Review of Suisun Marsh Levee Investigation Team Analysis, and Transport Conceptual Model

Charter Writing Group
December 8, 2005
Chris Enright

Topics

1. Suisun Marsh flood of 1998 (quick)
2. CALFED Suisun Marsh levee investigation team 1998 – 2000
3. Conceptual model: Change geometry, change transport…

→Mechanisms

- Tidal trapping (increases salinity mixing)
- Tidal energy damping (decreases salinity mixing)

Topics

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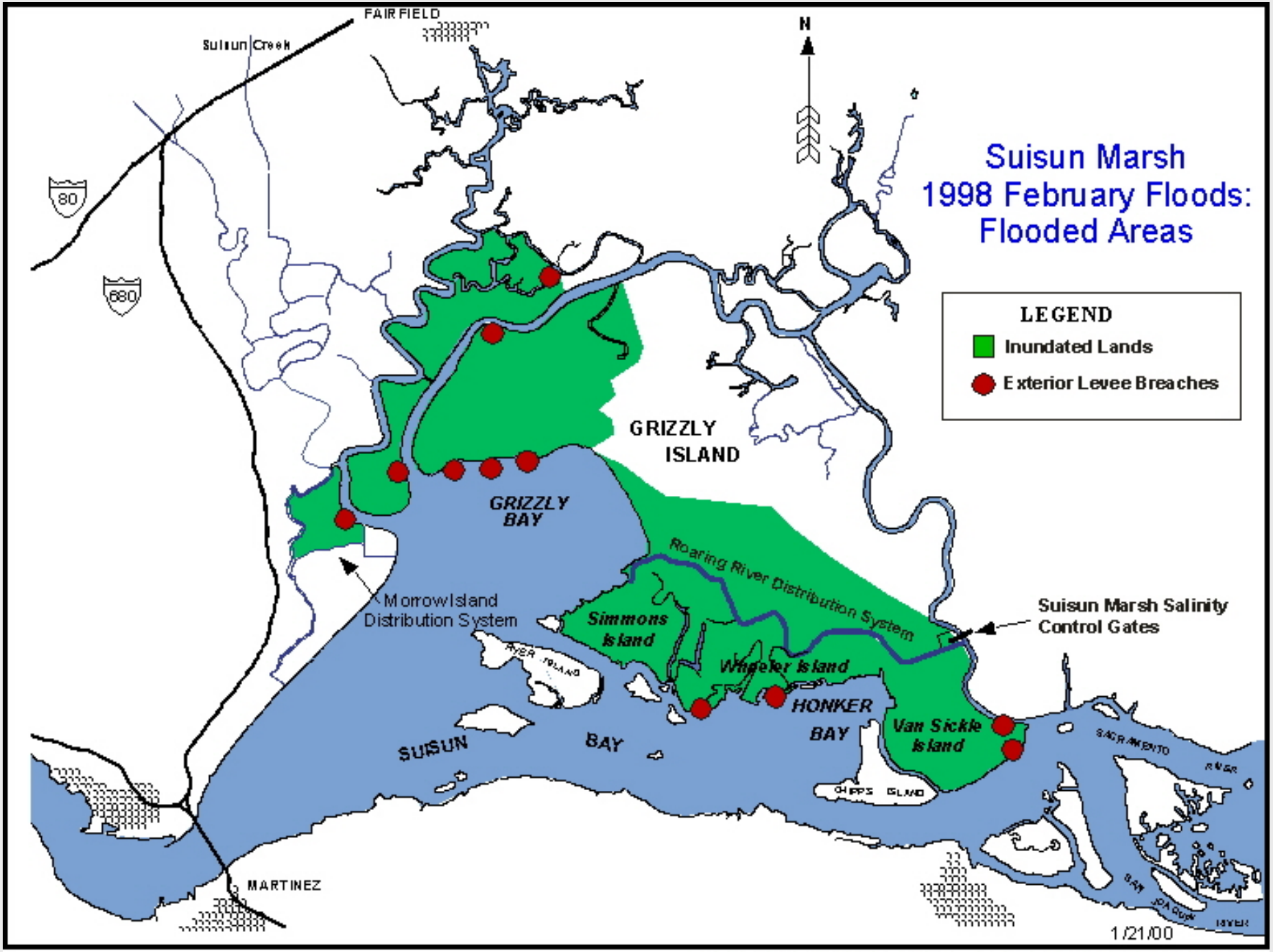
2. CALFED Suisun Marsh levee investigation team 1998 – 2000
3. Conceptual model: Change geometry, change transport…

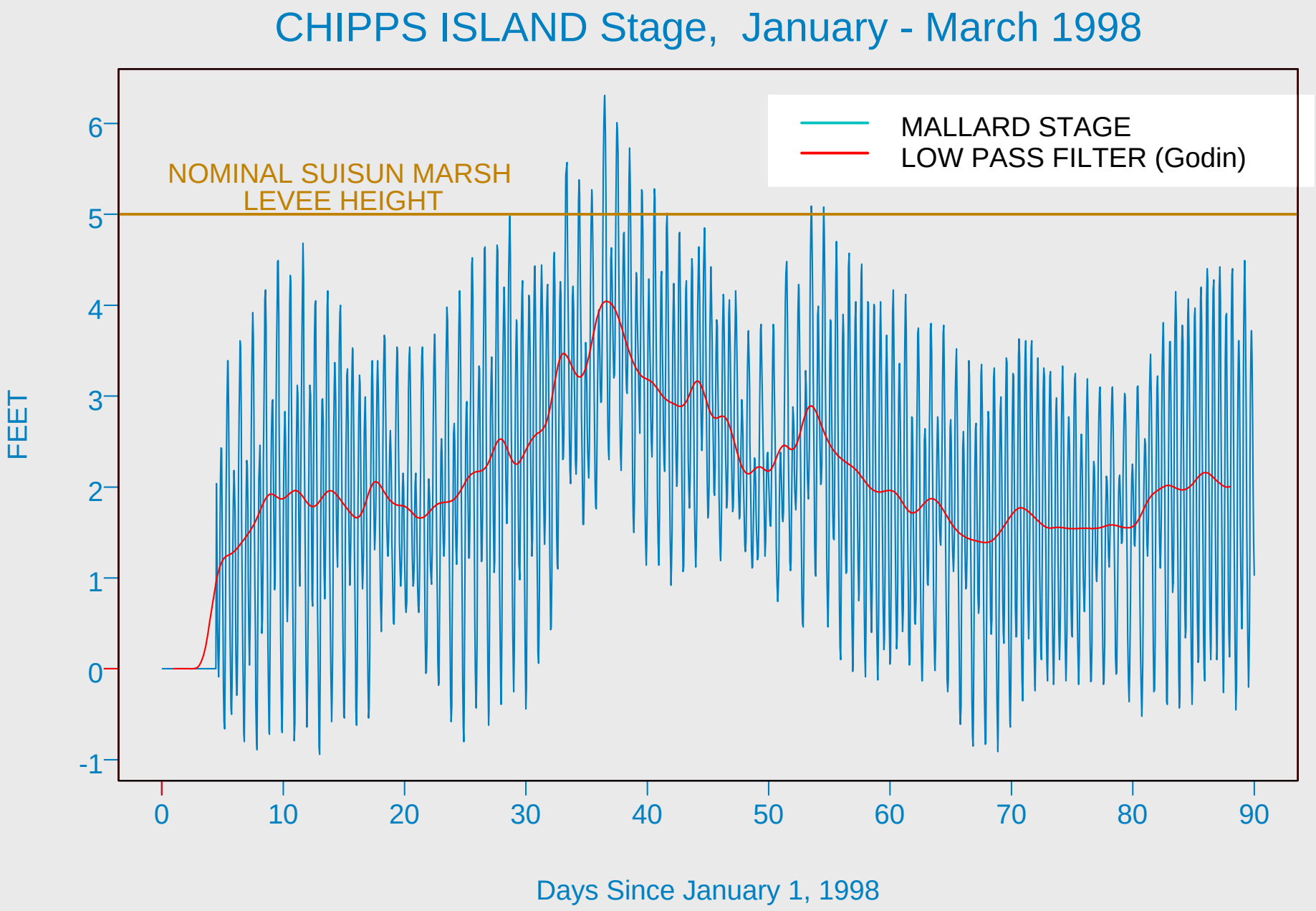
→Mechanisms

- *Tidal trapping (increases salinity mixing)*
- Tidal energy damping (decreases salinity mixing)

1. Suisun Marsh flood of 1998



Department of Water Resources - Suisun Marsh Planning


CHIPPS ISLAND Stage, January - March 1998
MALLARD STAGE
LOW PASS FILTER (Godin)
NOMINAL SUISUN MARSH
LEVEE HEIGHT
FEET
6
5
4
3
2
1
0
-1
0
10
20
30
40
50
60
70
80
90
Days Since January 1, 1998

Lessons from Suisun Marsh flood

- Suisun Marsh levees are susceptible to storm related overtopping and breaching.
- Levee breaches will happen.
- We didn’t (and still don’t really) know what Marsh and Delta salinity impacts would be.

2. CALFED Suisun Marsh Levee Investigation Team (SMLIT)

- Charge from CALFED
- Approach
- Recommendations of SMLIT

SMLIT charge from CALFED

- Should Suisun Marsh levees be included in the CALFED levee program?

- If Suisun Marsh levees are added to the program, are there opportunities for water quality improvement and ecosystem restoration?

Suisun Marsh Levee Investigation Team report on the Web:

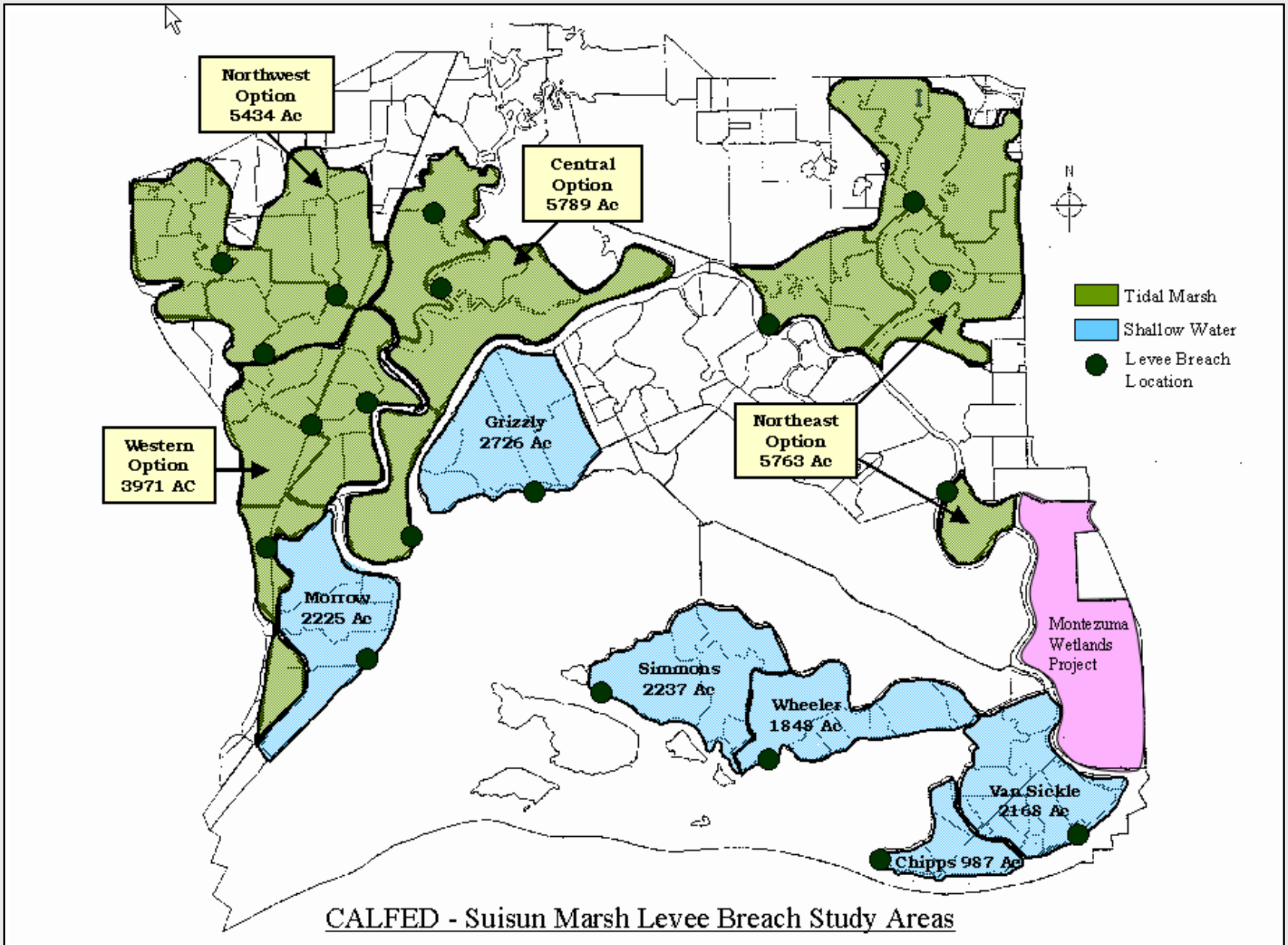
- www.iep.ca.gov/suisun/modeling/calfedlevee/results.html

SMLIT Modeling Approach

- Be consistent with CALFED goals
  - ~ 2000 acres of shallow water habitat
  - ~ 5000 acres of tidal Marsh restoration

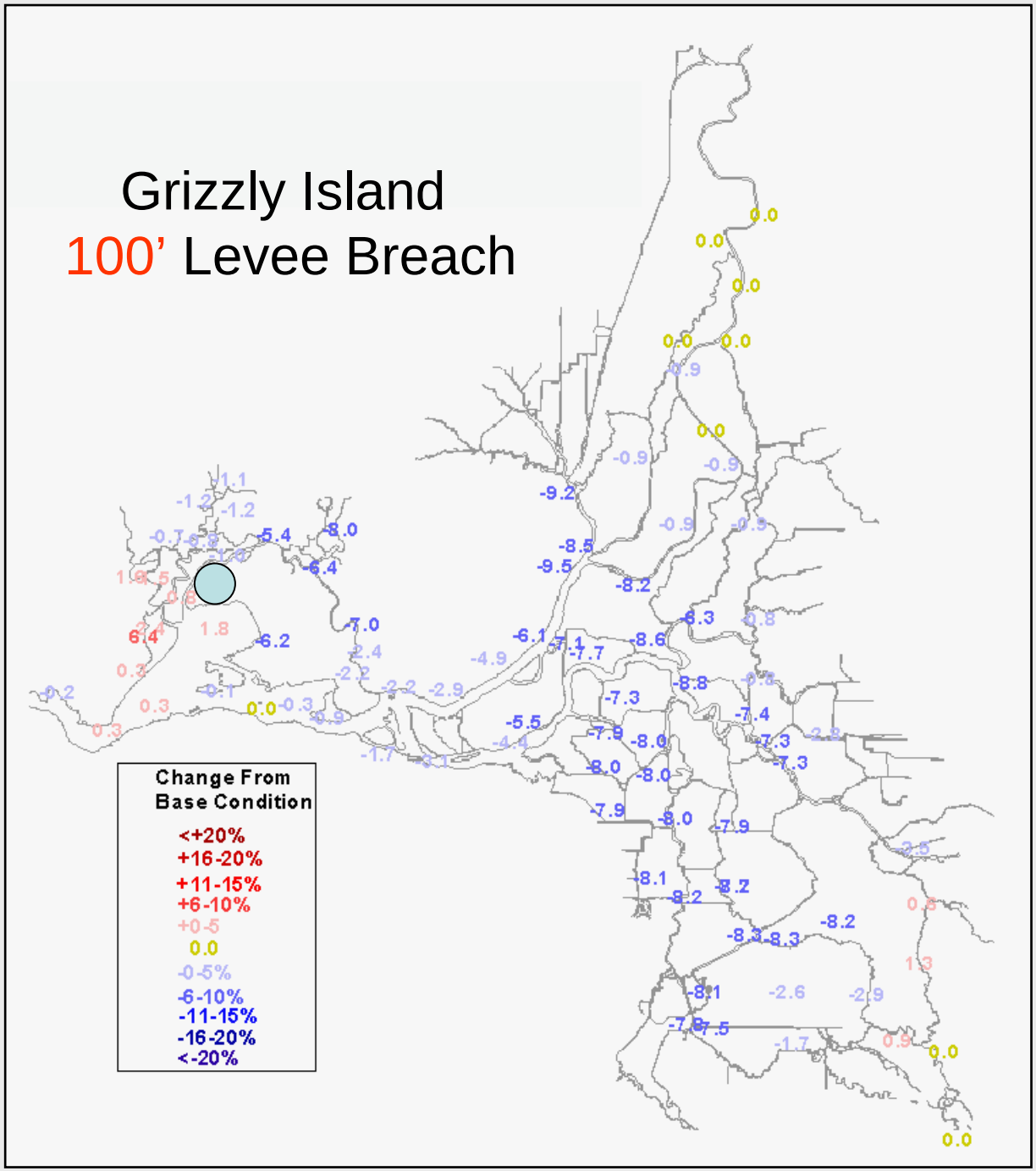
- Investigate the influence of
  - Breach location
  - Breach size
  - Extent of inundated acreage

SMLIT Modeling Approach



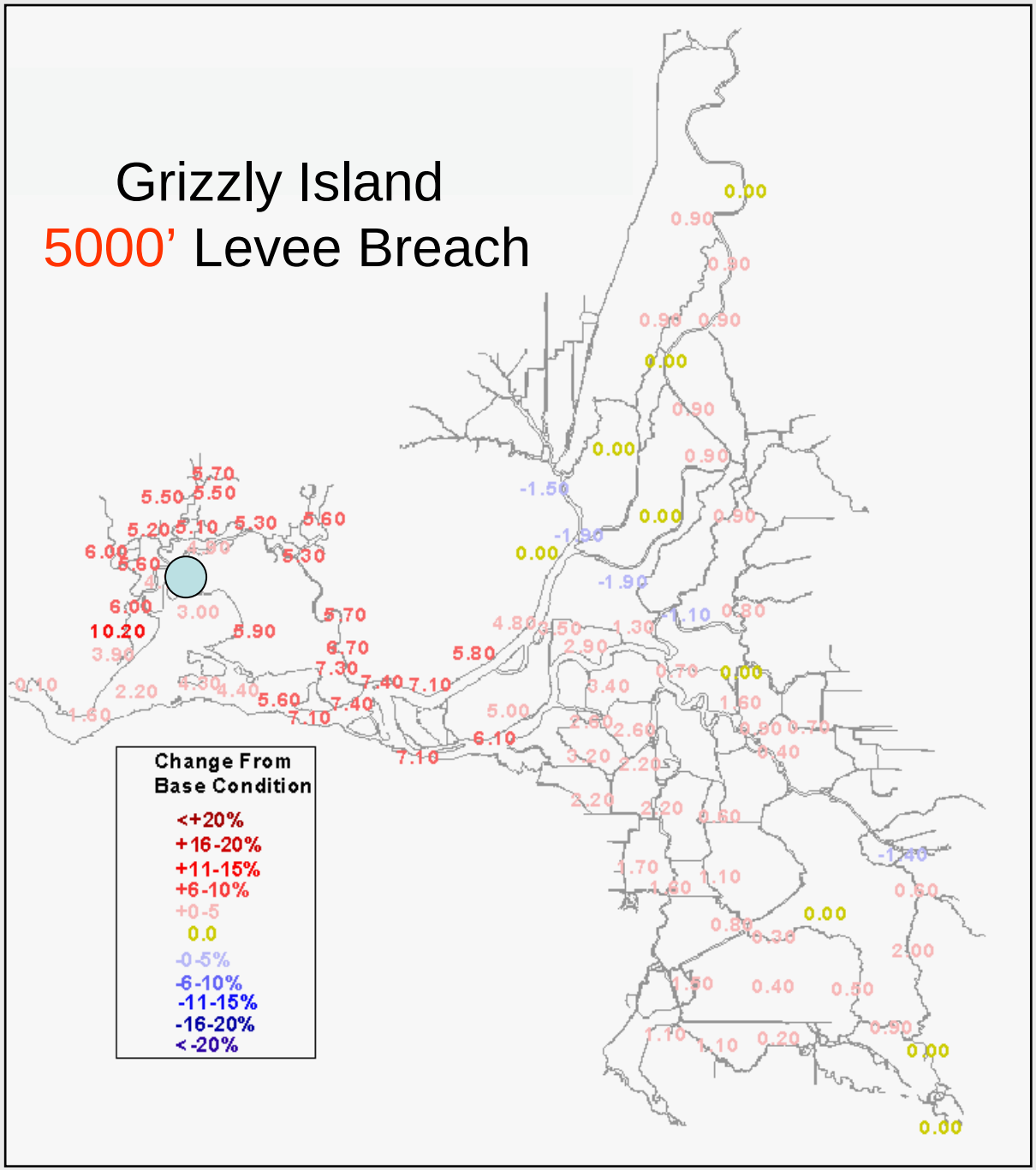
Some Results

Effect of breach size



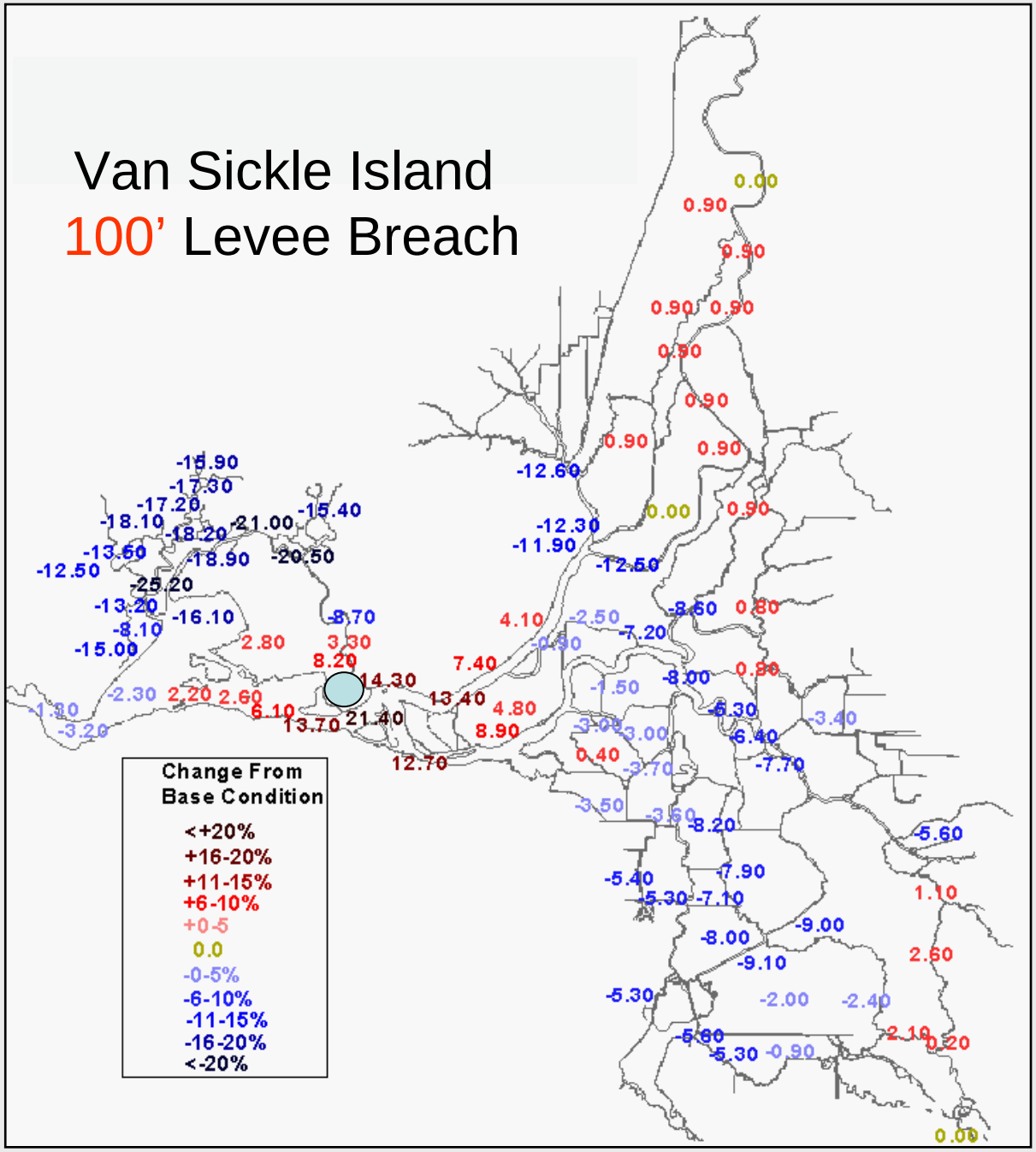
CALFED Suisun Marsh
Levee Team
1998-2000

