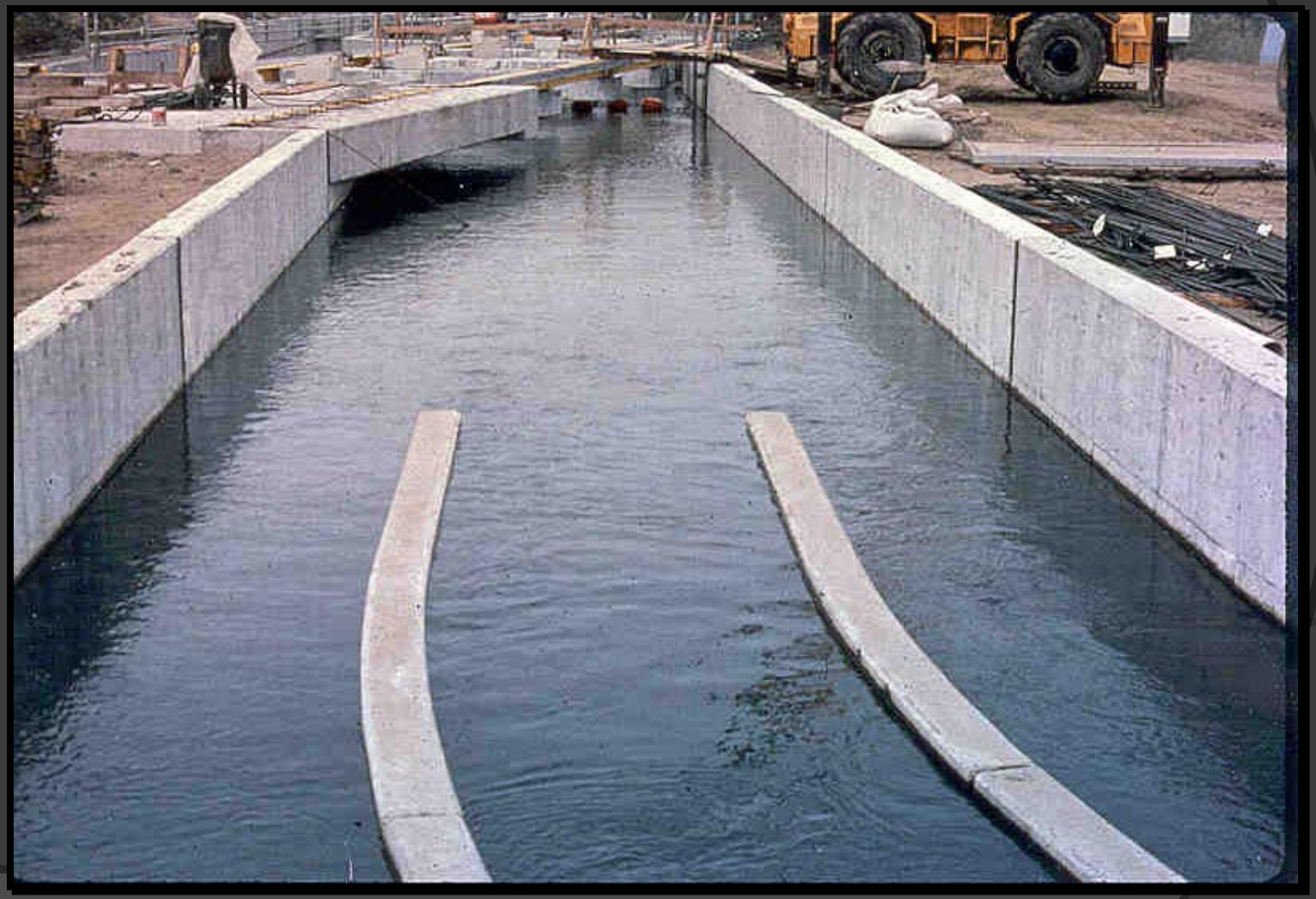
Off-Channel Diversion



On-Channel Diversion



Channel Configuration – Approach Flow Conditions



Other Site Considerations

- Diversion Canal as Fish Habitat
- Diversion Operations – Pitfalls
- Starting and Stopping of Diversions

Topic 7. Facility Design

- NMFS NWR Fishway Design Criteria and Guidelines will be posted by Erich (?)

- Design Features
  - Flow-Screen Angle
  - Uniform Approach Velocity
  - Channel Configuration
  - Trashracks
  - Seals
  - Cleaning System

Screen Velocity Criteria (NMFS NWR)

Approach Velocity (Va)

Criteria developed using basic principle that salmonid fry swimming for a short term (less than one minute) can avoid impingement if screen approach velocity is less than 0.4 feet per second.

Approach velocity criteria developed via sustained stamina swimming tests for salmonid fry, swimming in temperatures as low as 4 degrees Celsius.

Stamina swim tests for salmonid fry conducted at U. of Washington in 1987 by L.S. Smith and L.T. Carpenter – repeated by others, with similar results.

