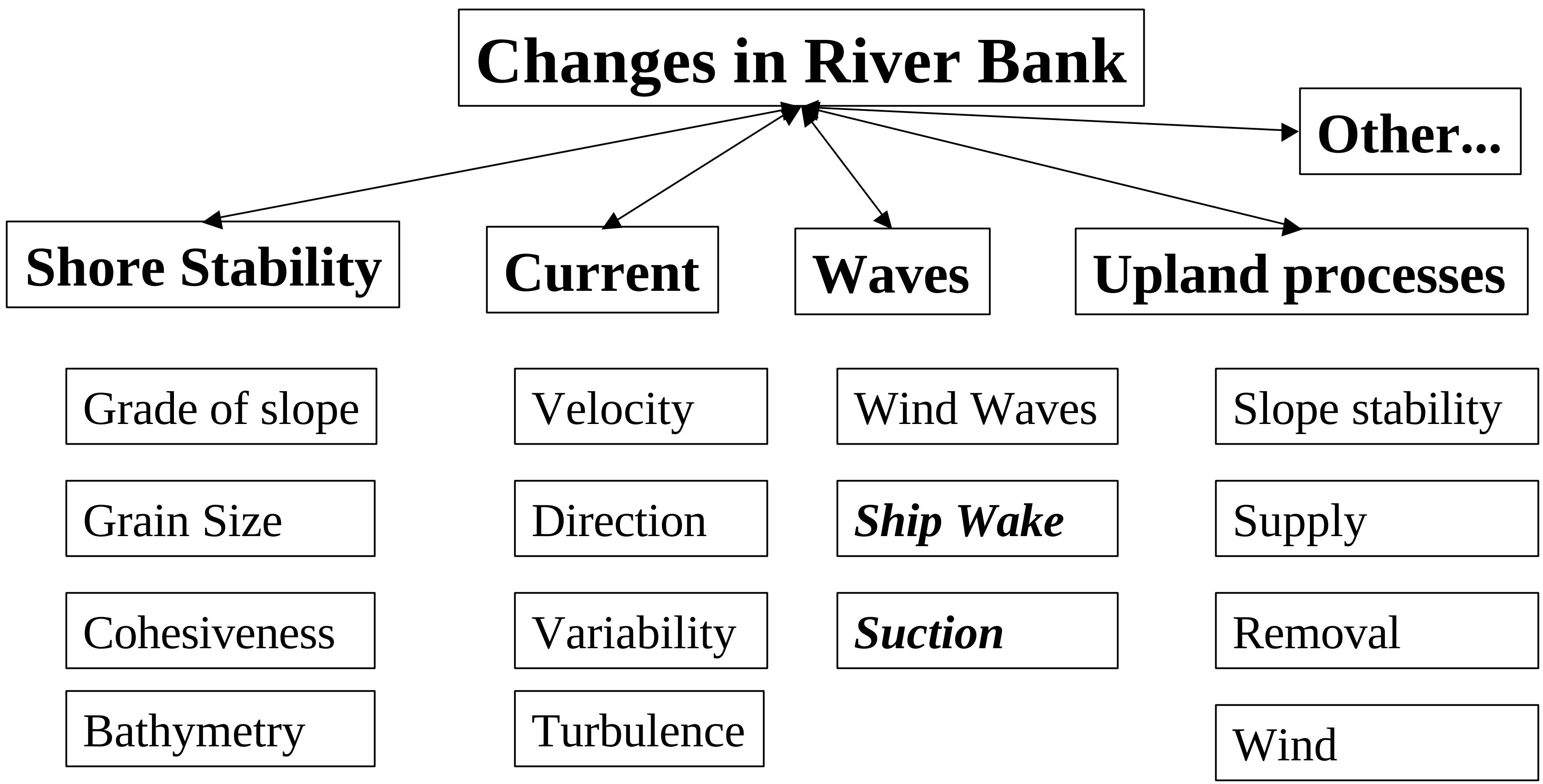
The Ship wake issue

Channel Deepening -> Ship Wake-> River Bank change -> effects on Salmon Habitat

Three different steps:

- Relation between Channel Deepening and Ship Wake
- Relation between Ship Wake and Bank Erosion/Accretion
- Relation between Bank Erosion/Accretion and Salmon Habitat

Factors in Bank Erosion/Accretion



Factors in Ship wake

- Vessel Speed
- Bathymetry
- Water Depth
- Vessel Shape
- Keel Clearance
- Current

Hydraulic effects by ships

- Primary water movement:

  caused by displacement of water volume by the ship, results in **suction**

- Secondary water movement:

  different kinds of **waves** generated by ship: bow, stern, propeller

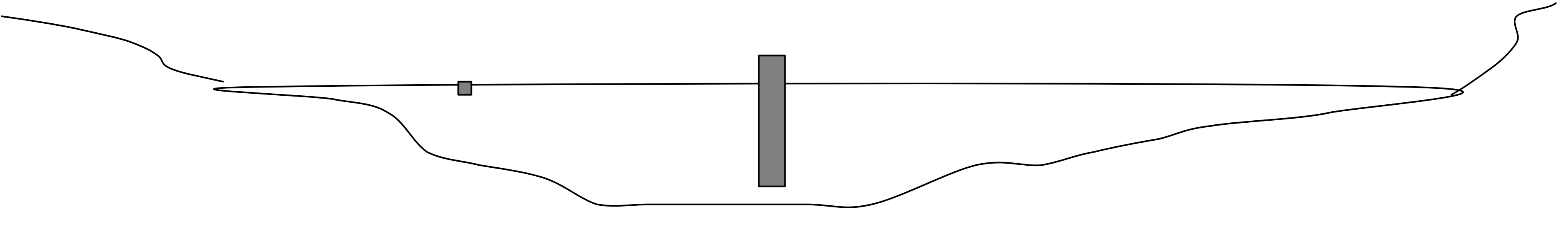
Hydraulic effects by ships

- A strong primary water movement (“suction”) reduces the ability for secondary water movement (“waves”) to develop
- Large vessels with large cross-section ==> potential for suction, minor chances for significant secondary waves
- Small boats with negligible cross section ==> no suction, but potential for significant secondary waves

Primary water movement (“suction”)

Suction is mainly dependent on:

- vessel speed
- the ratio of the cross sections of ship and waterway



Primary water movement (suction)
-change in cross section ratio ("blockage-factor")-

Cross section 40 ft draft vessel: 100 ft x 40 ft = 4,000 ft 2
Cross section 40 ft channel : 600 ft x 45 ft = 27,000 ft 2
Ratio: 4,000/27,000 = **0.148**

Cross section 43 ft draft vessel: 100 ft x 43 ft = 4,300 ft 2
Cross section 43 ft channel : 600 ft x 48 ft = 28,800 ft 2
Ratio: 4,300/28,800 = **0.149**

Primary water movement (suction)
-change in cross section ratio (“blockage-factor”)-

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Ratio: 4,000/28,800 = **0.139**

Secondary water movement (“waves”)

For each different kind of wave: wave height roughly increases by square of vessel speed

$$\mathbf{Hs \sim V_s^{\,2}}$$

Higher waves especially occur when different wave patterns interfere : “Froude number” close to 1:

$$F_n = n_s / \sqrt{g \times h_0}$$

Wave interference peaks

$$F_n = n_s / \sqrt{g \times h_0}$$

F_n = Froude number
V_s = vessel speed
g = gravitational force (= 9.8 m/s^2)
h_0 = waterdepth

So, $F_n \approx 1$, means $v_s \approx \sqrt{g \times h_0}$
For Columbia River circumstances: $h_0 \approx 15$ meter (50 feet),
$v_s \approx (9.8 \times 15)^{1/2} = 12$ m/s ≈ 22 knots

Summary

- There are several different sources for waves in the Columbia River
- Wave action is one of the many processes influencing the river banks
- Wave effects by deep draft vessels will be mostly primary water movement (suction), and not so much secondary wave action
- Deep draft vessels won’t sail at speeds that can result in accumulated waves through wave pattern interference
- The combination of Channel Deepening and deeper draft vessels could theoretically result in a marginal change in suction *(an estimated increase or decrease of cross section ratio of 1 to 3 percent)*