Effect of breach size



CALFED Suisun Marsh
Levee Team
1998-2000

Effect of breach size and Location



CALFED Suisun Marsh Levee Team
1998-2000

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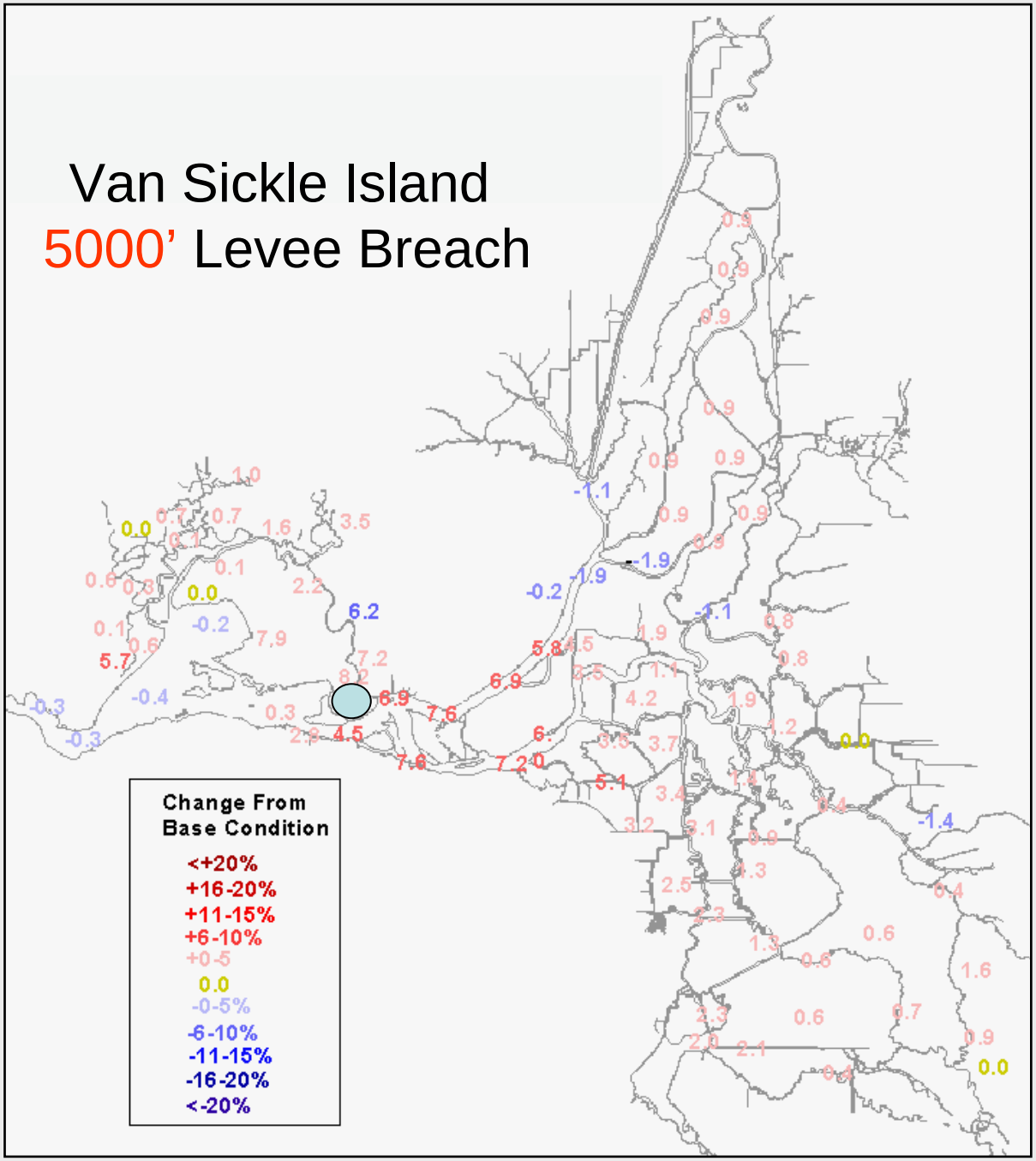


CALFED Suisun Marsh Levee Team
1998-2000

SMLIT technical conclusions

- Small (controlled) that levee breaches increase local salinity, but decreased Delta salinity.
- Large (uncontrolled) levee breaches will increase salinity in Suisun Bay and the Delta.
- Details of breach location, size, and extent of inundated area matter a lot.

SMLIT recommendation

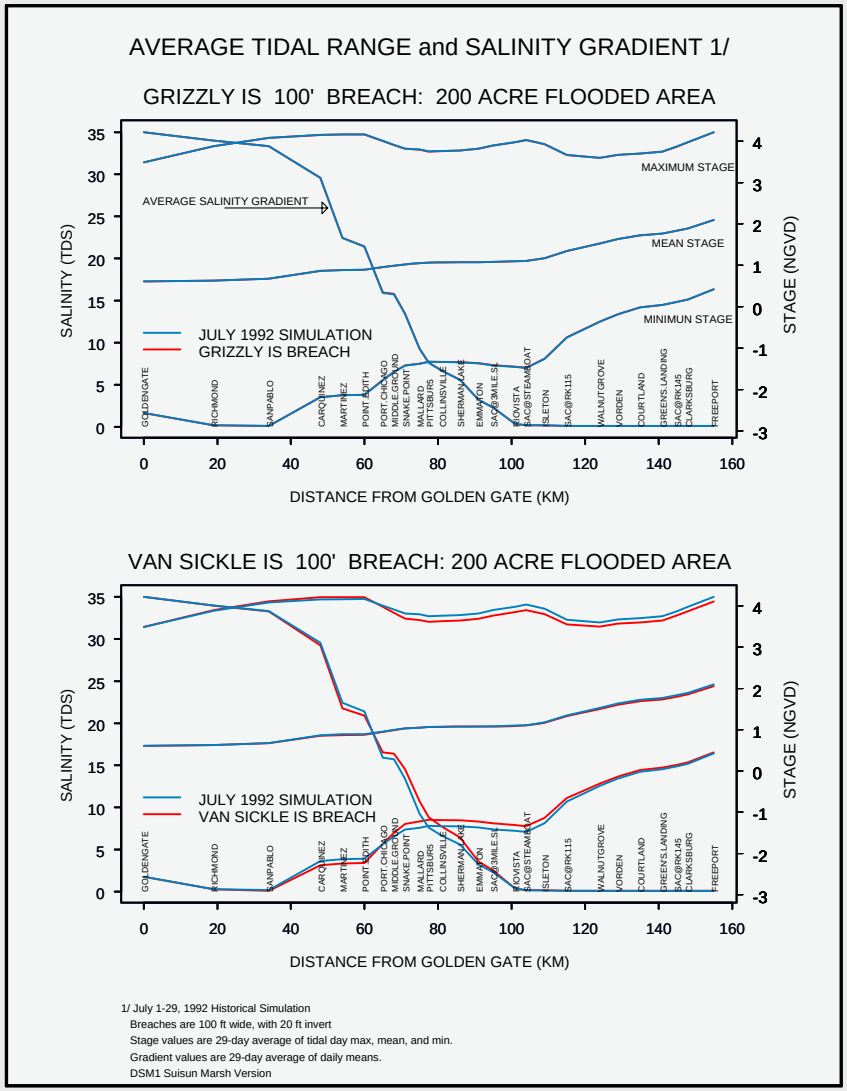
- Include Suisun Marsh in the CALFED levee program to protect Delta salinity and allow *planned* managed wetland enhancement and tidal wetland restoration.

3. Change geometry, change transport

Mechanisms:

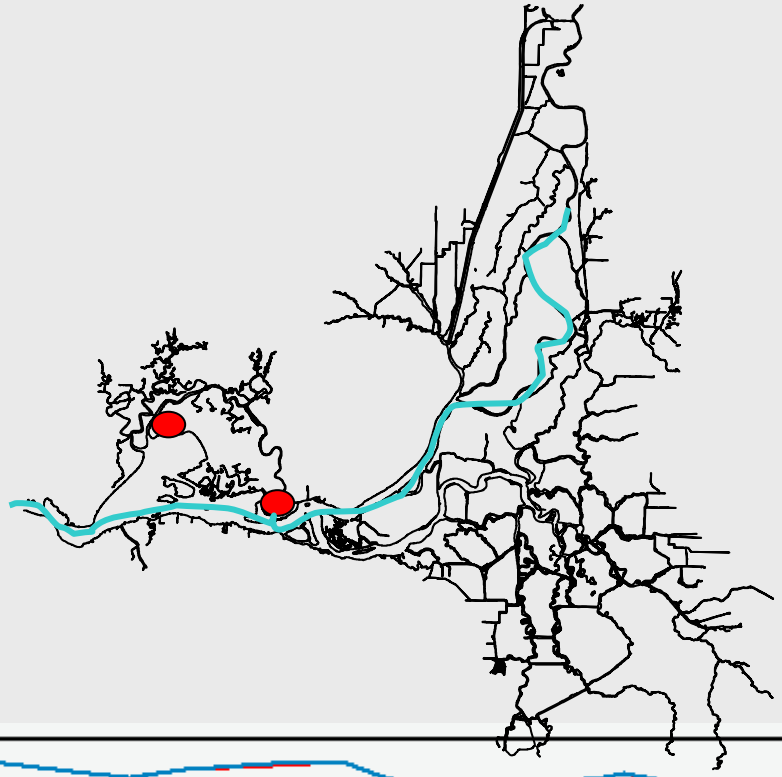
1. Breaches damp tidal energy (*decreases* salinity mixing)
2. Breaches “trap” salinity (*increases* salinity mixing)

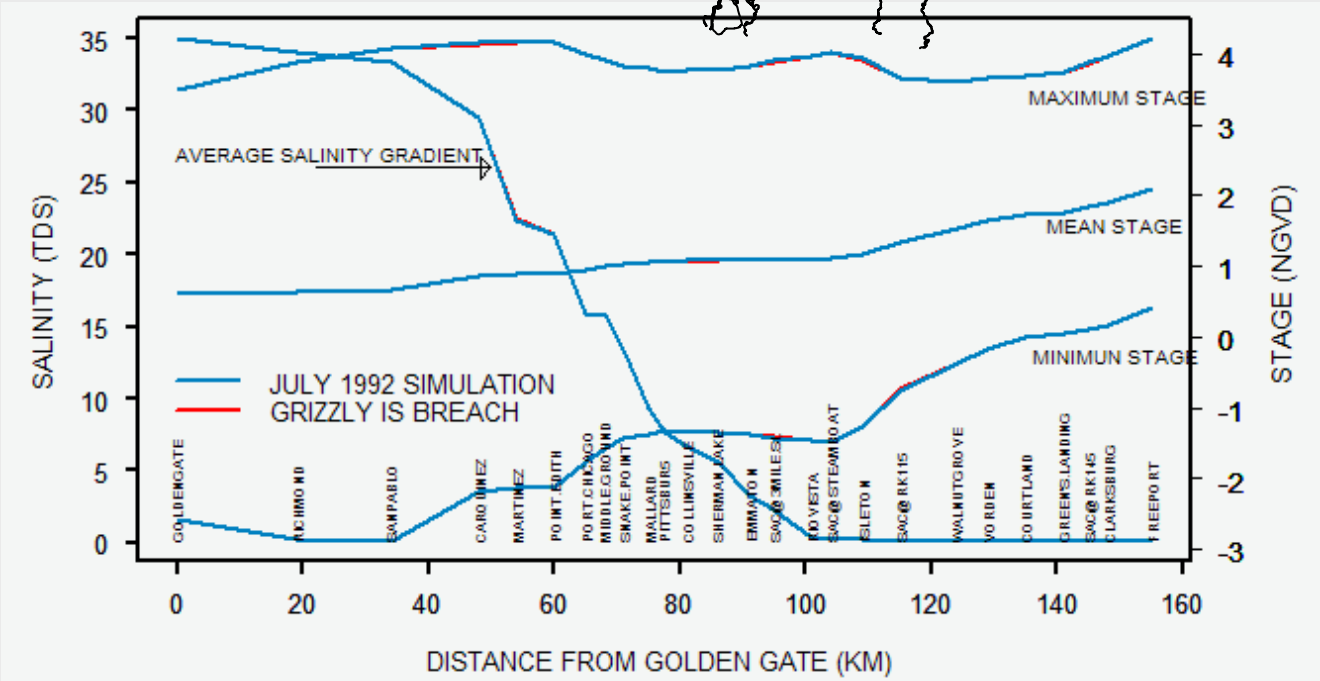
1. Breaches damp tidal energy



1. Breaches damp tidal energy

Tidal range along the estuary





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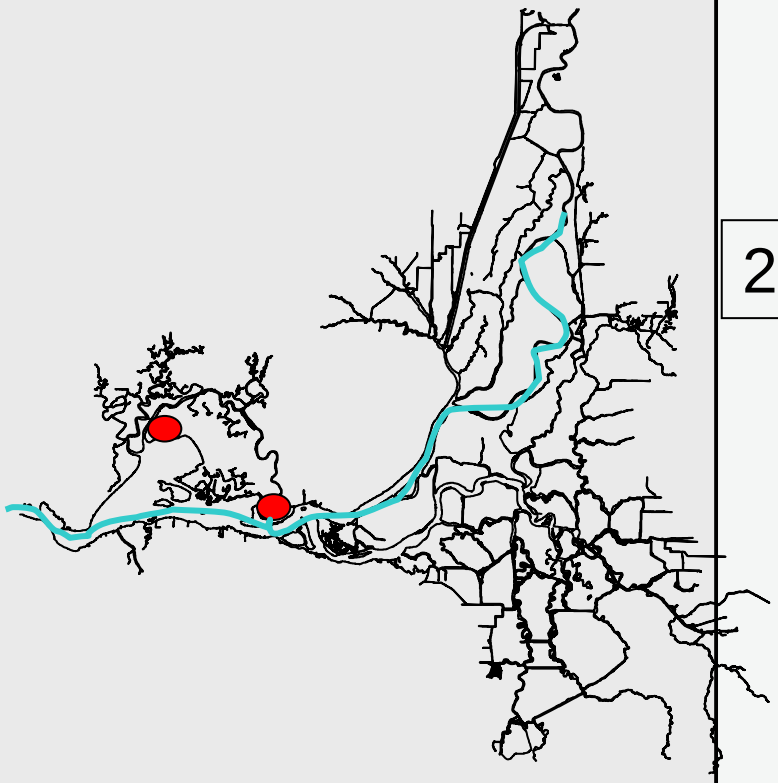
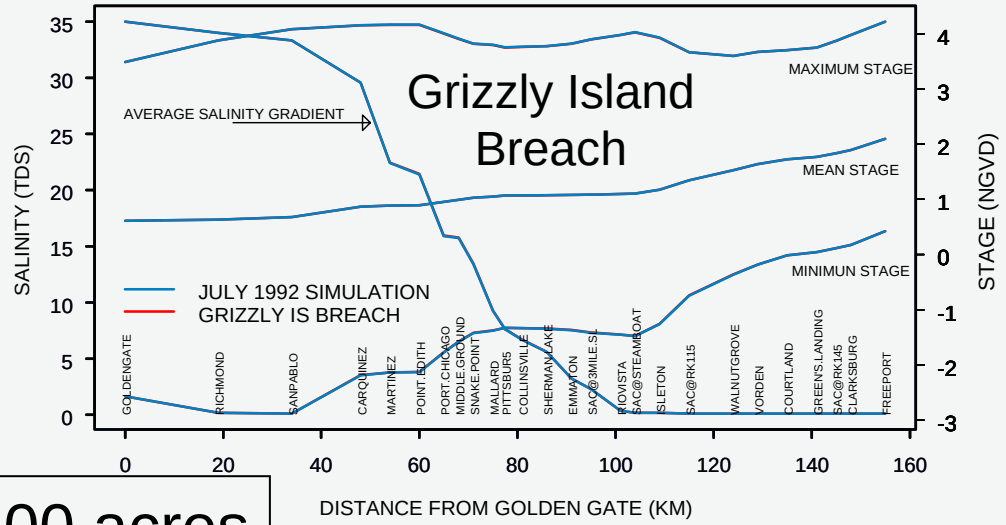
Effect of Levee breach location and size on estuary tidal range



AVERAGE TIDAL RANGE and SALINITY GRADIENT 1/

GRIZZLY IS 100' BREACH: 200 ACRE FLOODED AREA



200 acres

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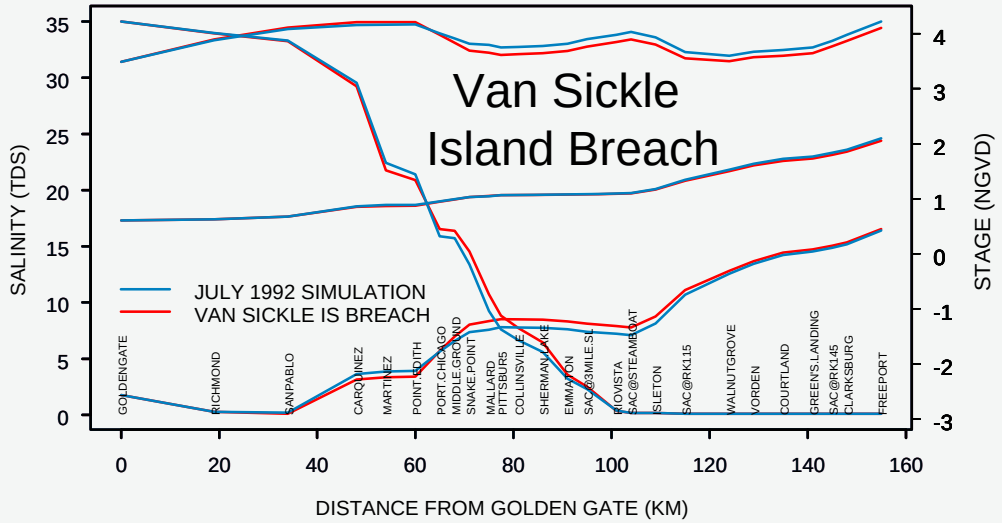

1/ July 1-29, 1992 Historical Simulation
Breaches are 100 ft wide, with 20 ft invert
Stage values are 29-day average of tidal day max, mean, and min.
Gradient values are 29-day average of daily means.
DSM1 Suisun Marsh Version

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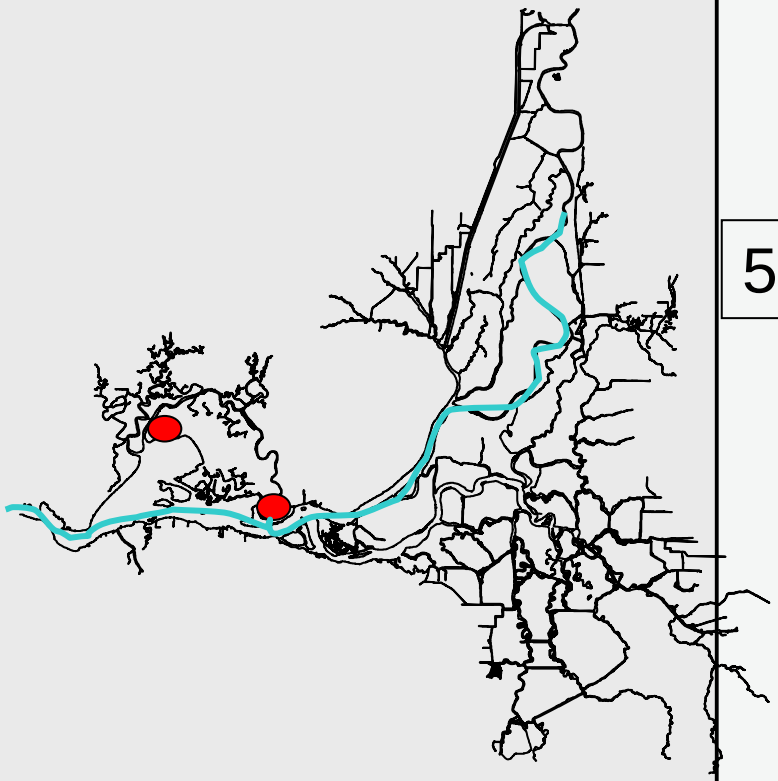
Effect of Levee breach location and size on estuary tidal range