Screen Velocity Criteria (NMFS NWR)

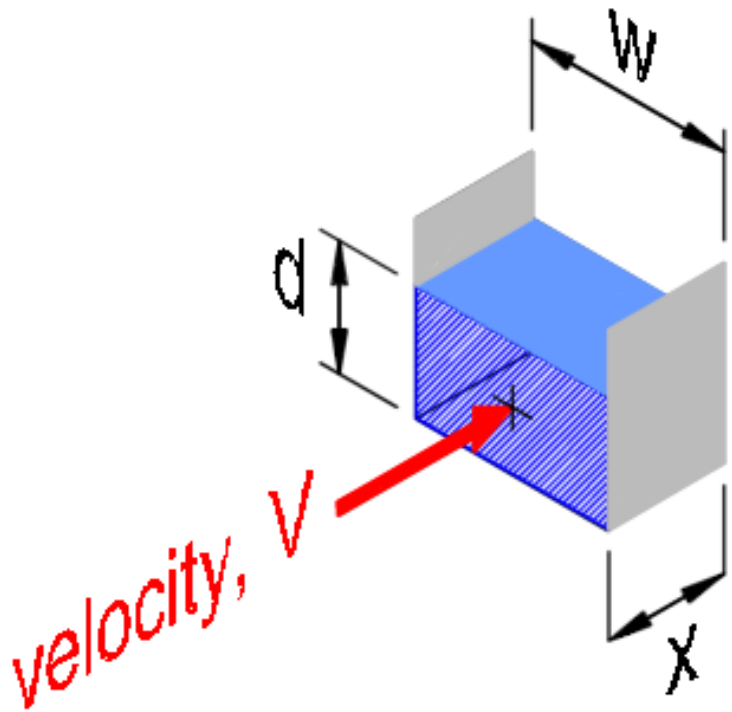
Sweeping Velocity (Vs)

- **Definition: Sweeping Velocity is the canal velocity component parallel to the screen face.**

- **Vs must be at least twice the approach velocity, must not decelerate or rapidly accelerate**

Sweeping velocity acts to move fish (and debris) toward bypass. Lab studies and field experience have shown that smooth sweeping velocity reduces migration delay.

Calculating Discharge (Q)



Volume = (d)(w)(x)

Area, A = (d)(w)

x = (V)(t)

where t = time (1 sec.)

Q = Volume flow rate

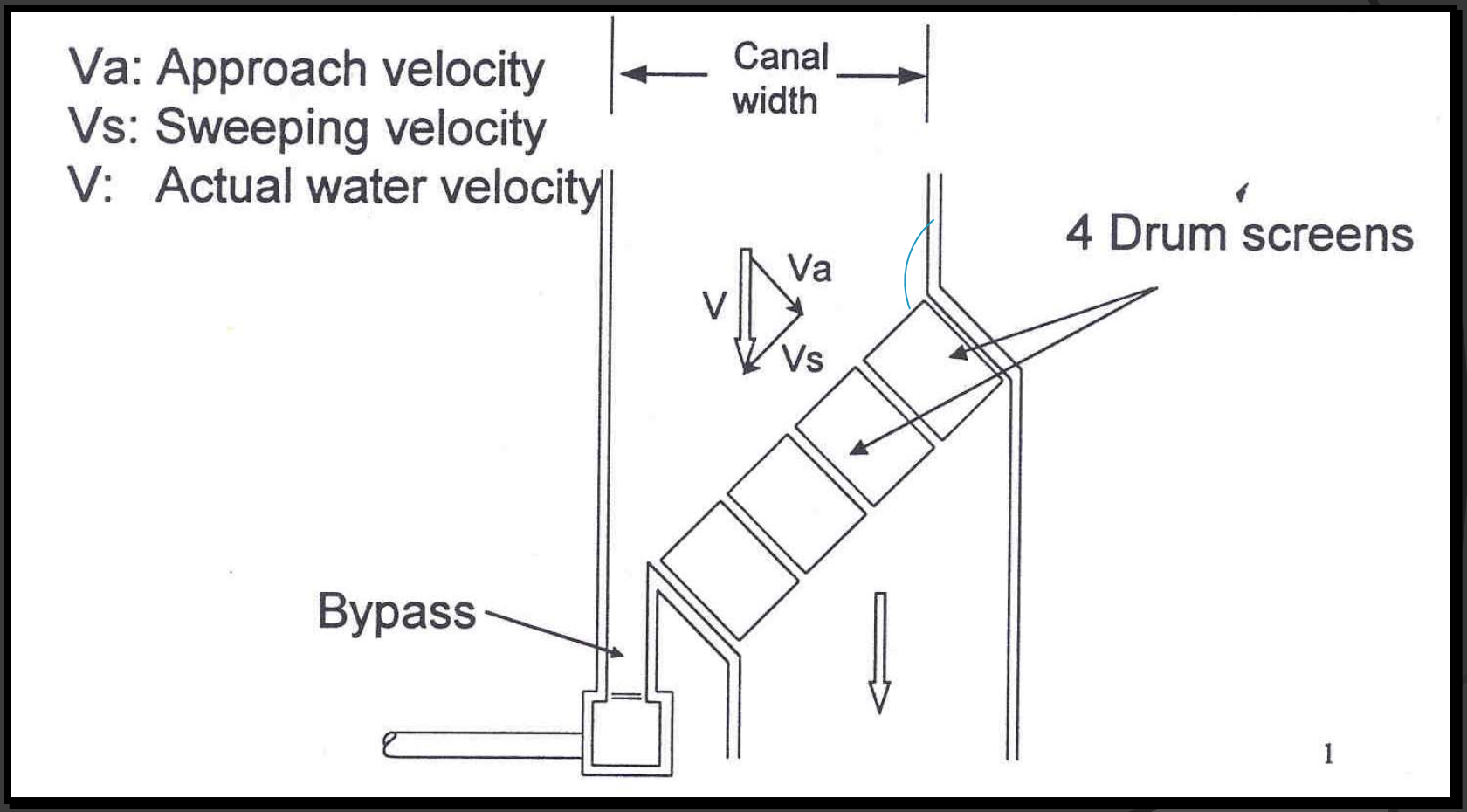
= Volume/time

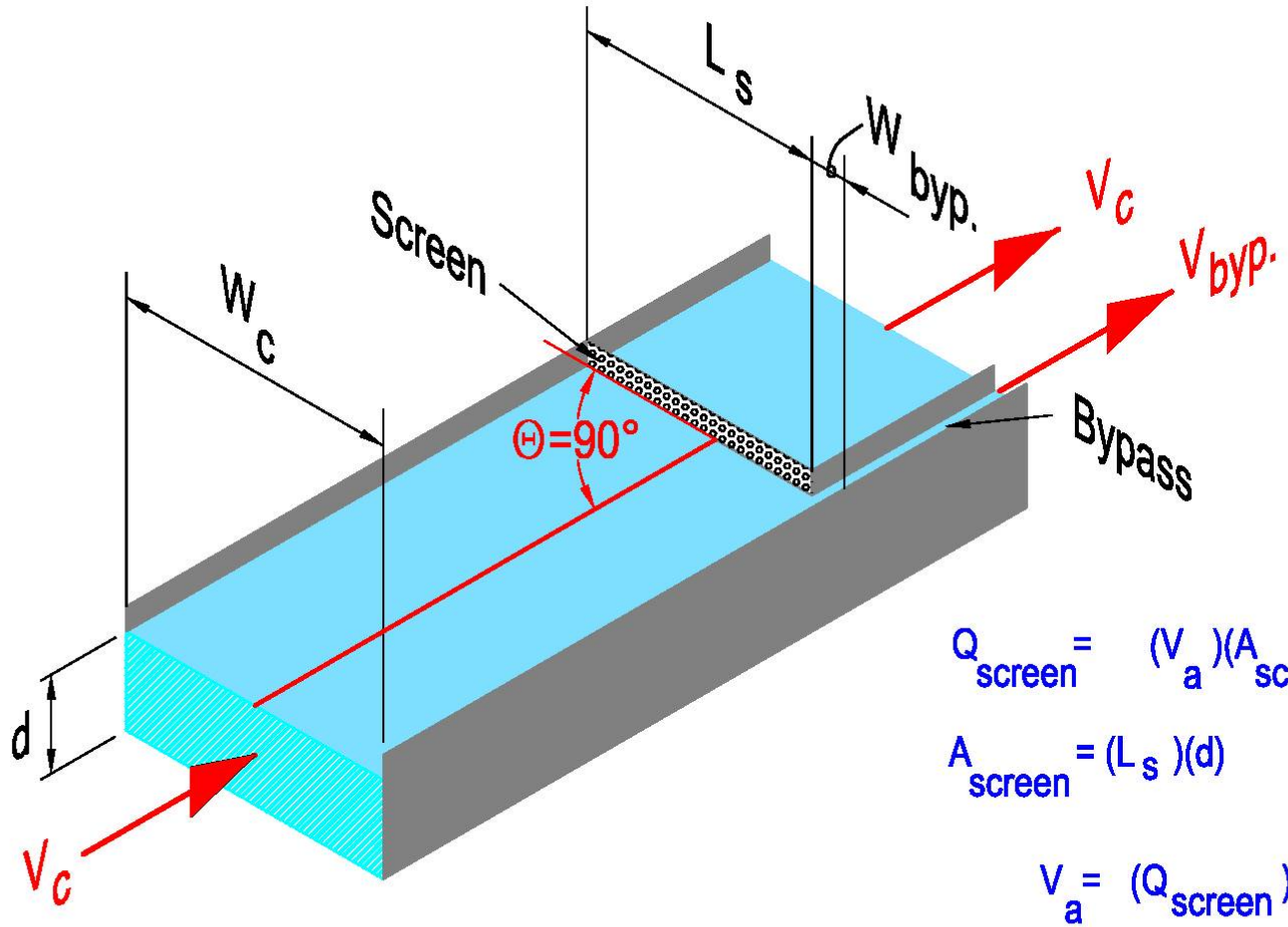
$$= \frac{A(V)\cancel{(t)}}{\cancel{(t)}}$$