AVERAGE TIDAL RANGE and SALINITY GRADIENT 1/

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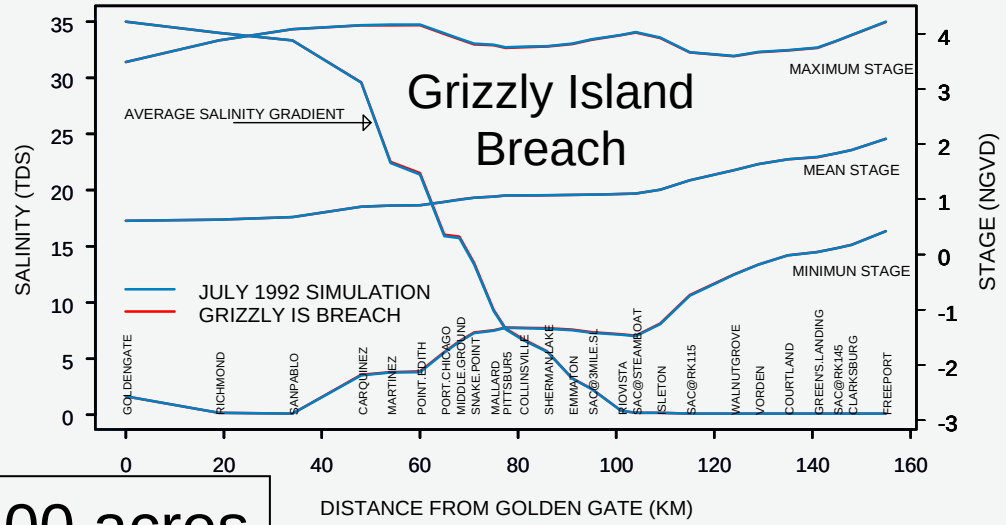

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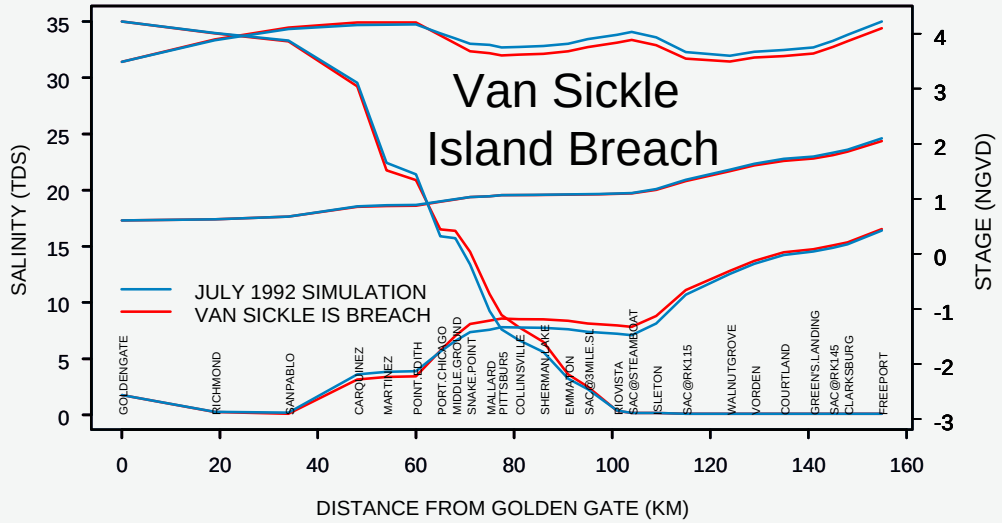

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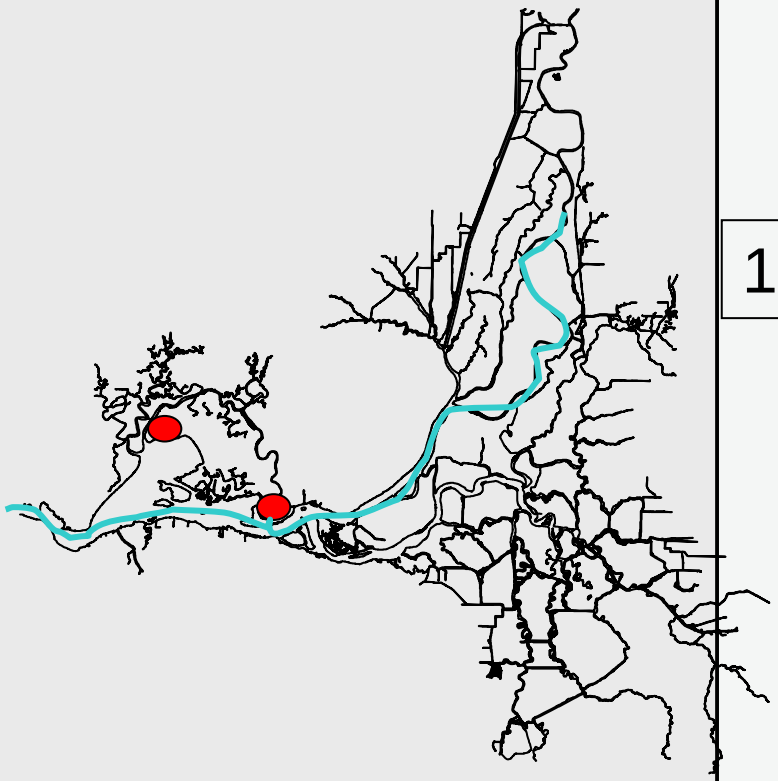

AVERAGE TIDAL RANGE and SALINITY GRADIENT 1/

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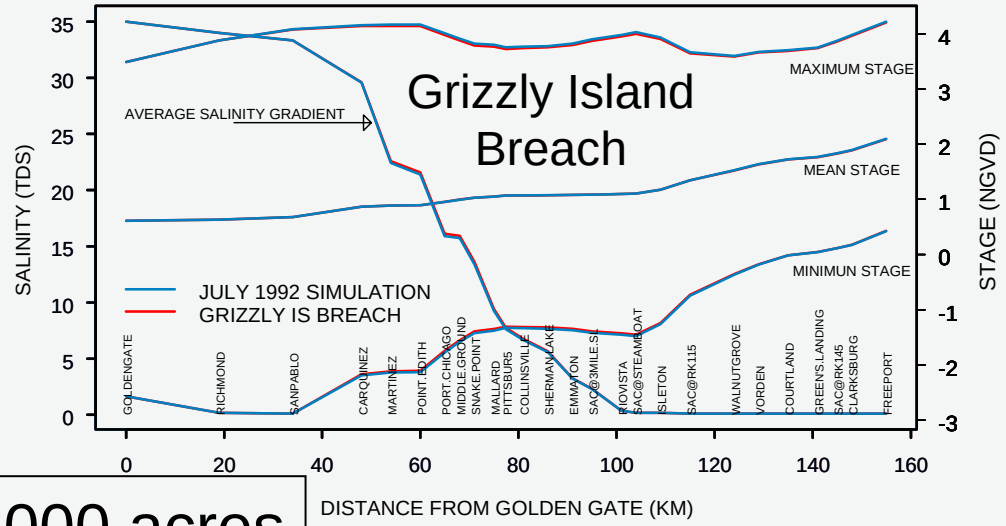

1000 acres

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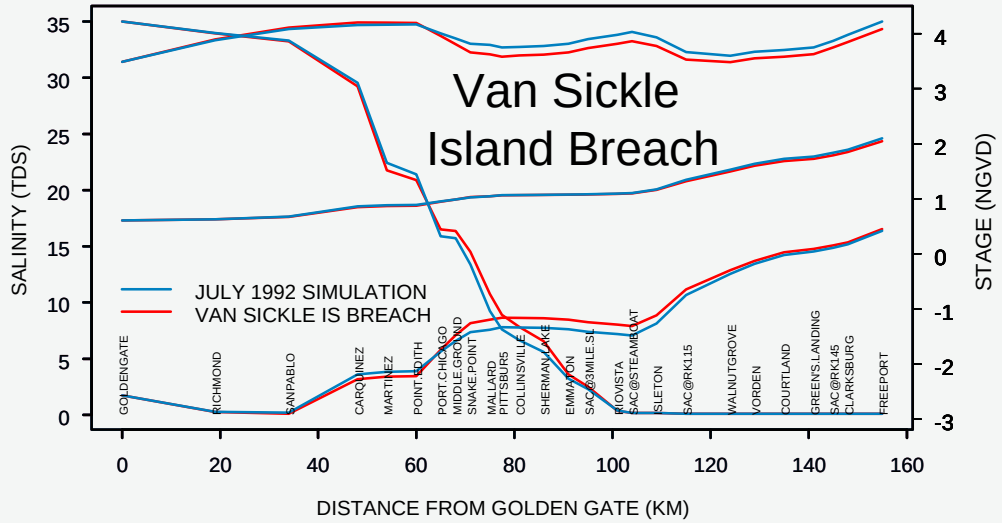

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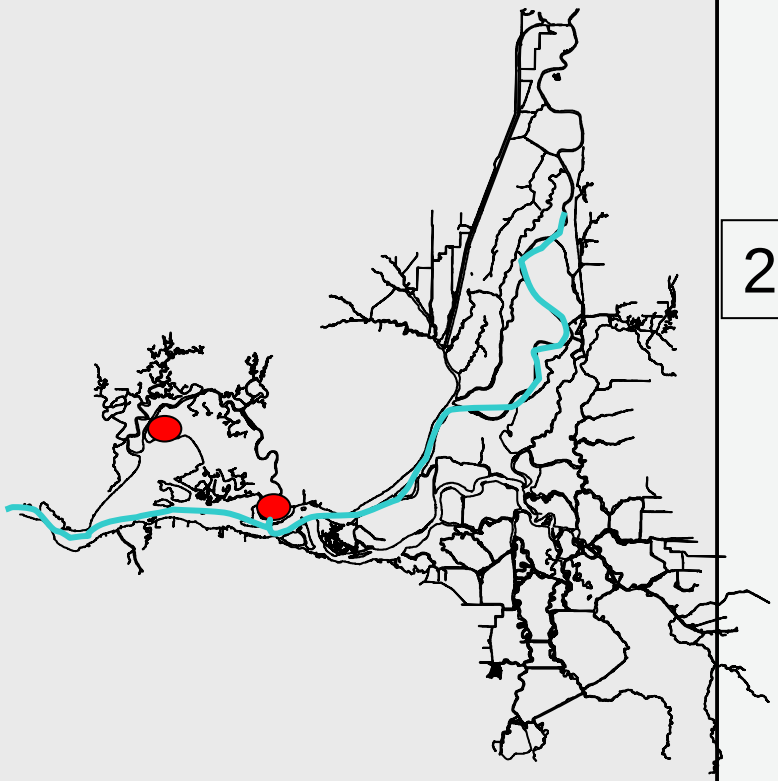

AVERAGE TIDAL RANGE and SALINITY GRADIENT 1/

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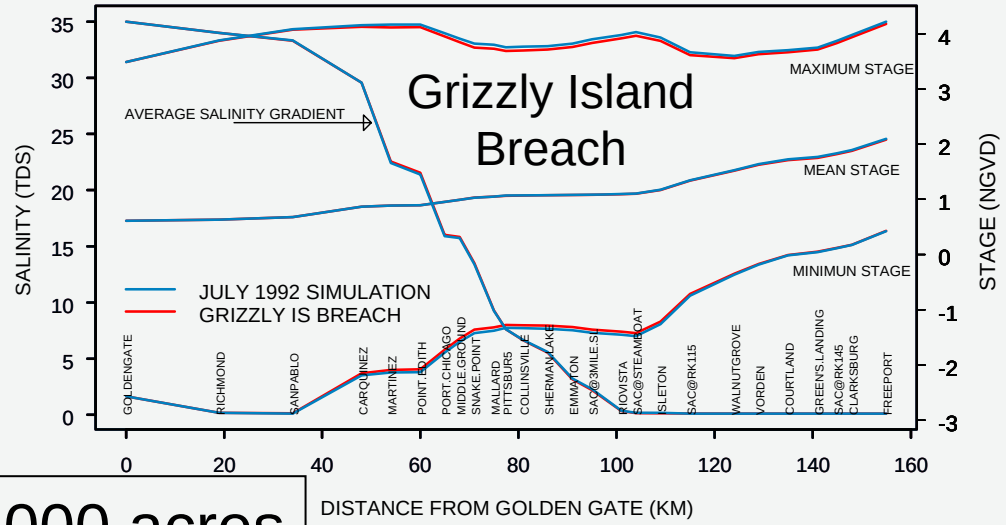

2000 acres

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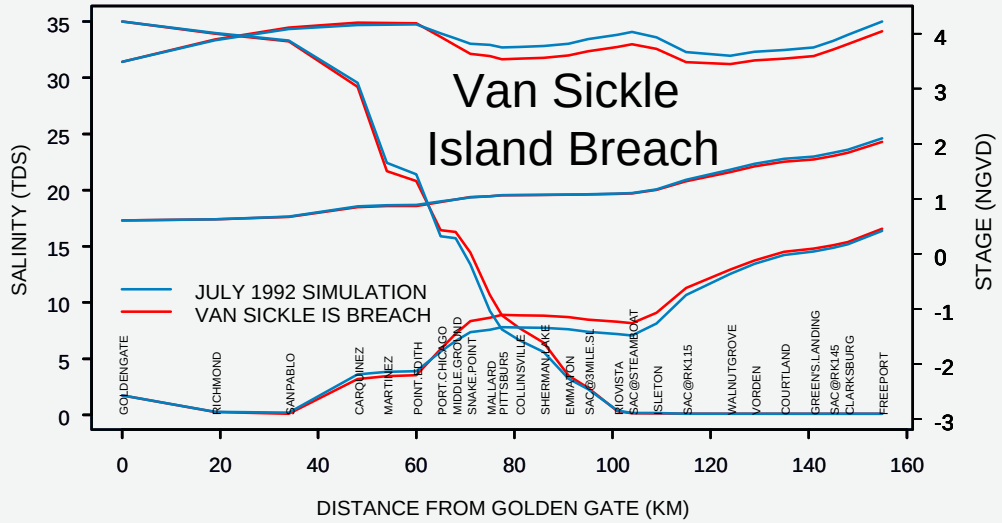

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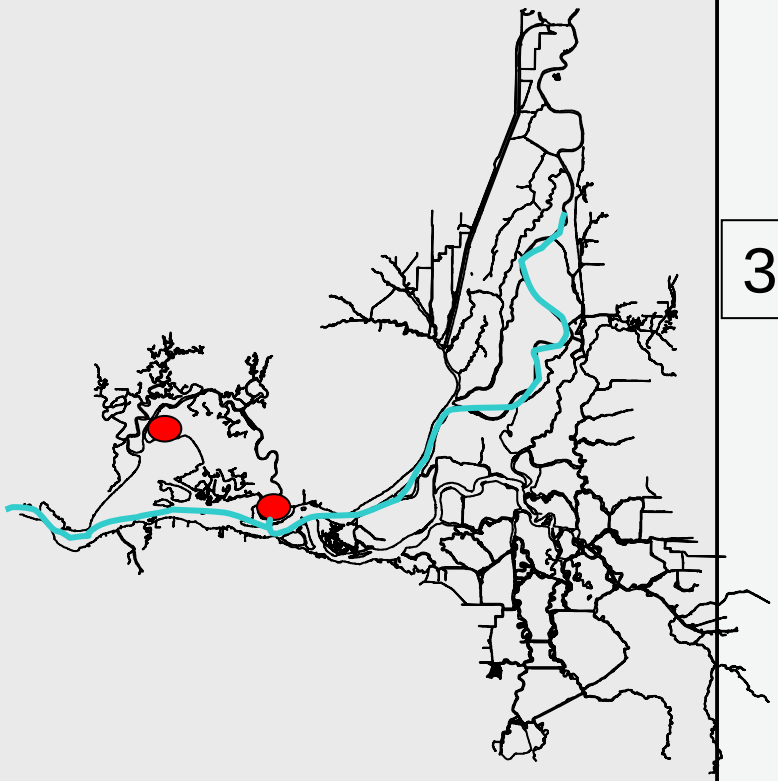

AVERAGE TIDAL RANGE and SALINITY GRADIENT 1/

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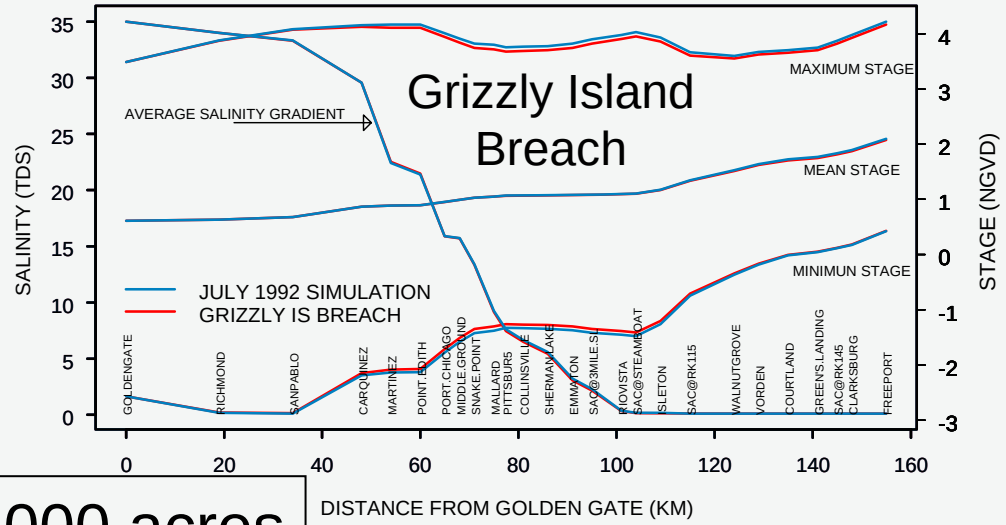

3000 acres

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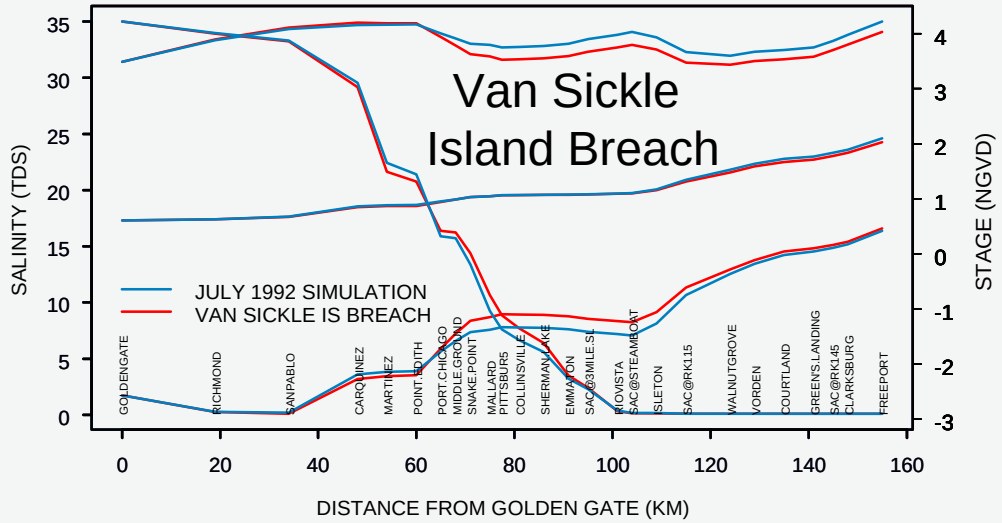