Q = VA

LJS
NOAA Fisheries
April 2003

Screen Velocity Components





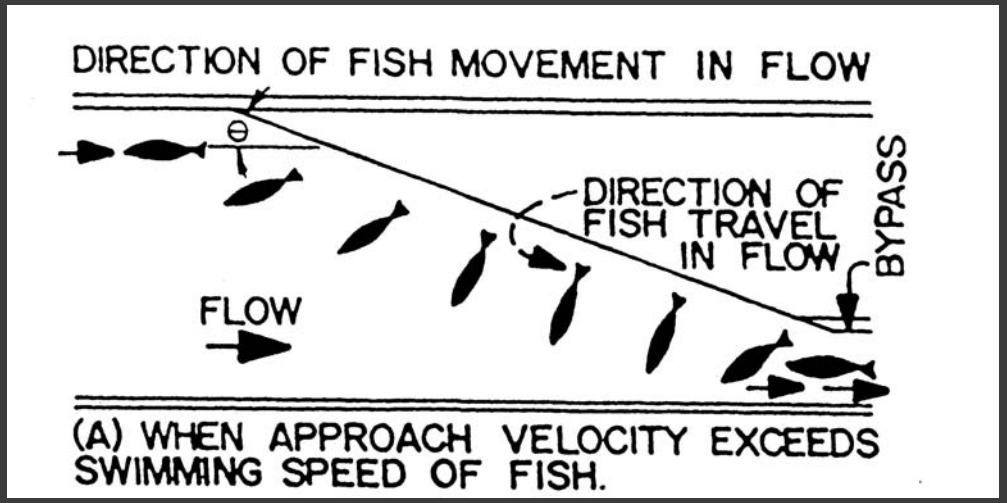
$$Q_{screen} = (V_a)(A_{screen})$$

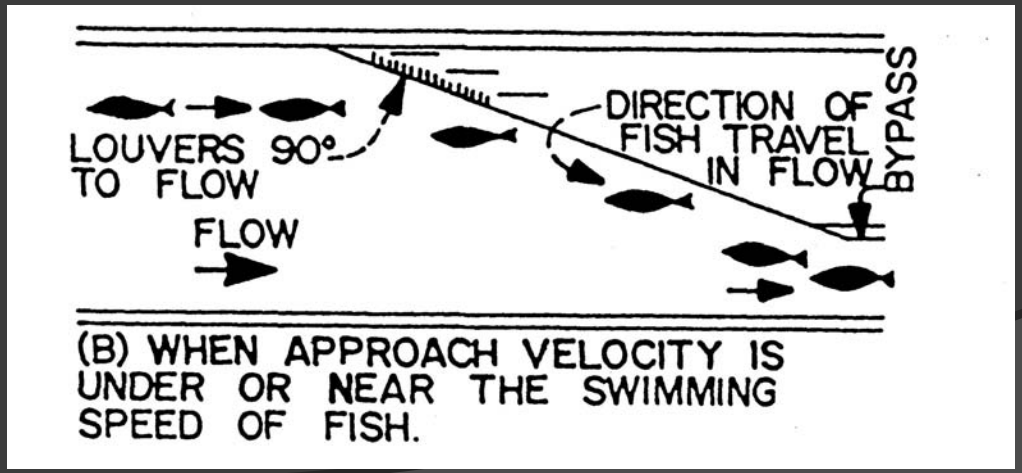
$$A_{screen} = (L_s)(d)$$

$$V_a = (Q_{screen})/(A_{screen})$$

$$V_a = (Q_{screen})/[(L_s)(d)]$$

•Fish Orientation in Front of Screens





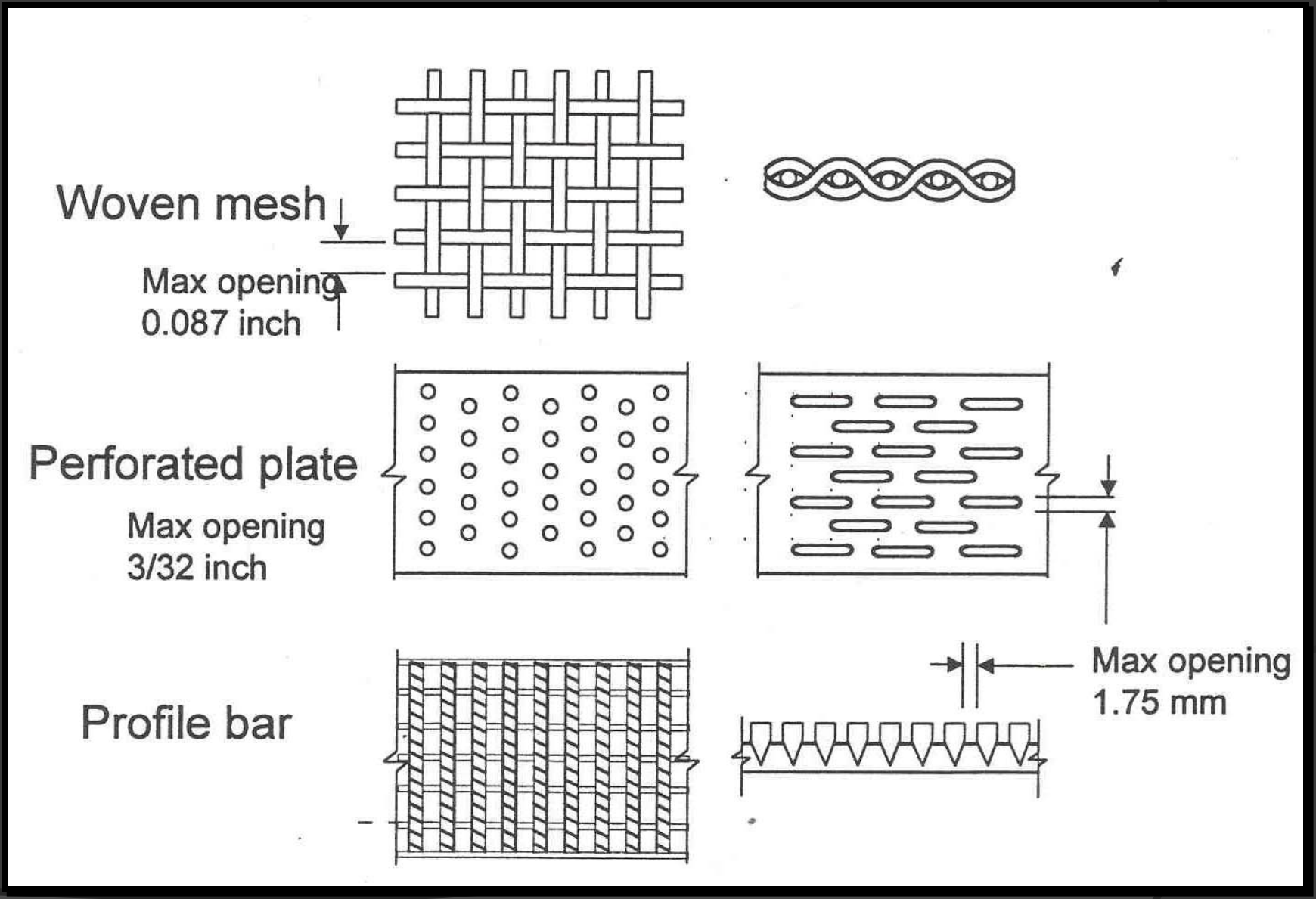
Screen Velocity Criteria (NMFS NWR)