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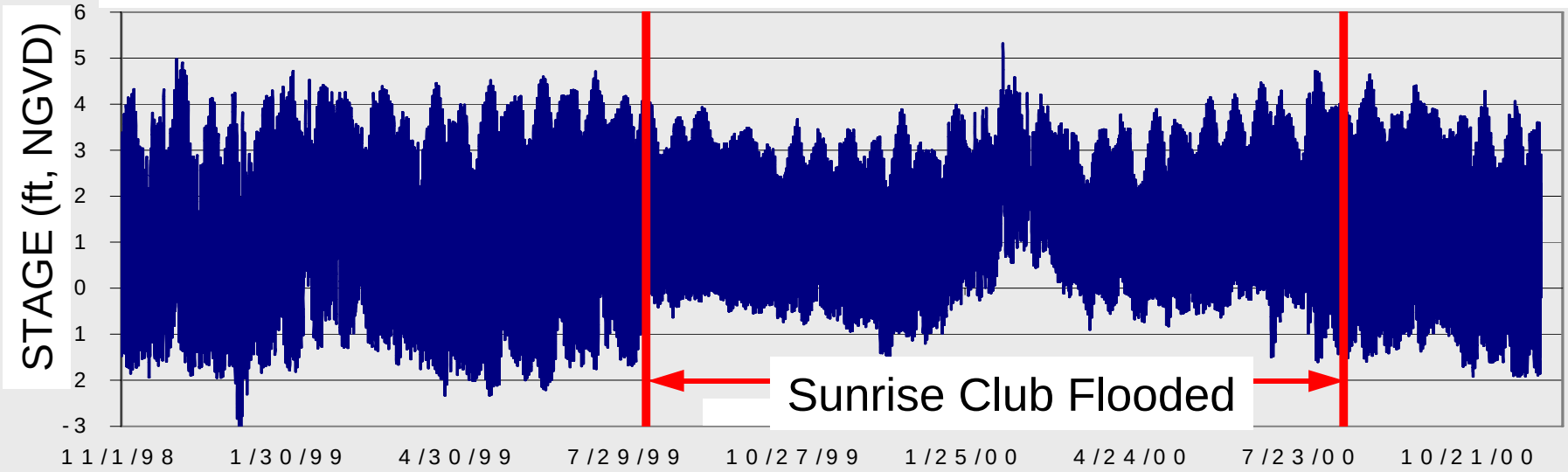
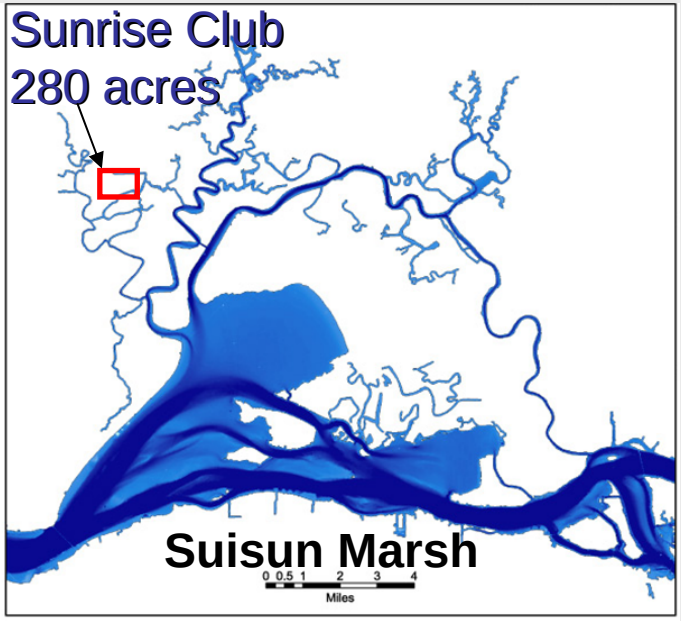
DSM1 Suisun Marsh Version

1. Breaches damp tidal energy

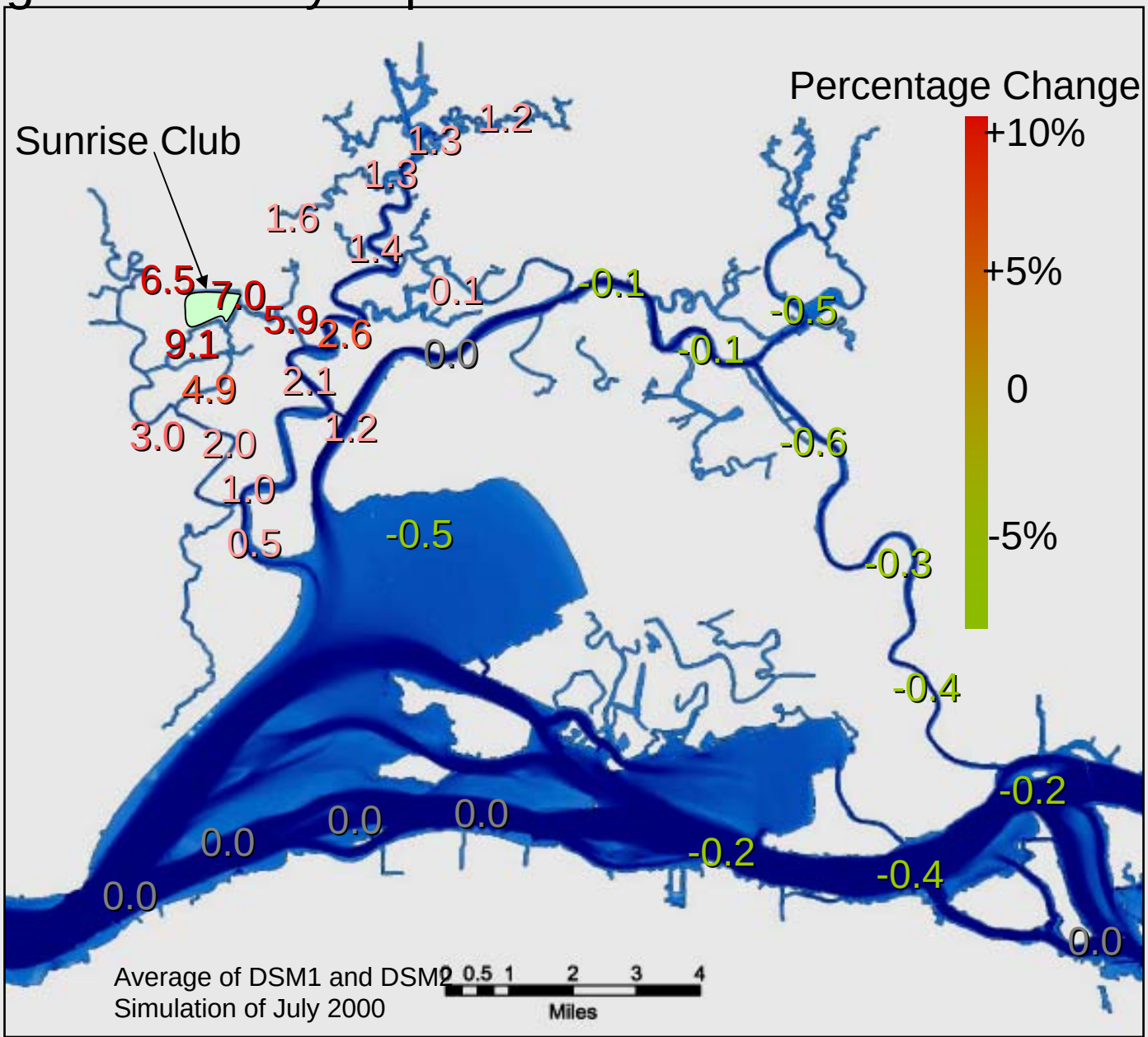
Tidal Range Reduction Due to Levee Breach





1. Breaches damp tidal energy

Regional Salinity Impact of Sunrise Club Levee Breach



2. Transport by tidal trapping

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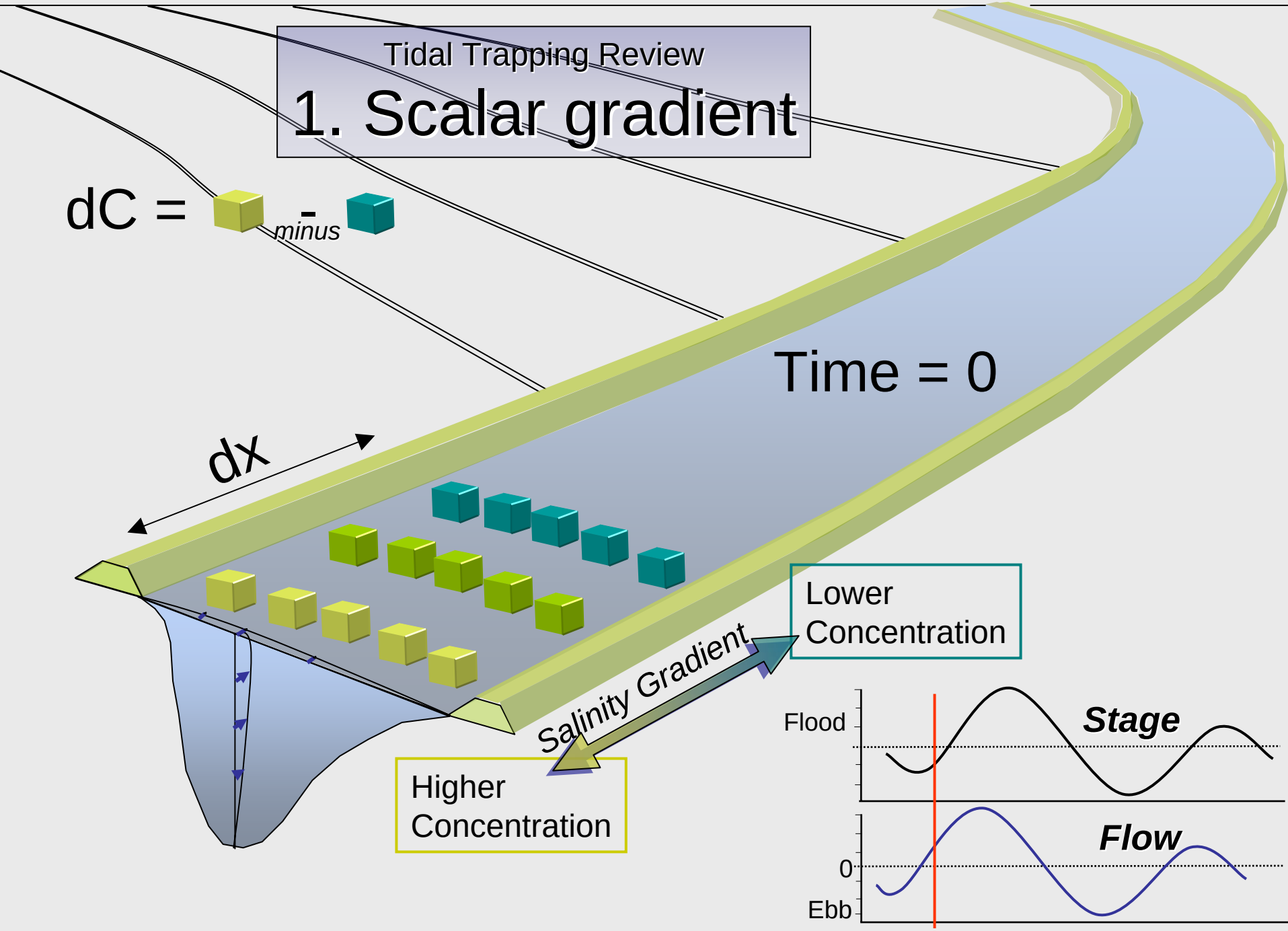
Two conditions must exist:

1. Scalar gradient (dC/dx, the rate of concentration change with distance)
2. Current asymmetry

Tidal Trapping Review

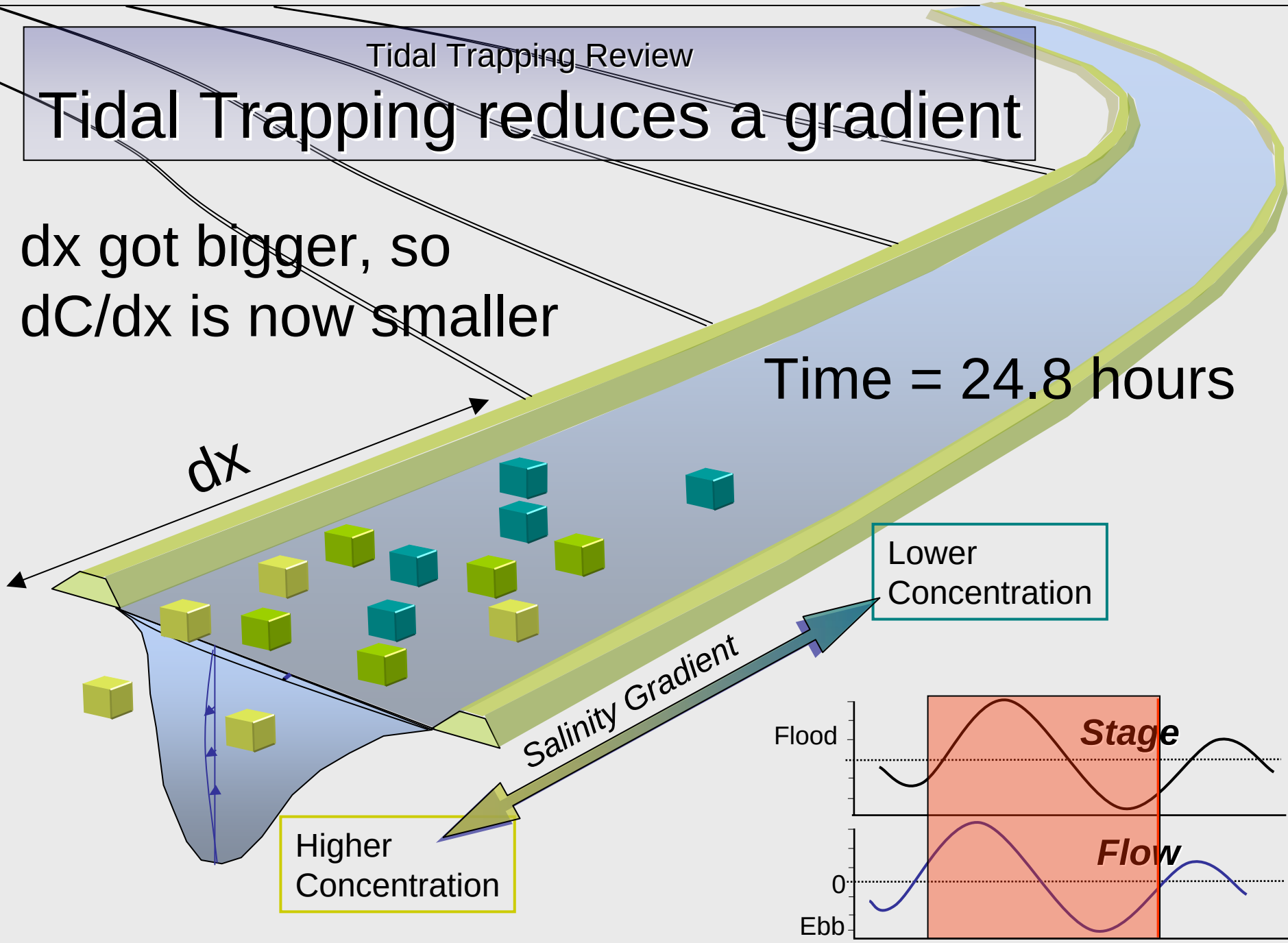
1. Scalar gradient



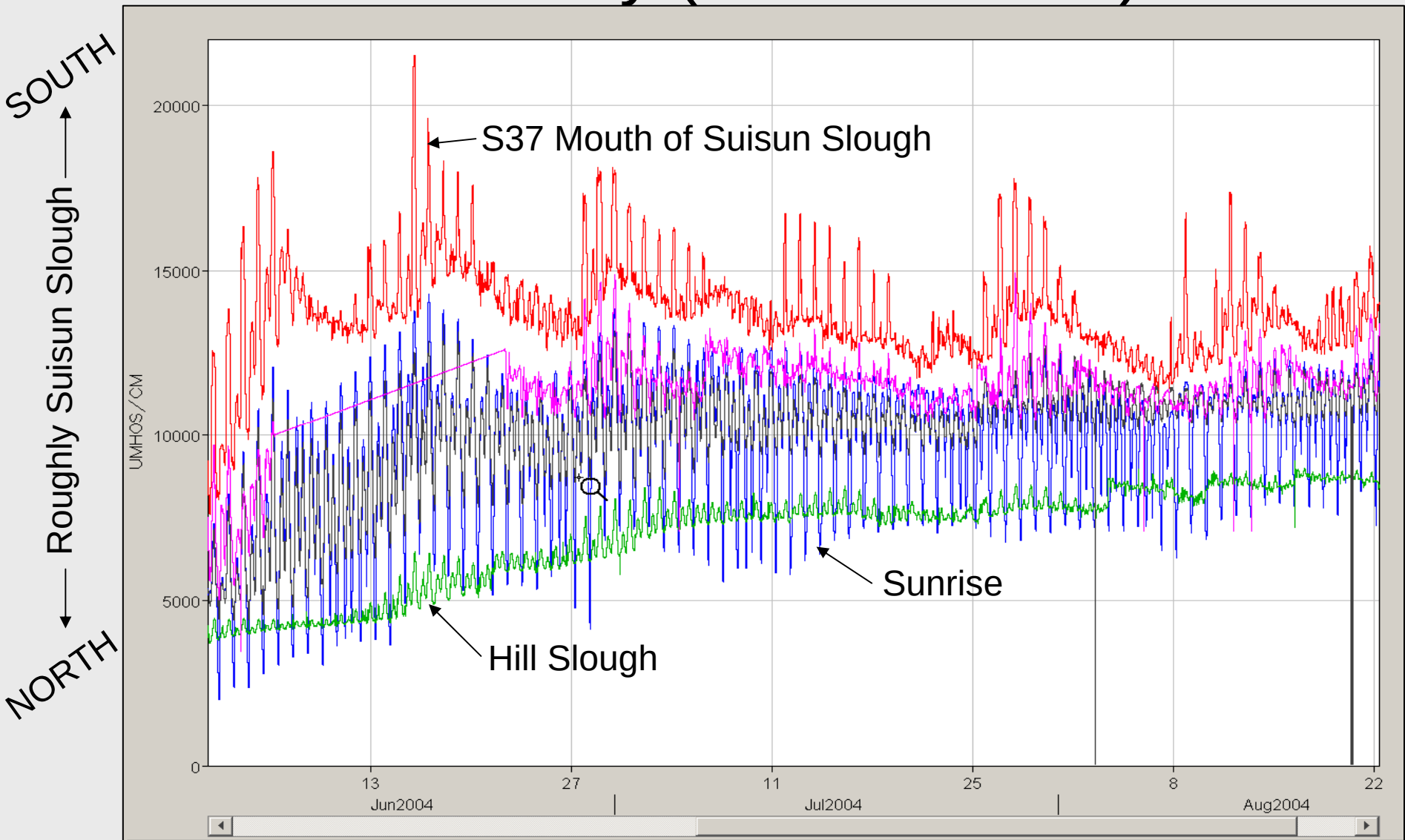
Tidal Trapping reduces a gradient

dx got bigger, so
dC/dx is now smaller

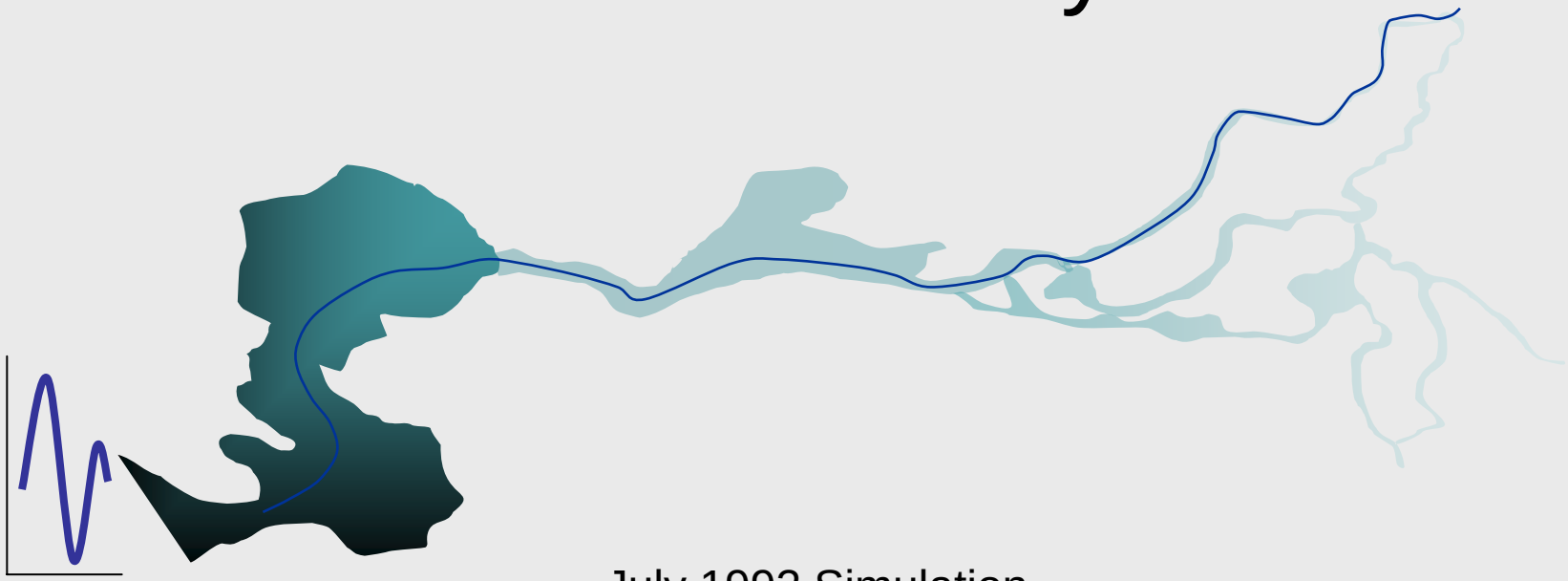
Time = 24.8 hours

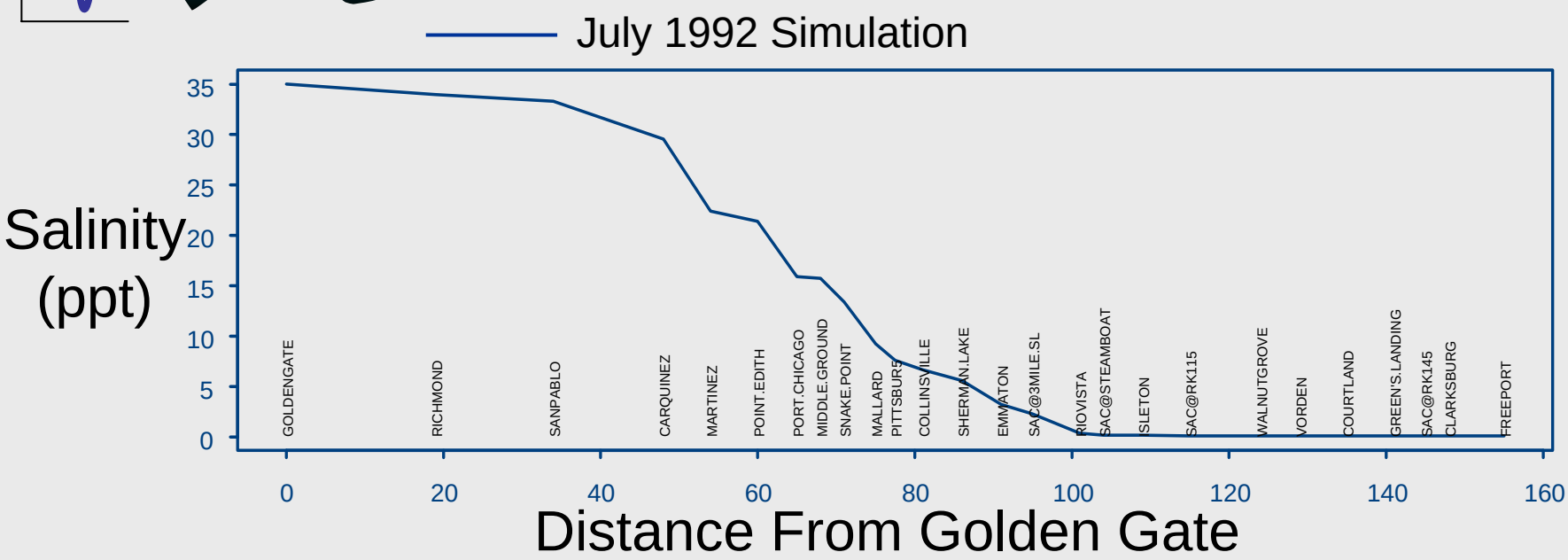


Suisun Marsh has the biggest gradients in the estuary (N-S and E-W)!



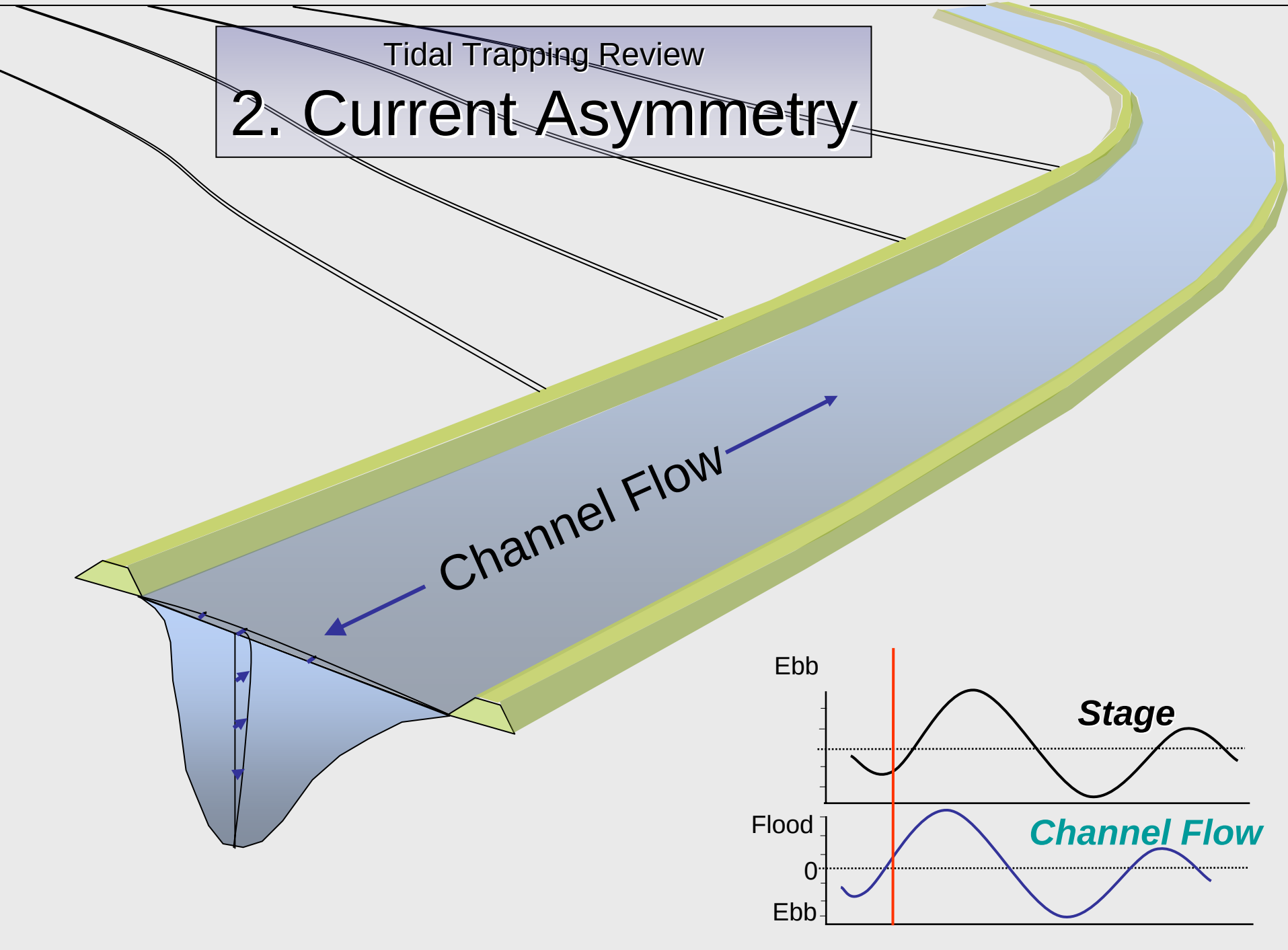
East-West Salinity Gradient





Tidal Trapping Review

2. Current Asymmetry



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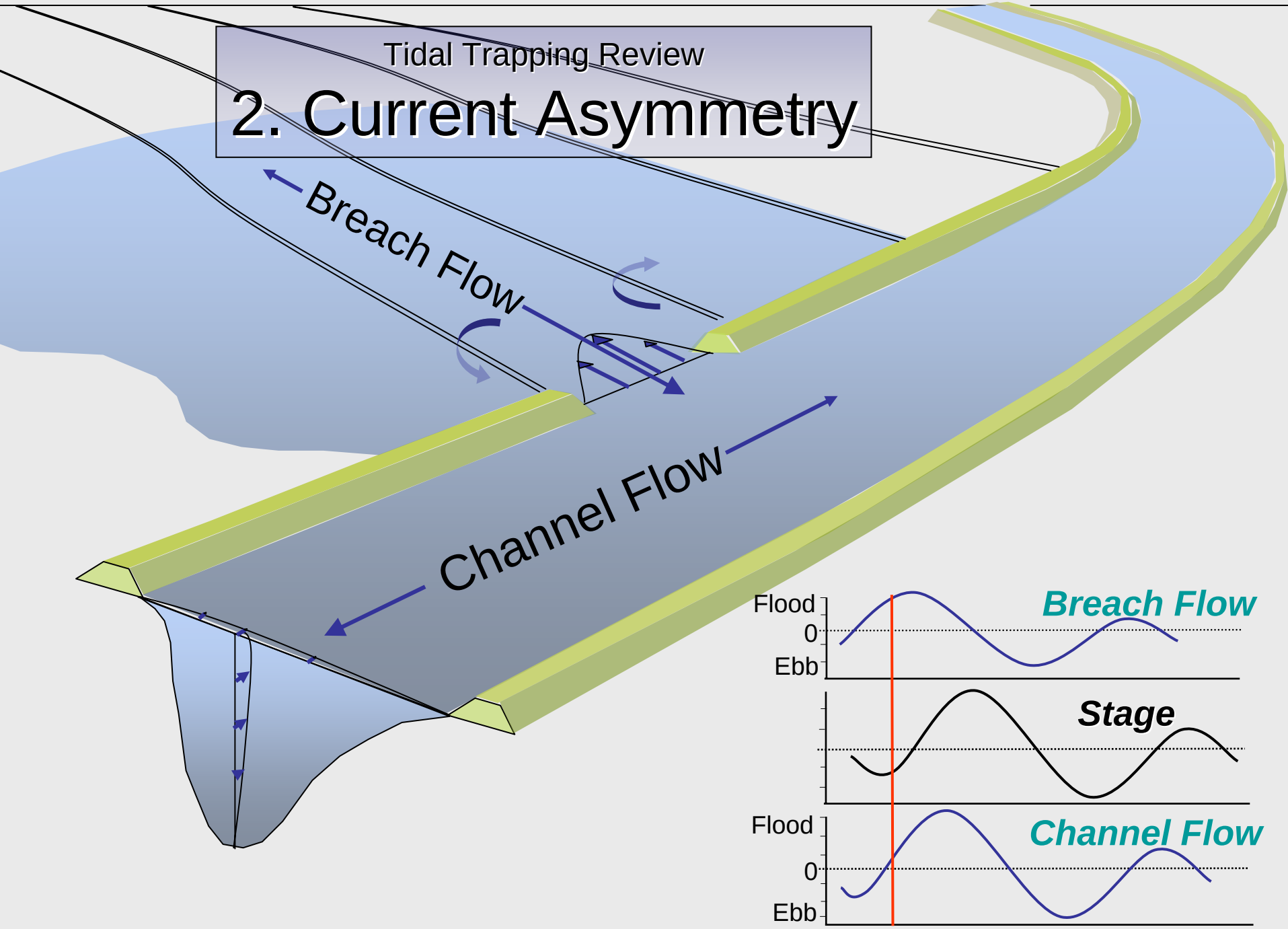

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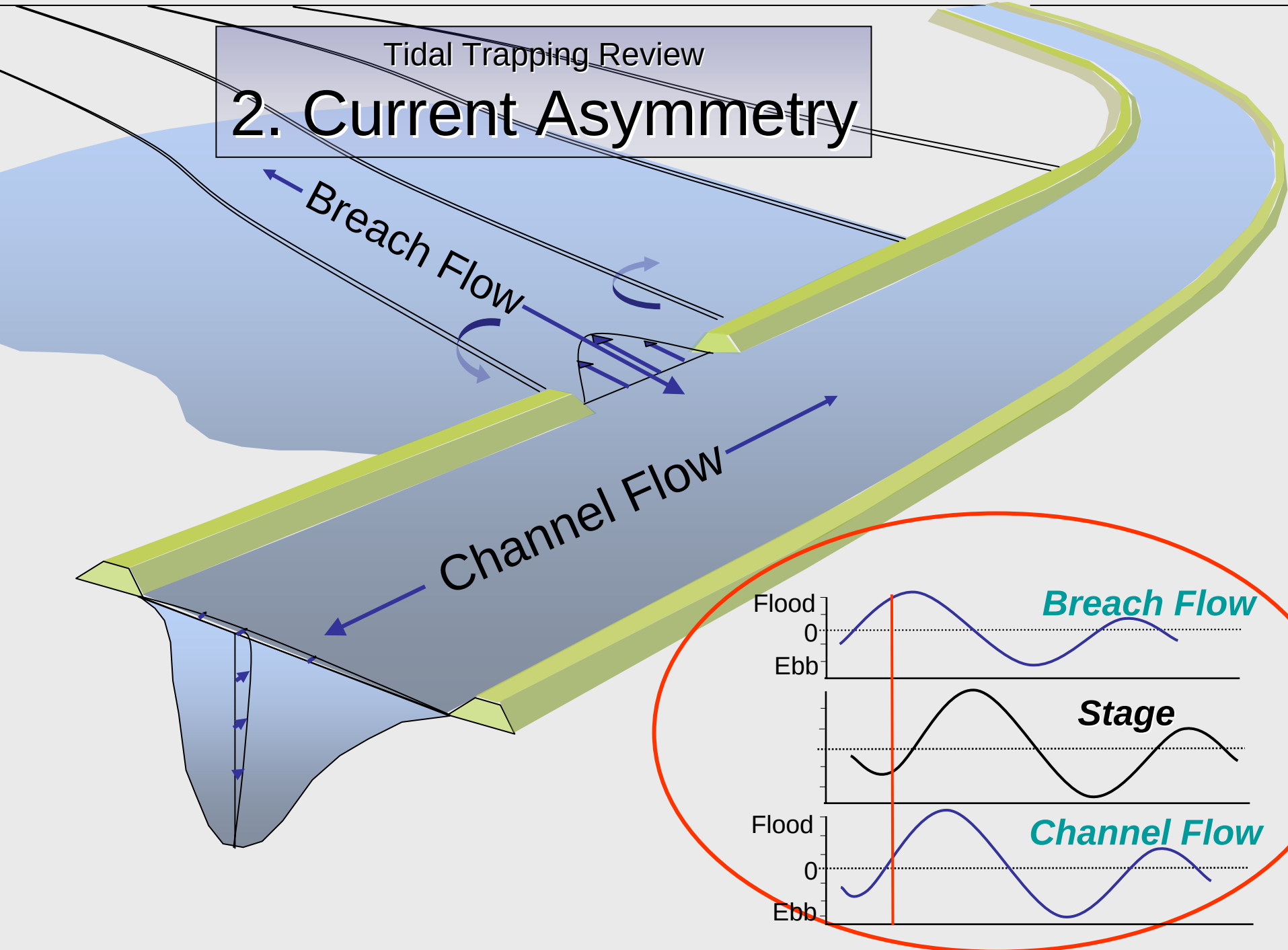
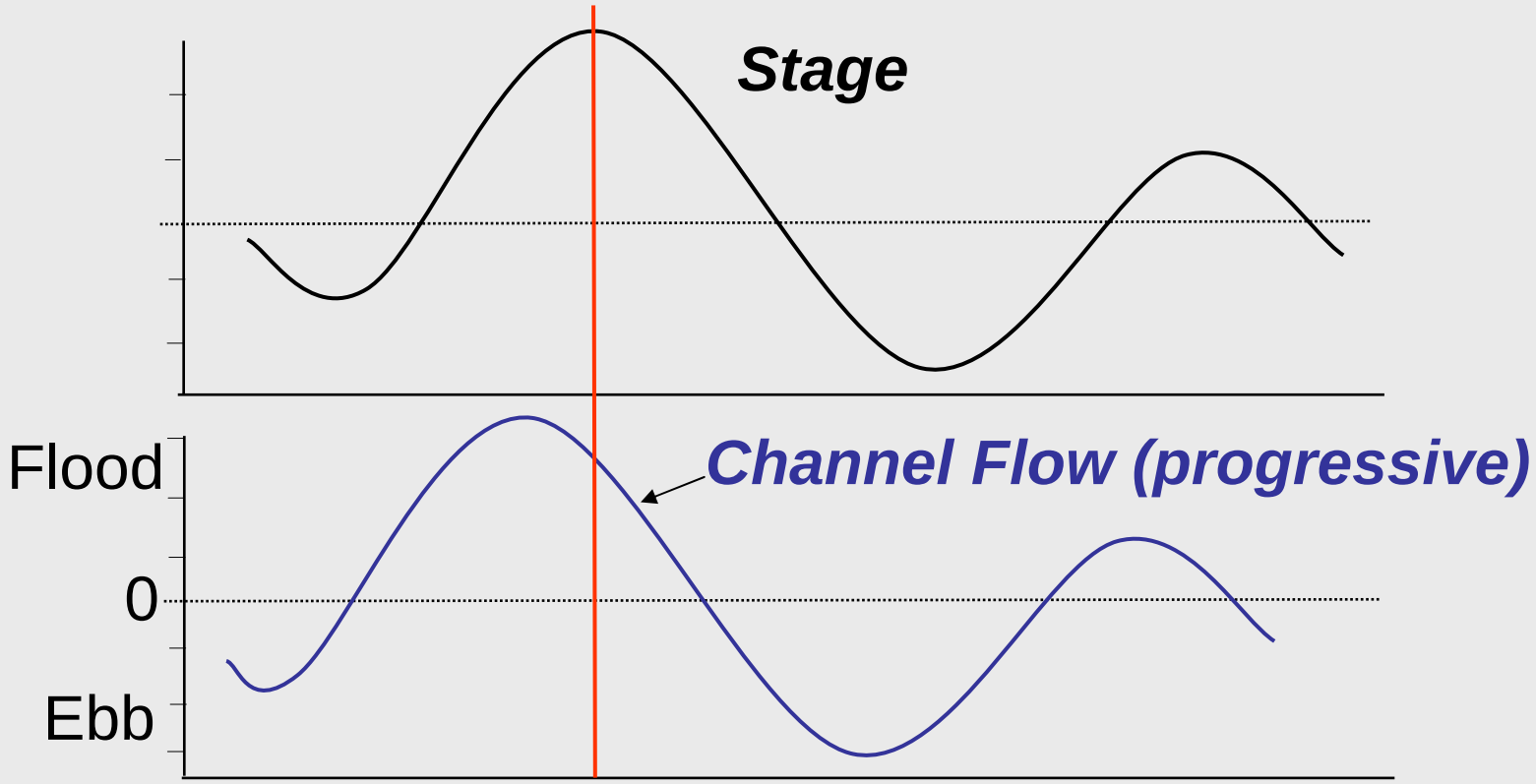


Tidal Trapping

- Timing of tidal stage and tidal flow:



Typical of Suisun Bay

Tidal Trapping

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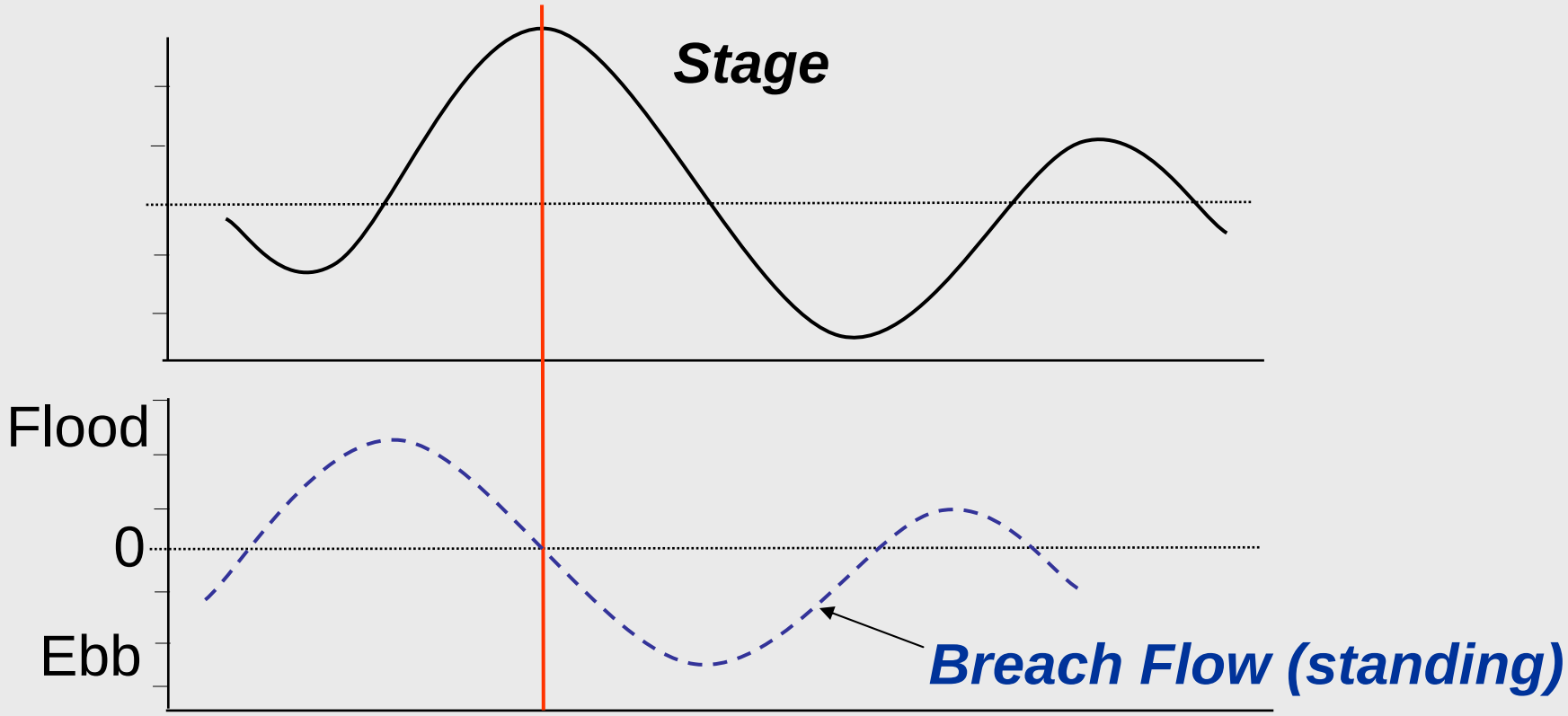

Typical of Suisun Marsh

Tidal Trapping

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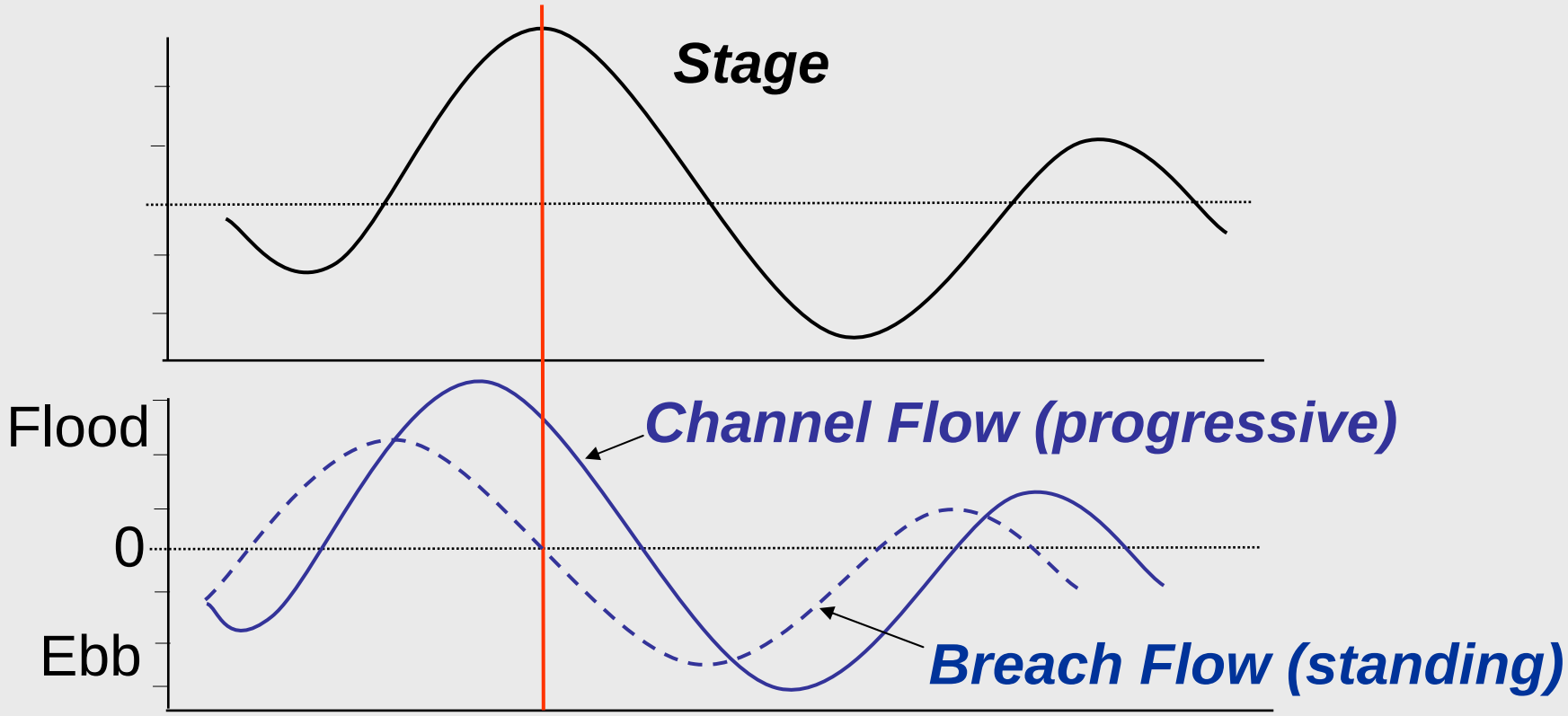