Approach Velocity (Va)

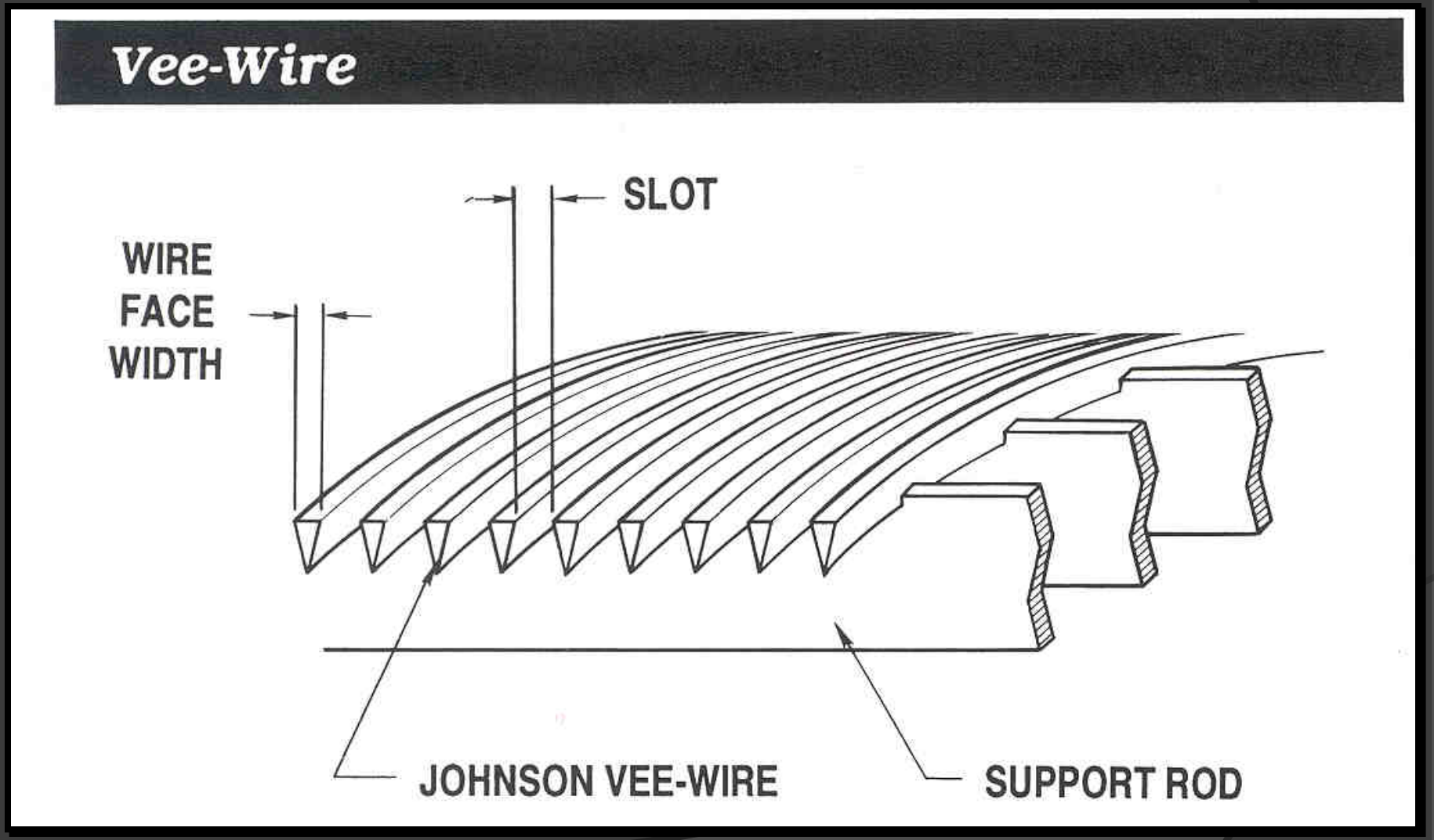
- **Definition: Approach Velocity is canal velocity component perpendicular to the screen face.**

- **Va must be less than or equal to 0.4 ft/s, not including any reduction for mesh, and not including mesh occluded by structural members, and must be nearly uniform**