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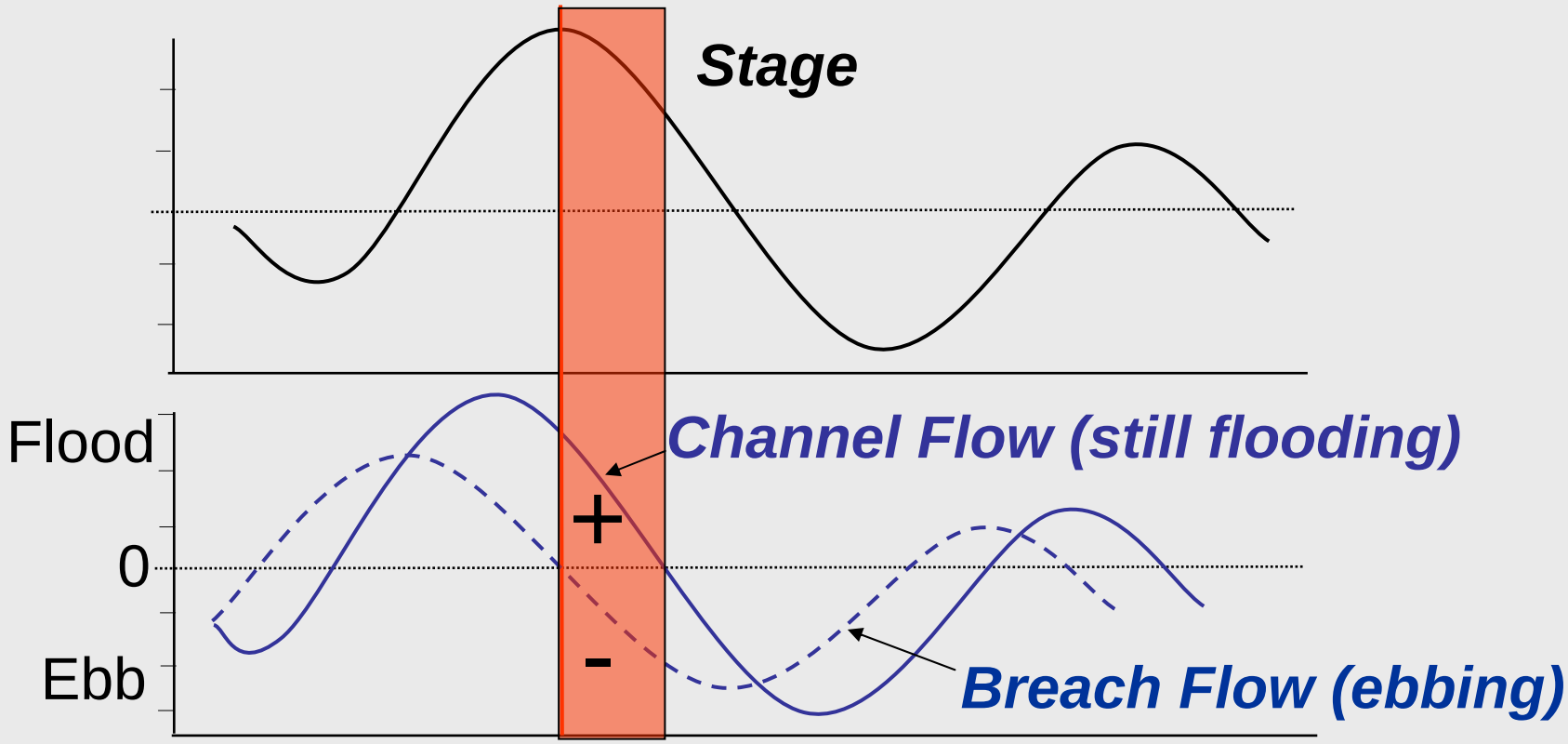
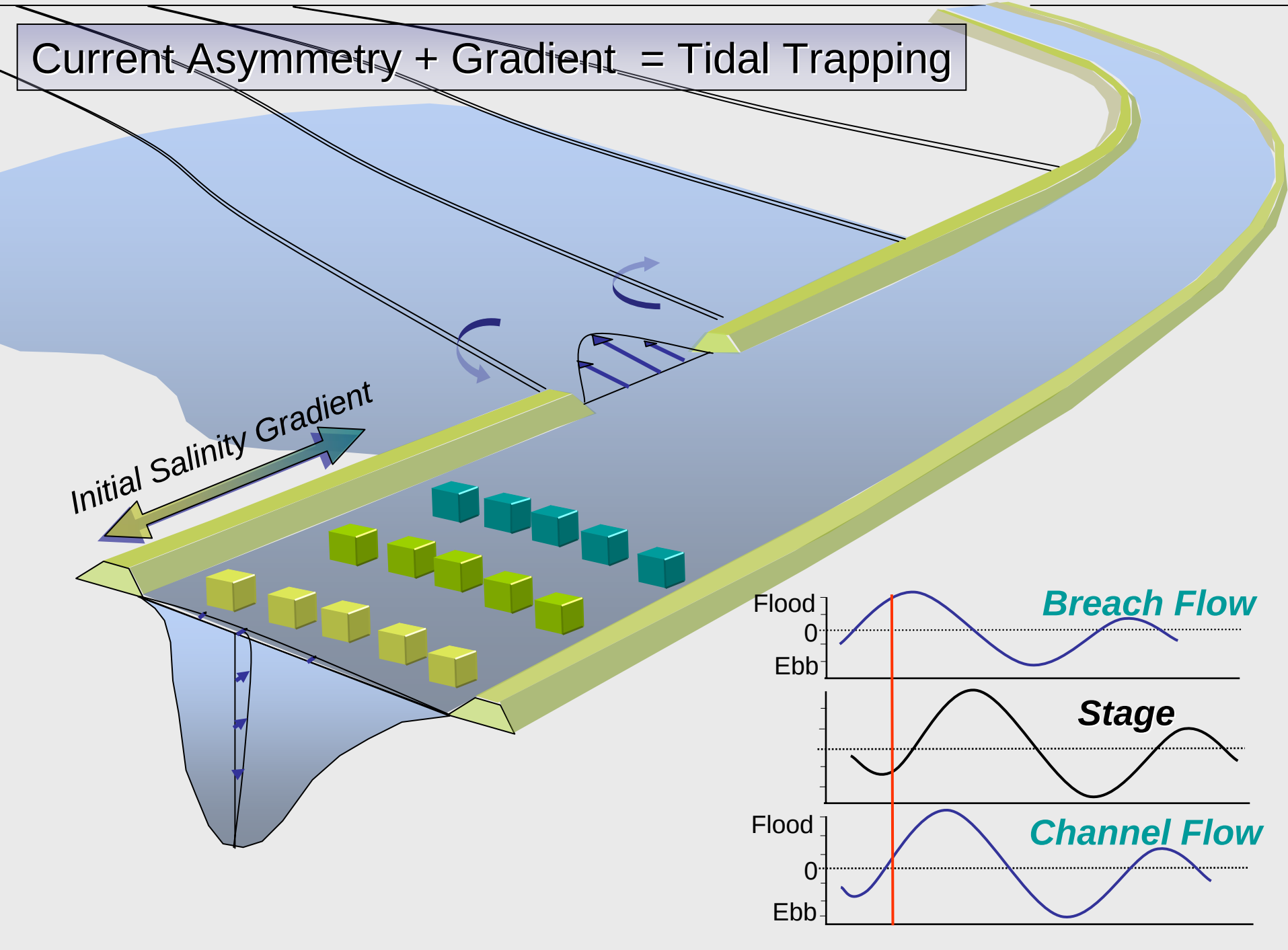


Current Asymmetry + Gradient = Tidal Trapping



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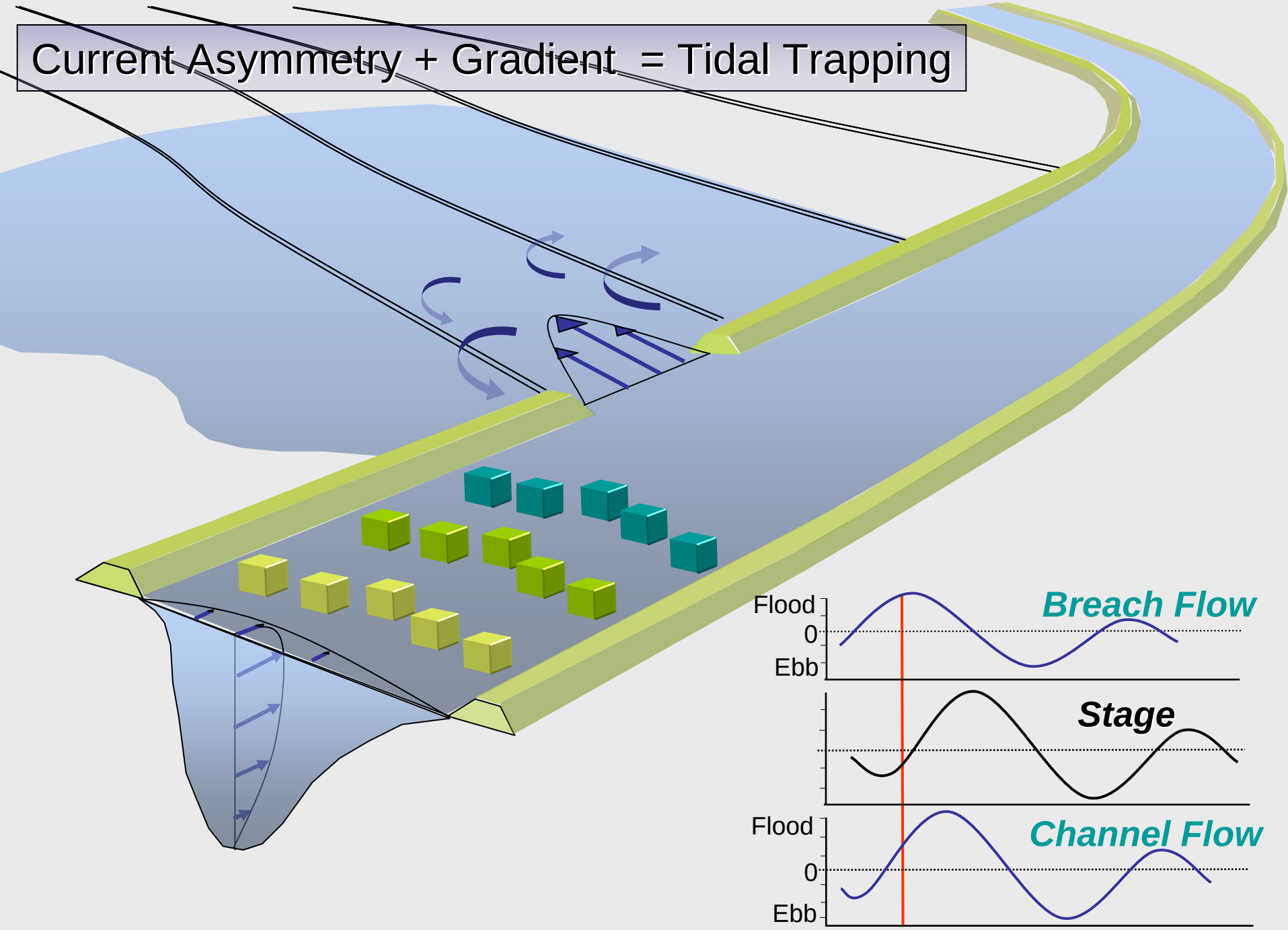

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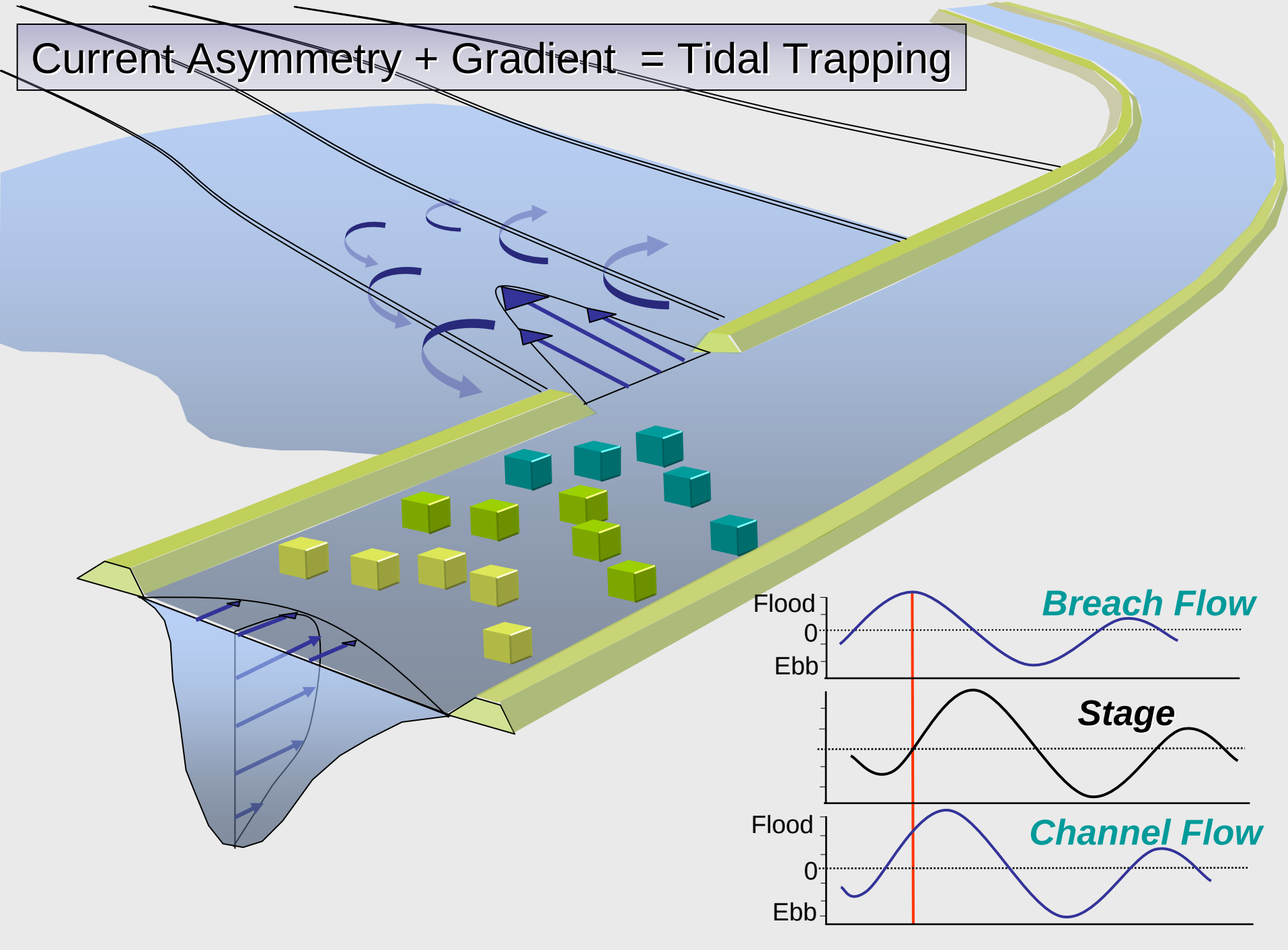

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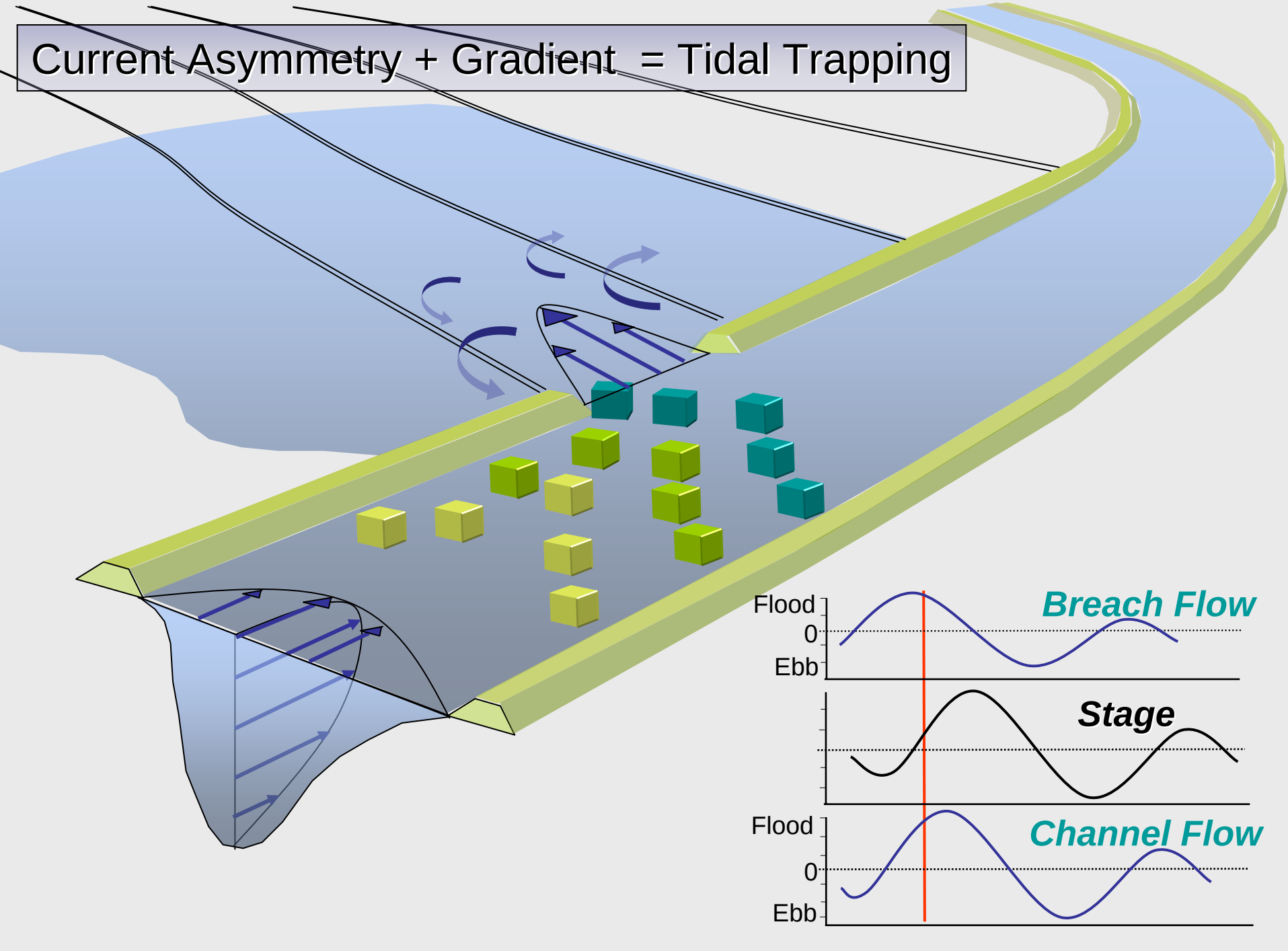