Screen Materials

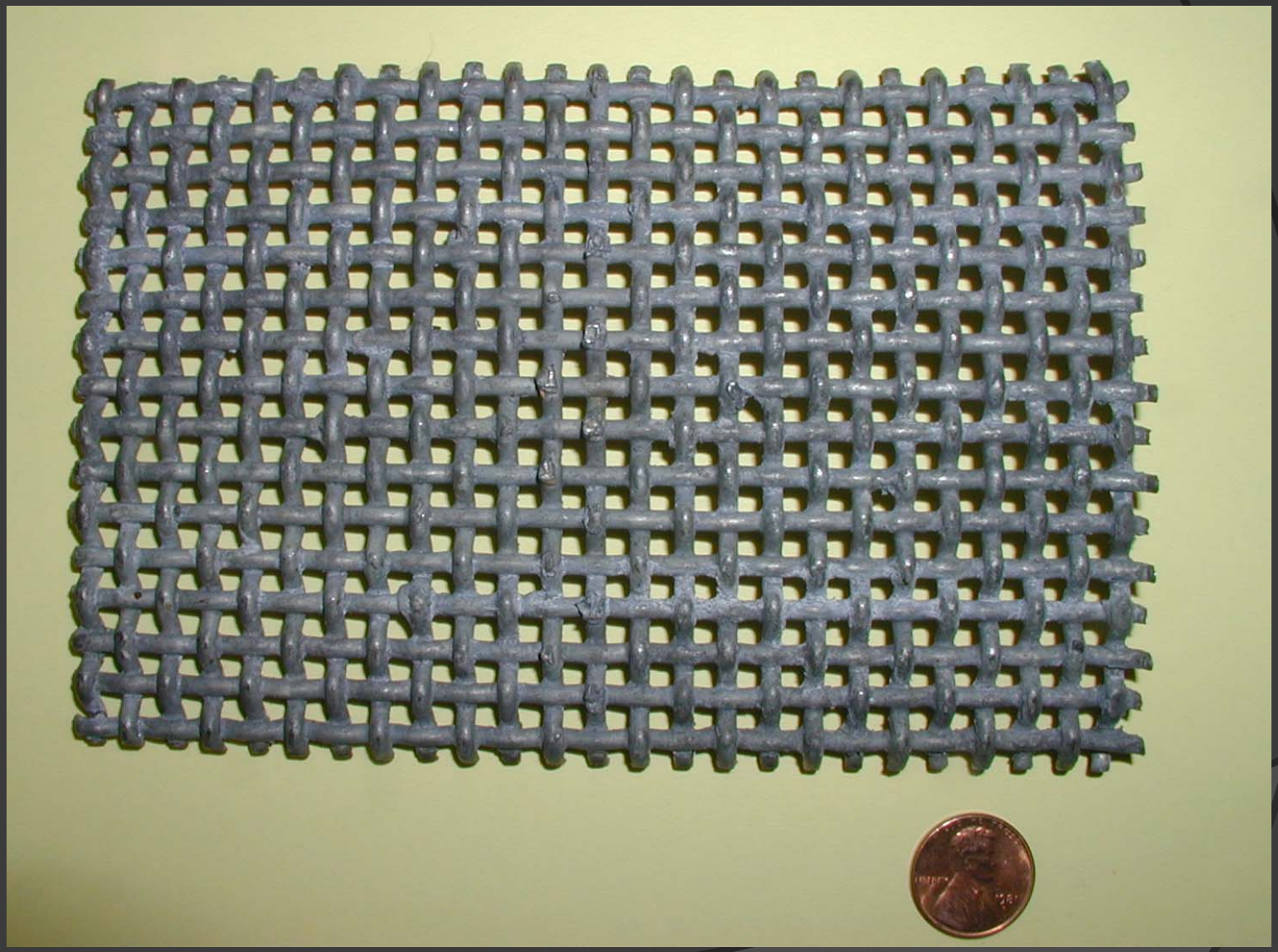


Screen Materials

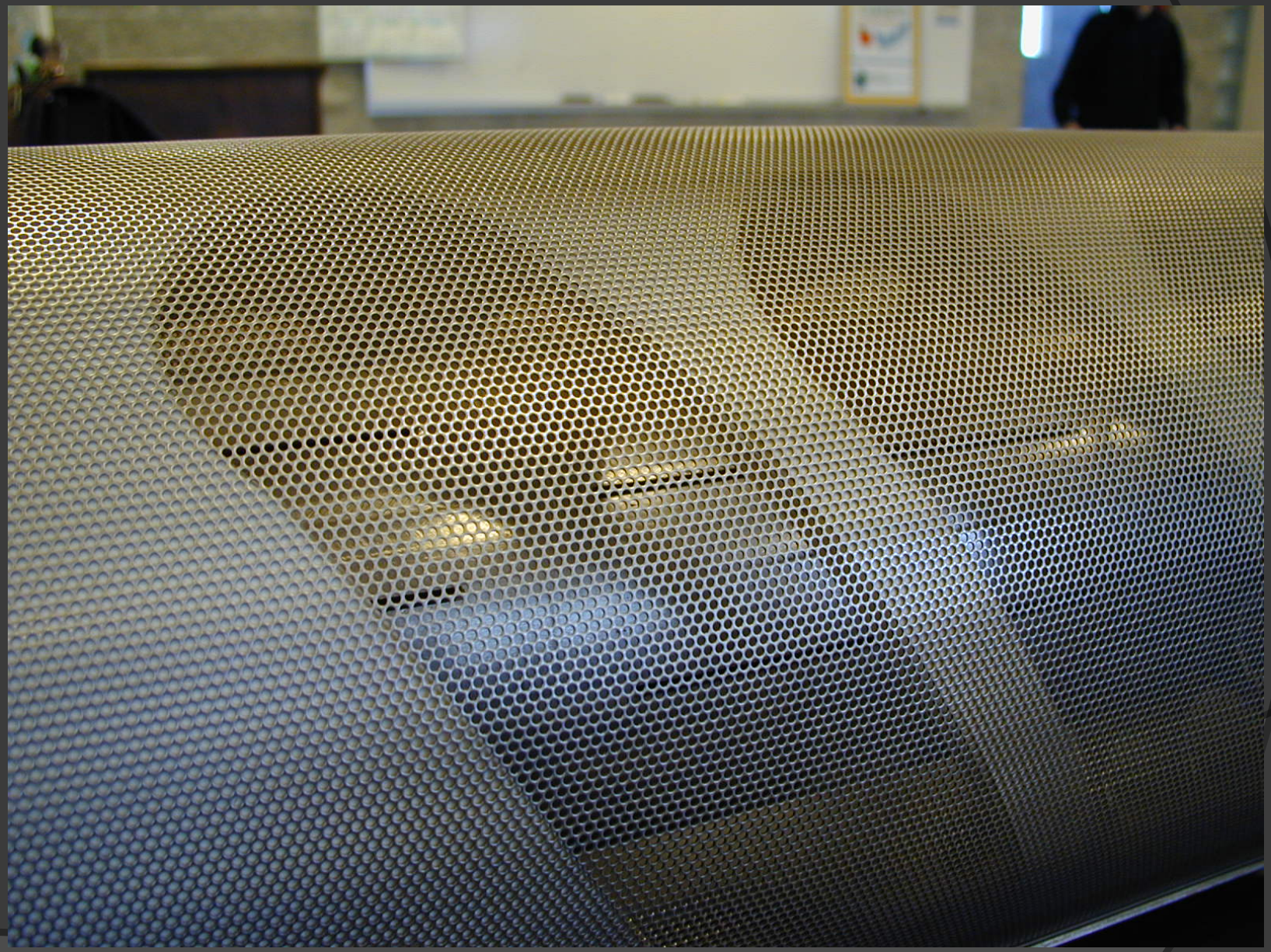


Profile Bar

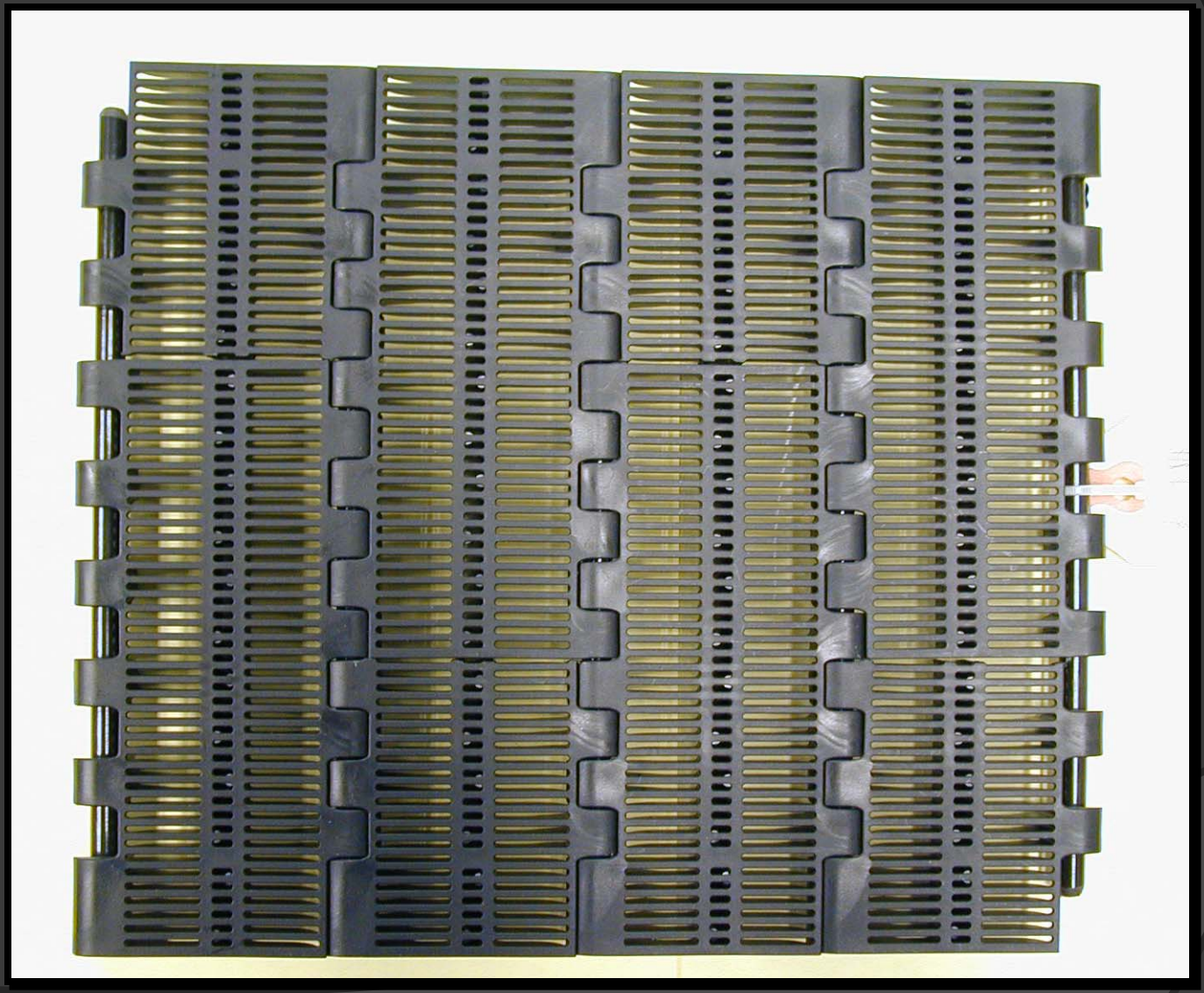
Woven Wire



Perforated Plate



Other Materials - Intralox



Topic 8. Types of Positive Barrier Screens

- Rotary Drum
- Fixed Vertical Plate
- Vertical Traveling – belt and panel