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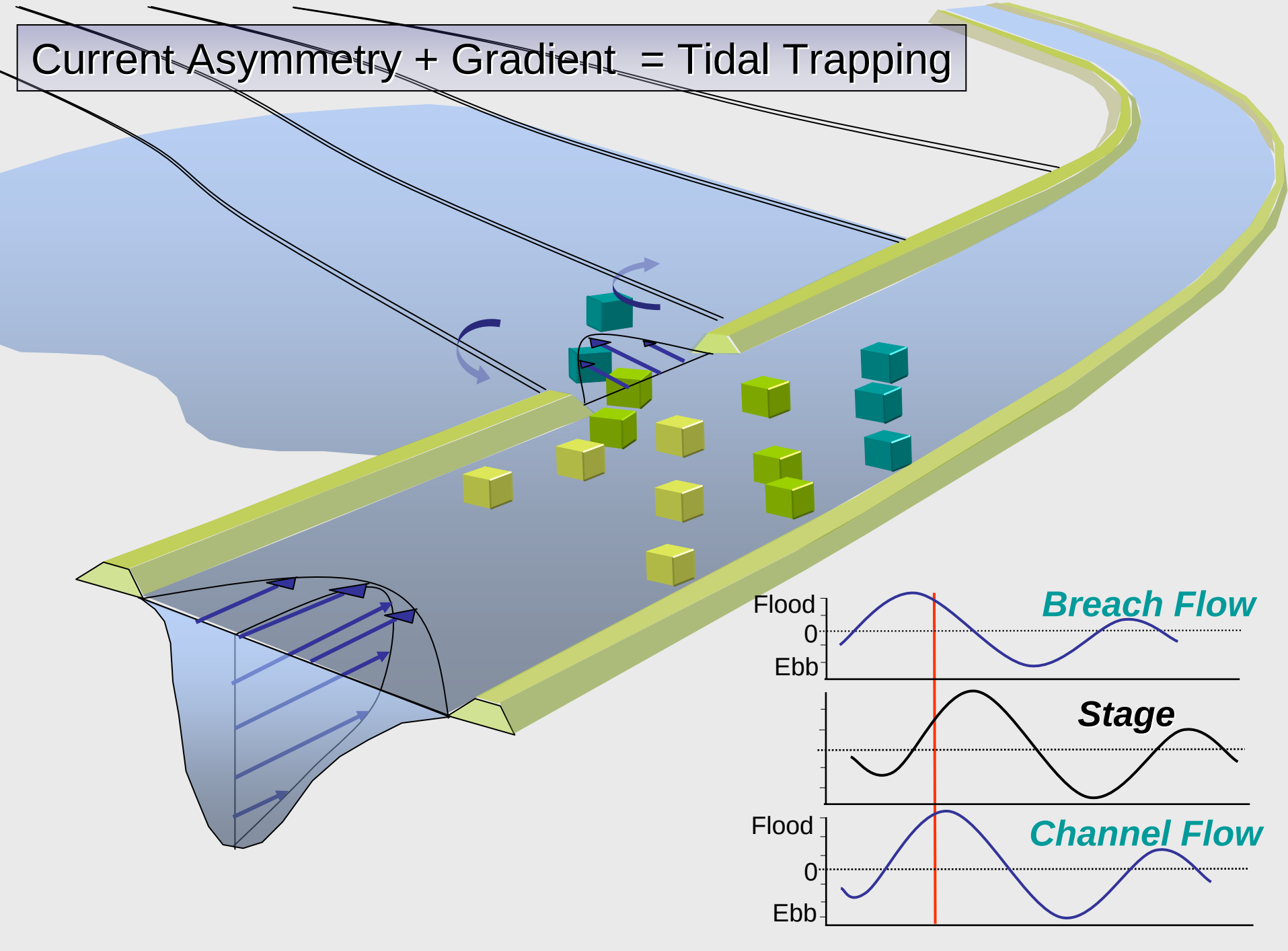

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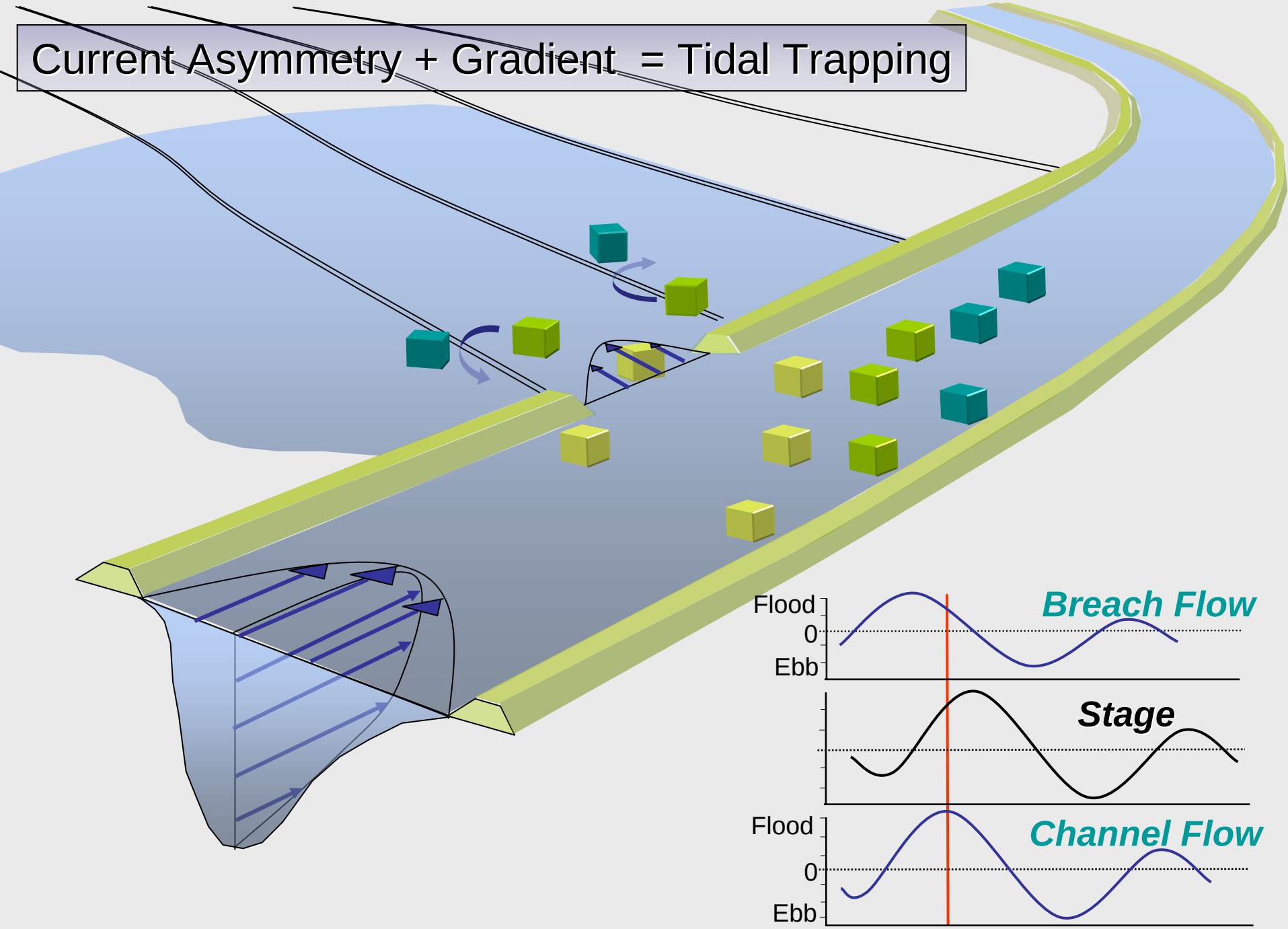

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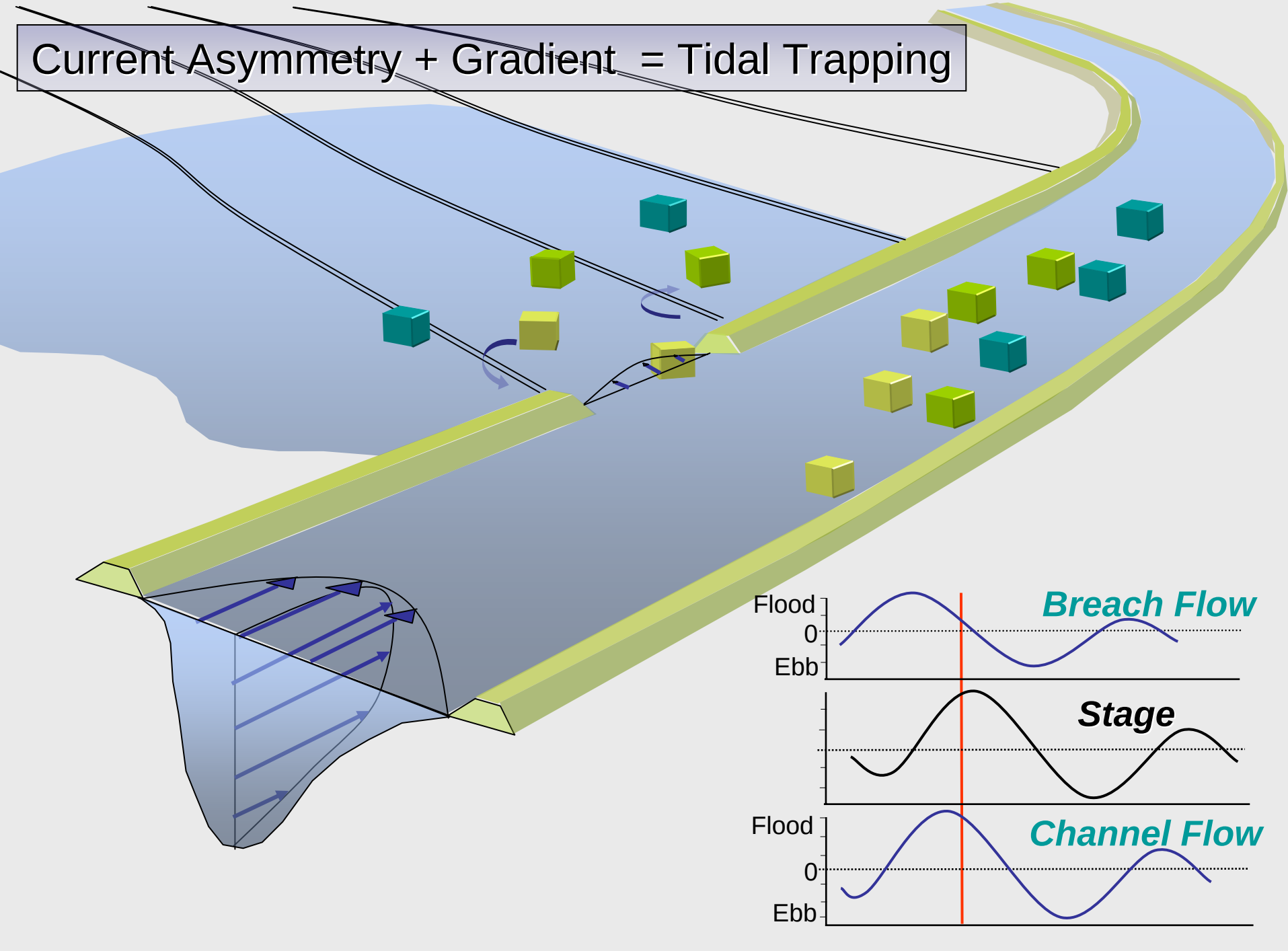

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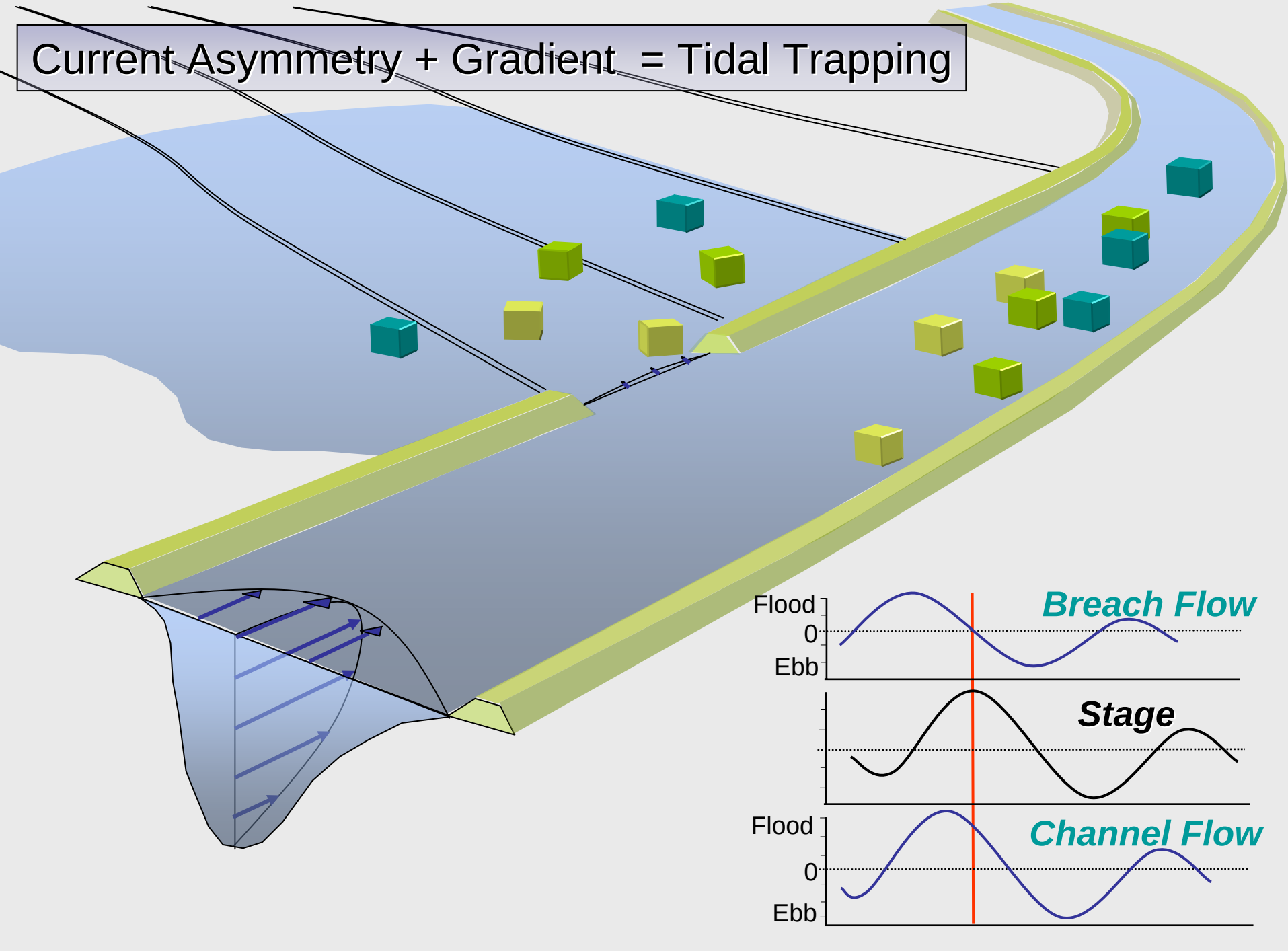

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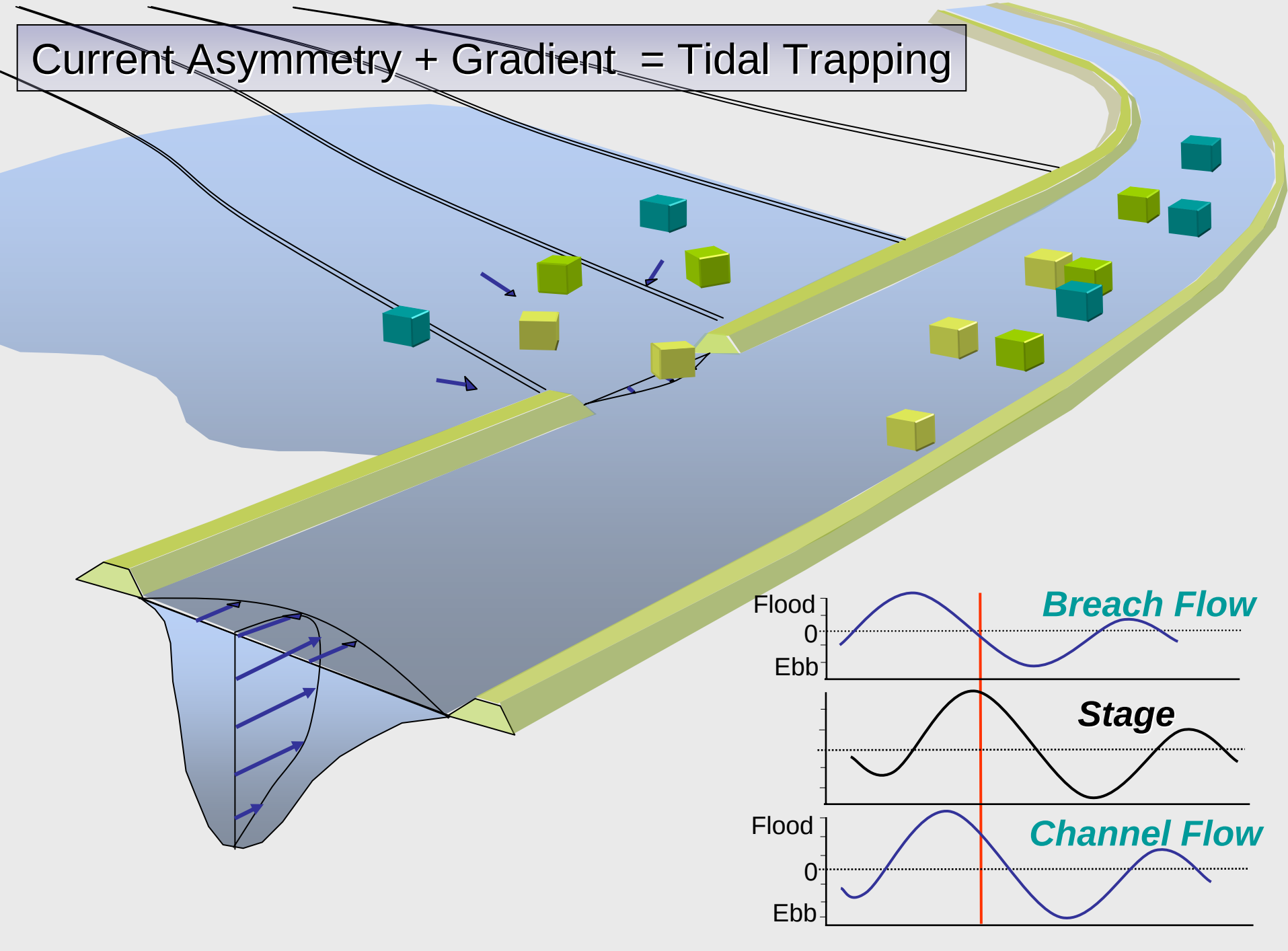
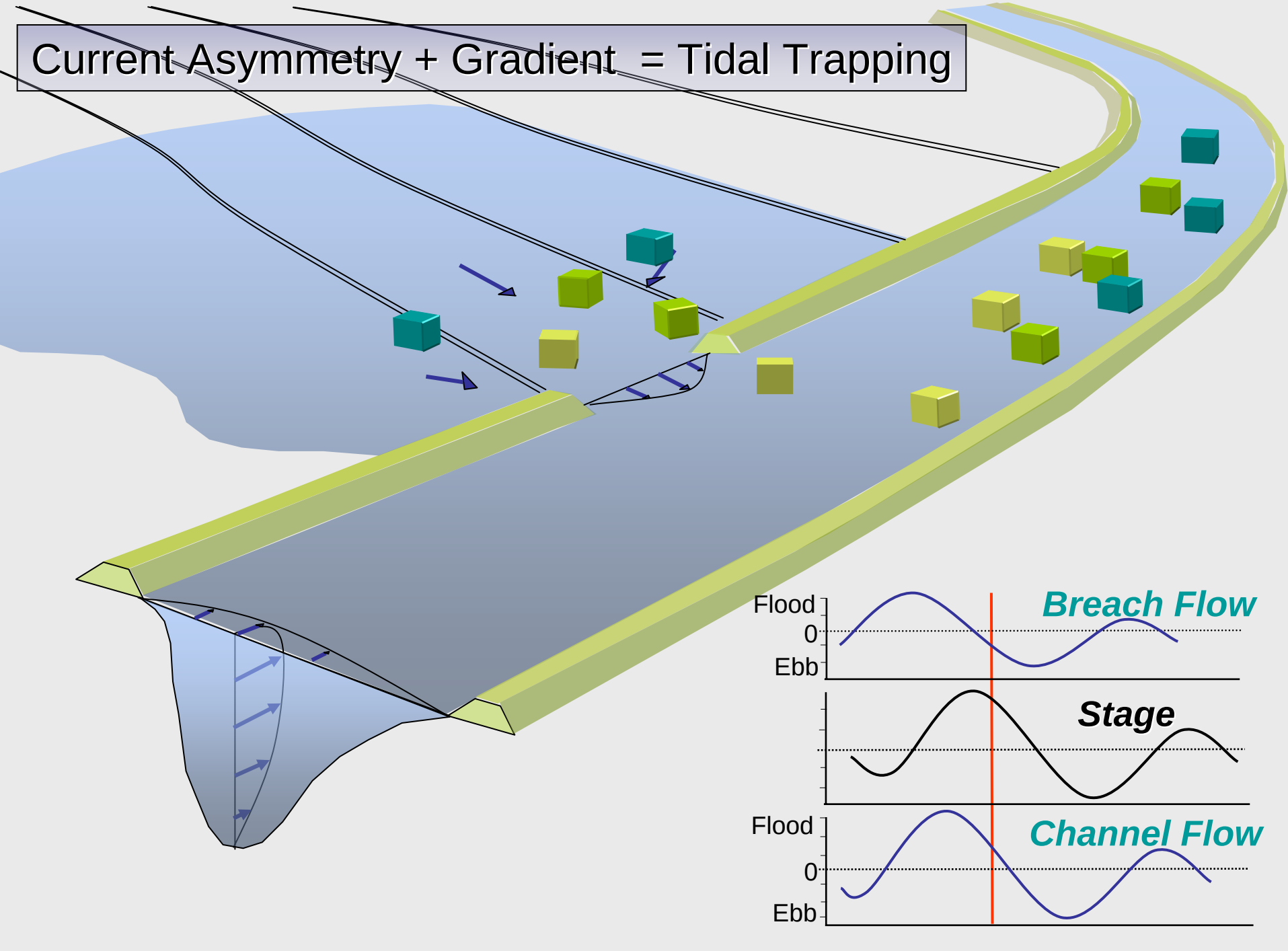
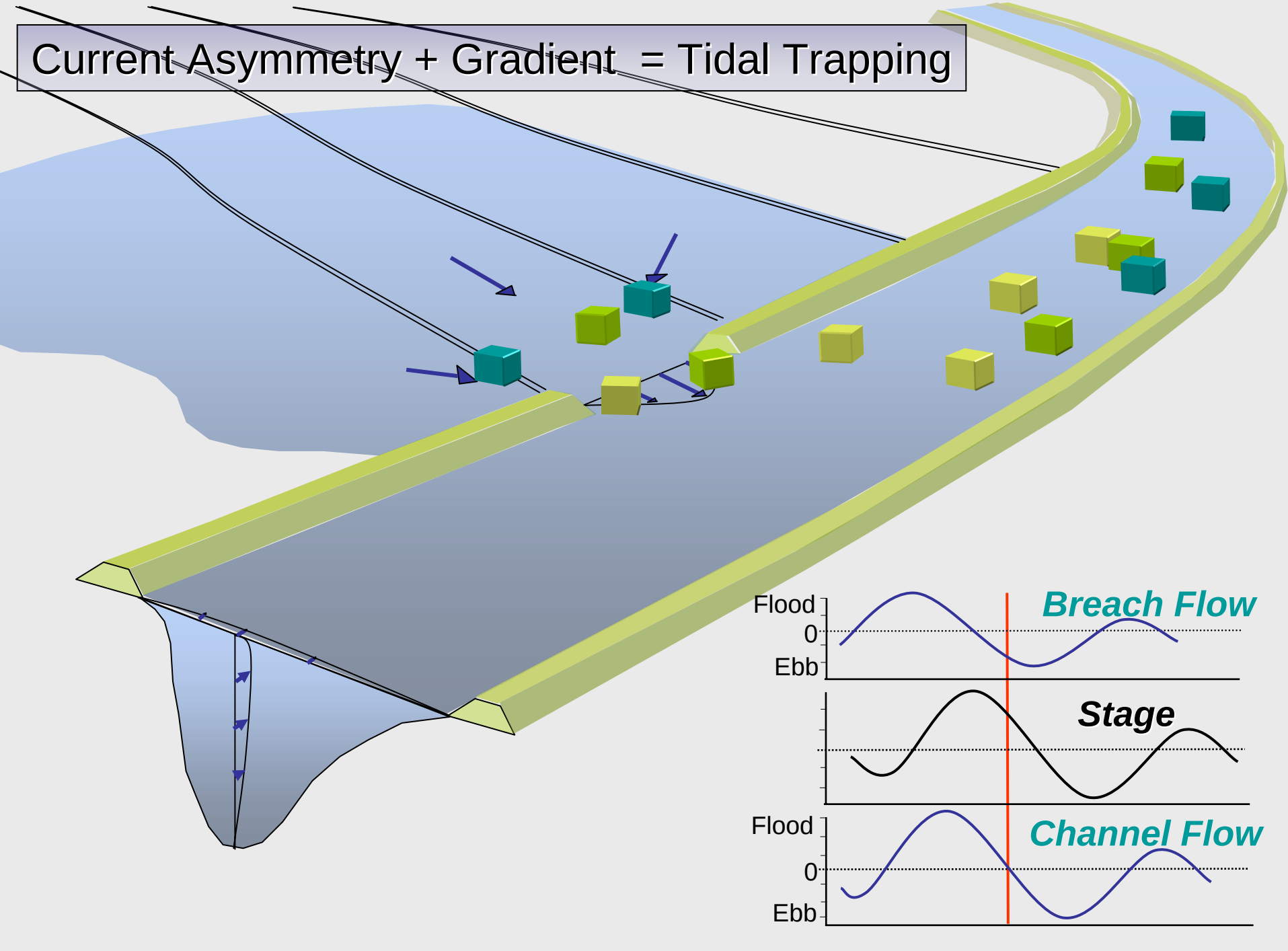