- Non-Vertical Fixed Plate
- Horizontal Fixed Plate
- Eicher Screen
- Modular Inclined Screens
- End-Of-Pipe (Pump) Intake Screens

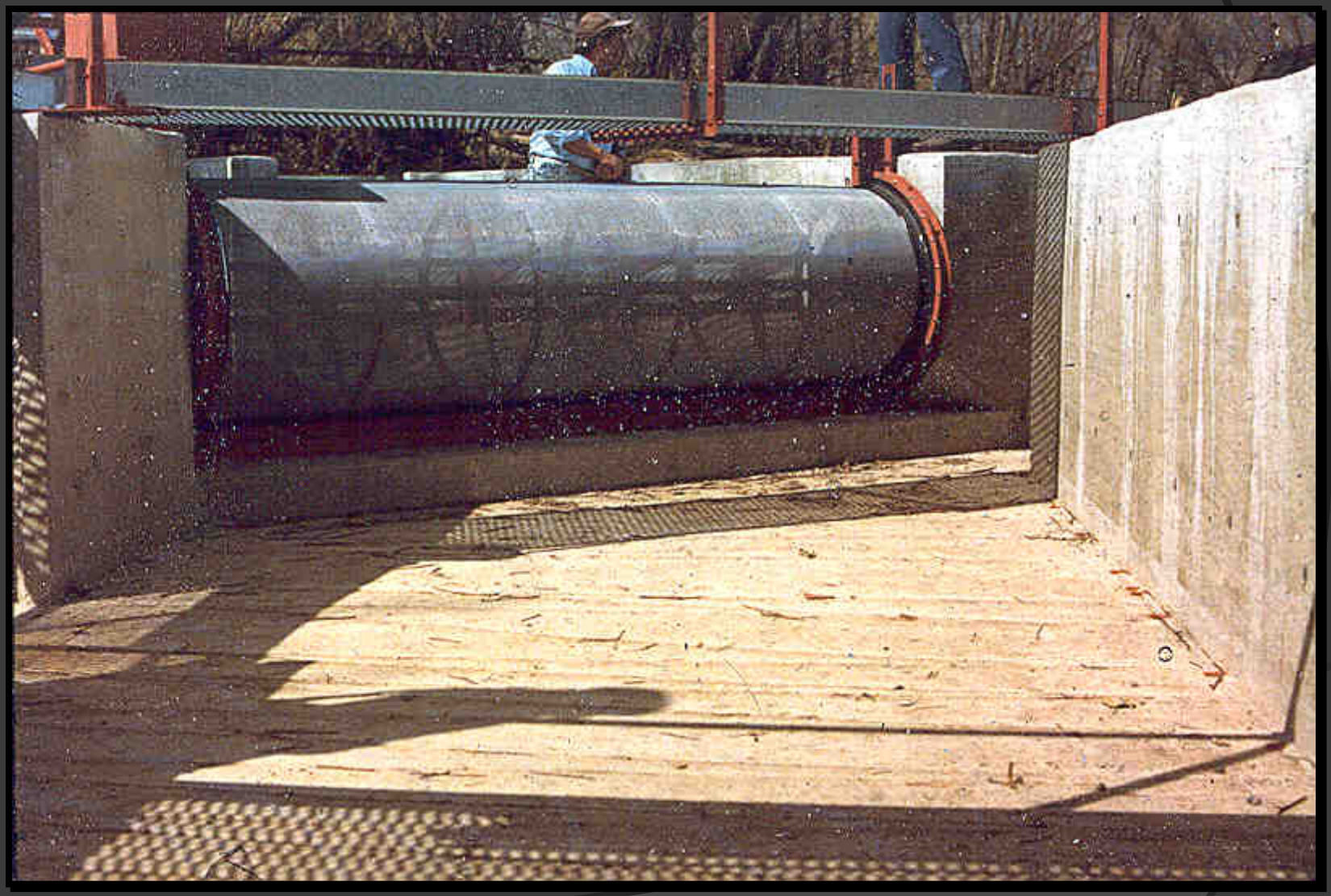
Rotating Drum Screens

Rotary Drum Screens

Rotating Drum Screens

Rotary Drum Screen Seals

Seals



Seals

Rotating Drum Screens - Advantages

- Proven fish protection
- Self-cleaning by rotation
- Passes debris downstream

Rotating Drum Screens - Disadvantages

- Susceptible to direct hits from large debris
- Large civil works are required.
- Seals require much maintanance.
- Susceptible to abrasions by sand - mesh requires periodic replacement.

Vertical Fixed Plate Screens

Vertical Fixed Plate Screens