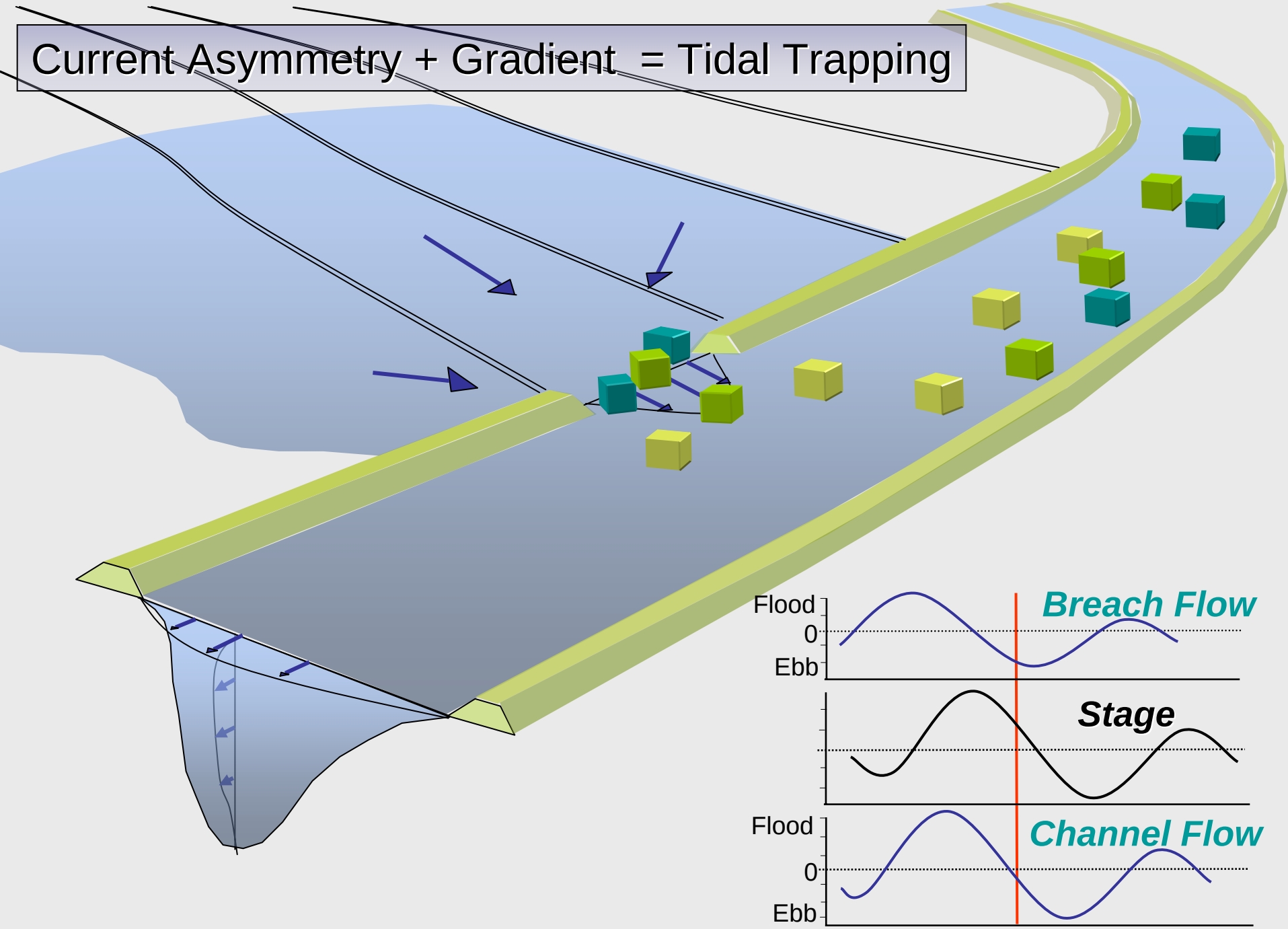
Current Asymmetry + Gradient = Tidal Trapping



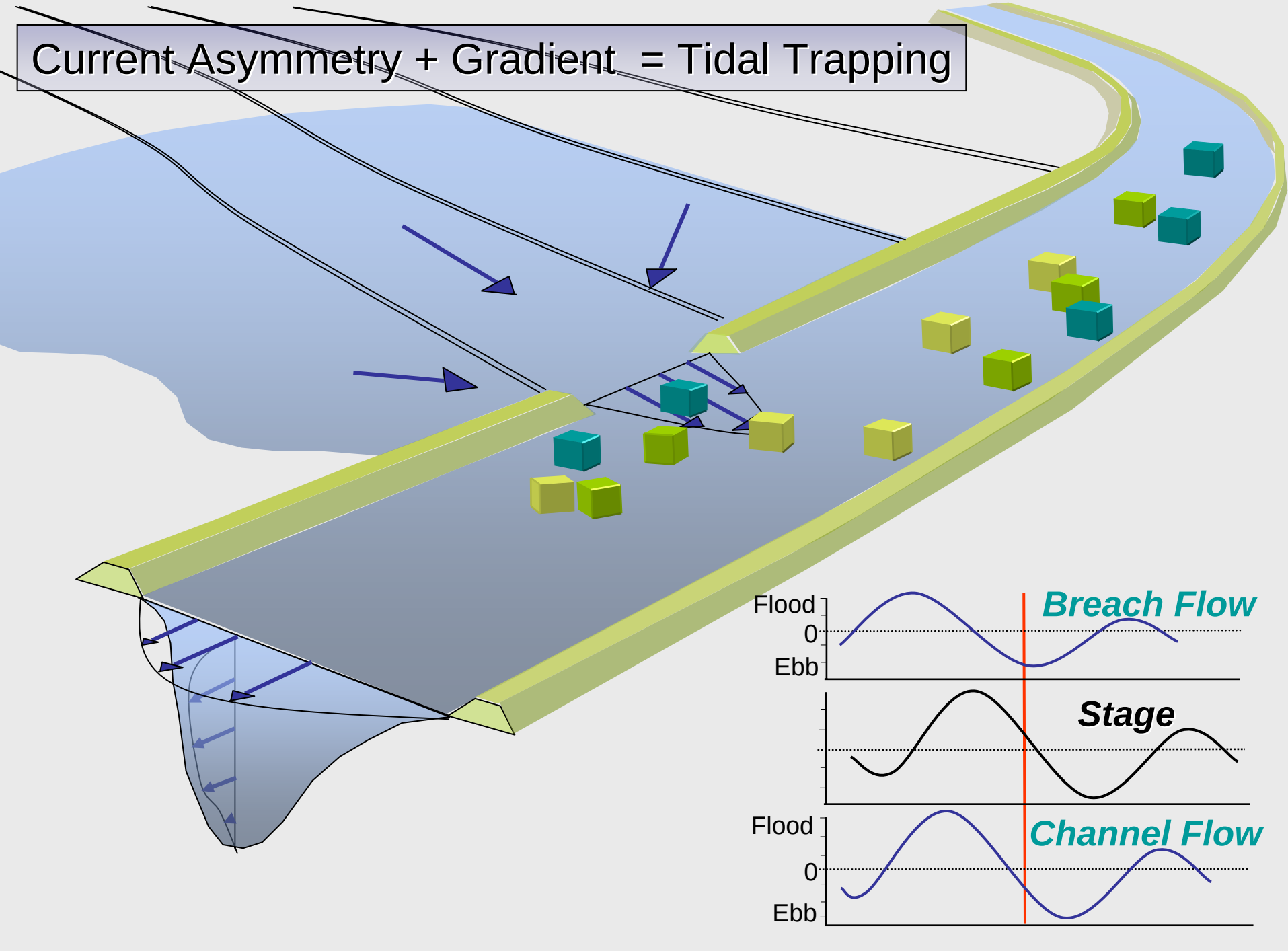
Current Asymmetry + Gradient = Tidal Trapping



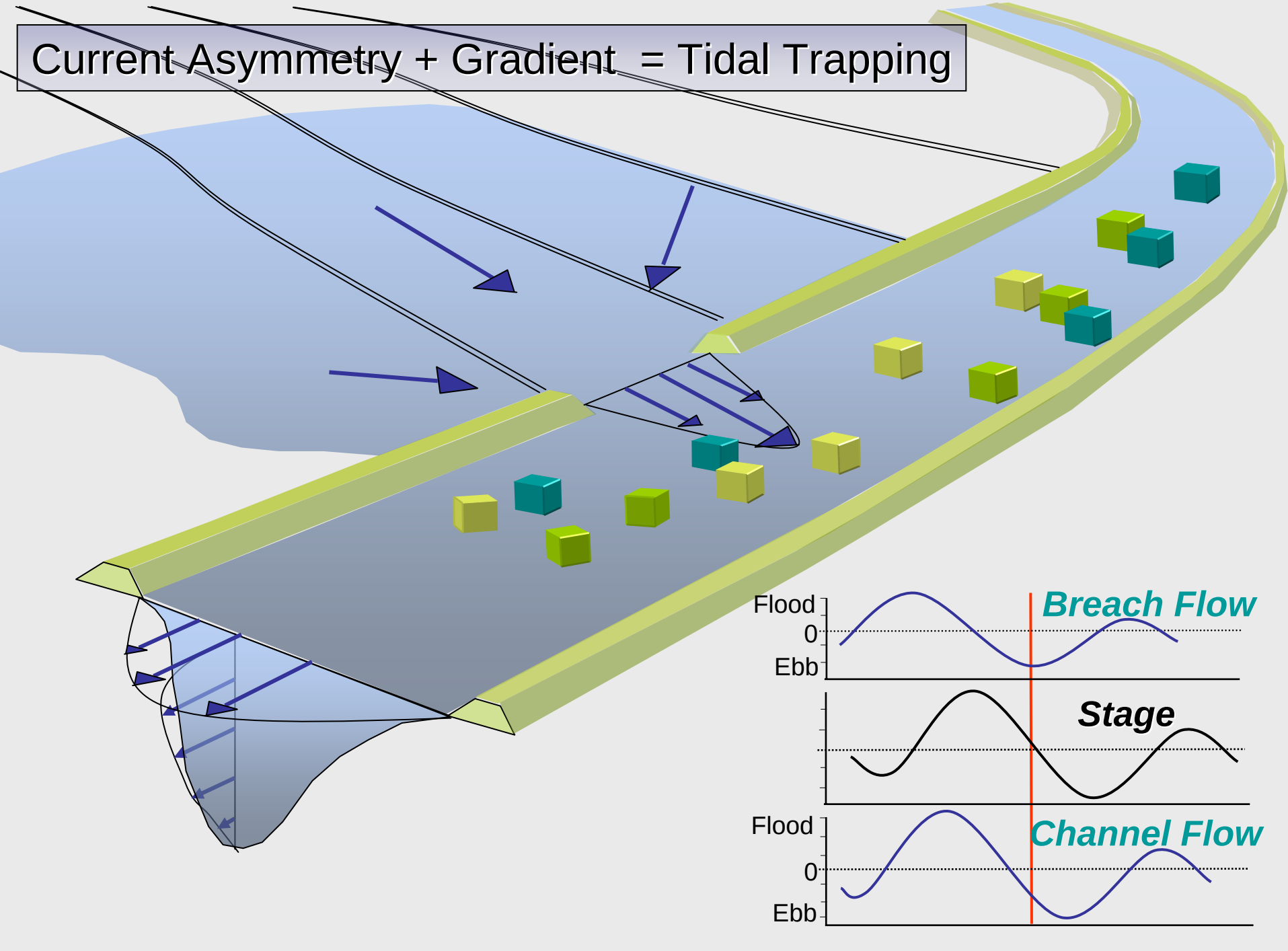
Current Asymmetry + Gradient = Tidal Trapping



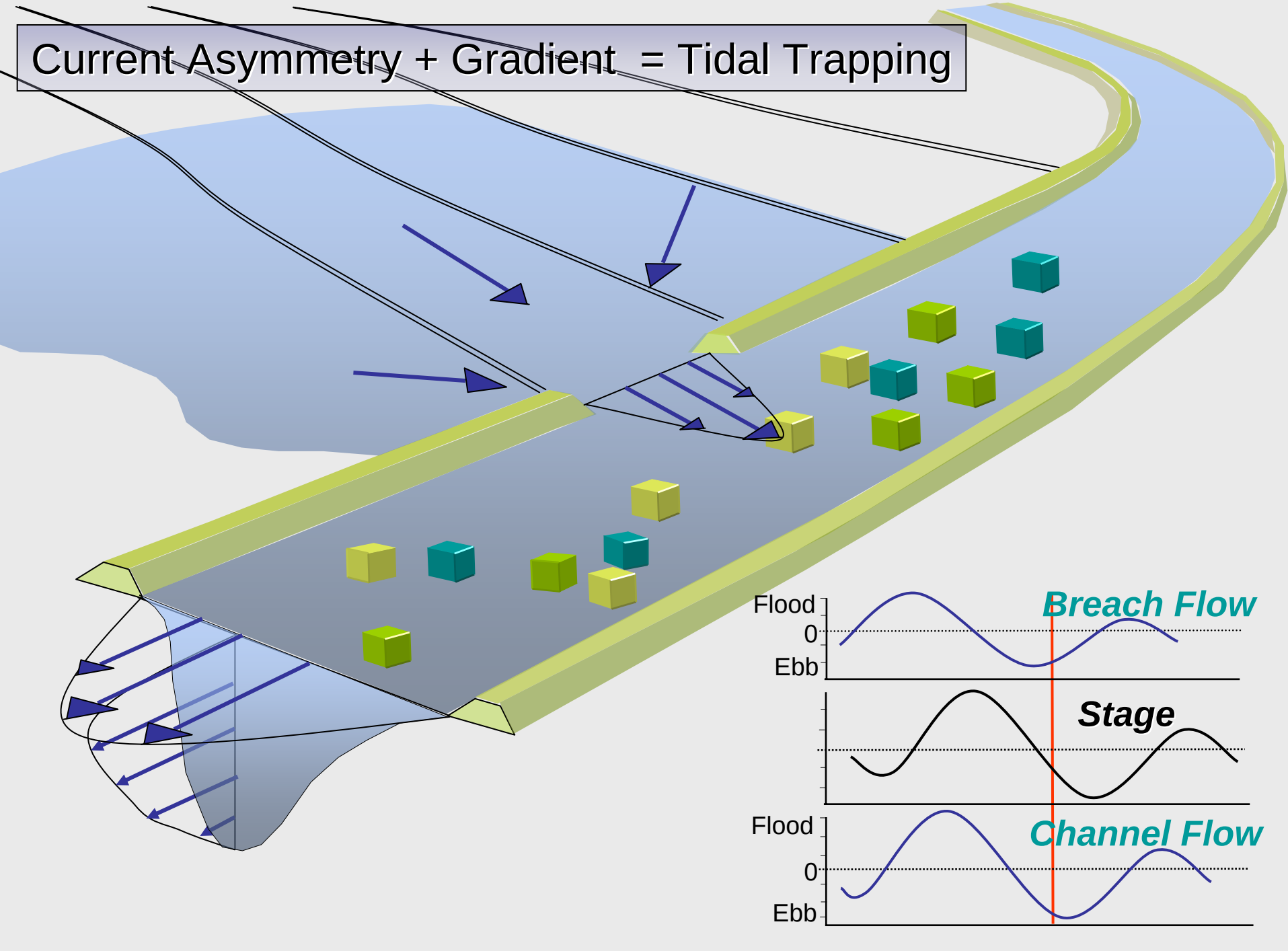
Current Asymmetry + Gradient = Tidal Trapping



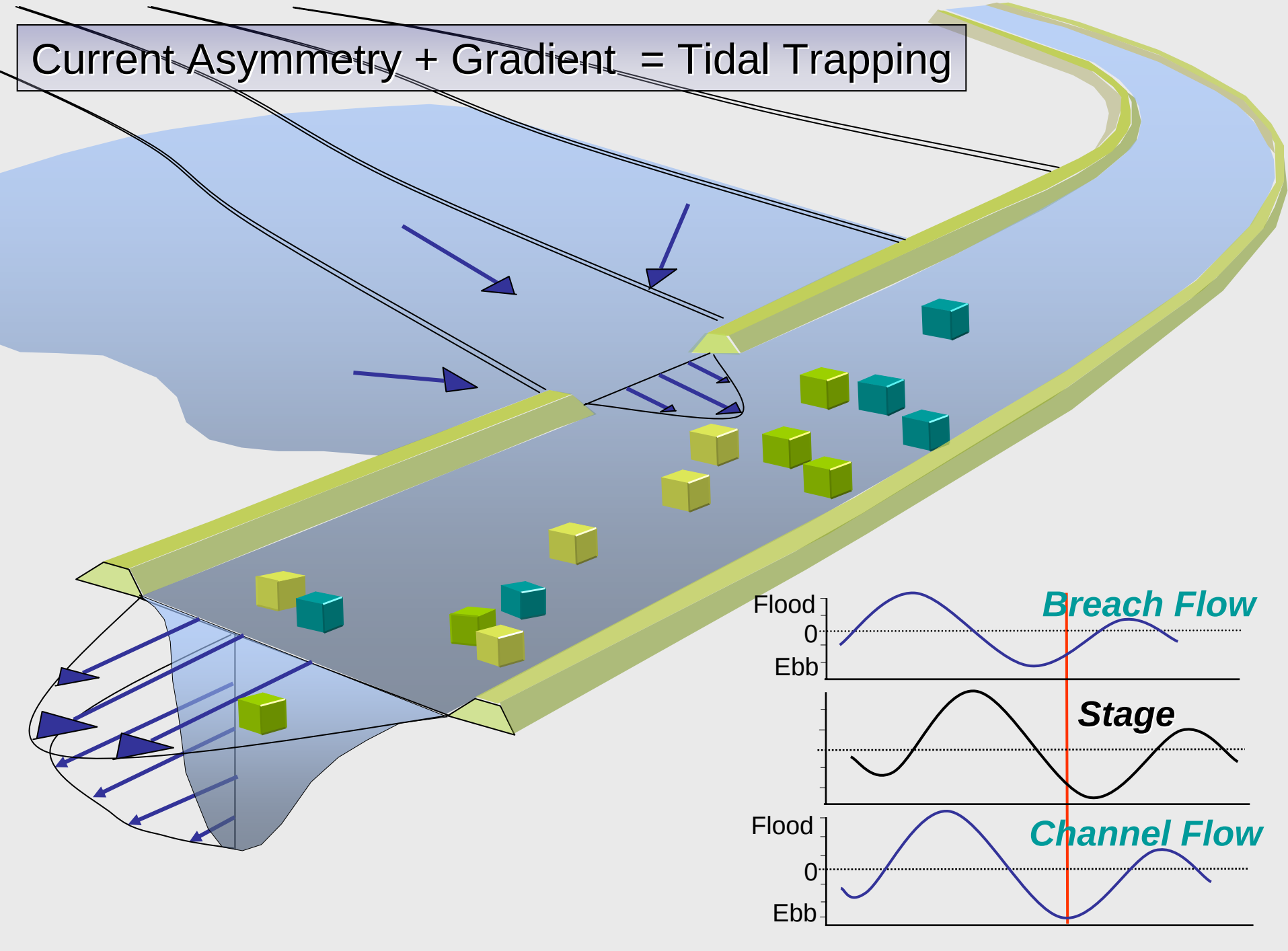
Current Asymmetry + Gradient = Tidal Trapping



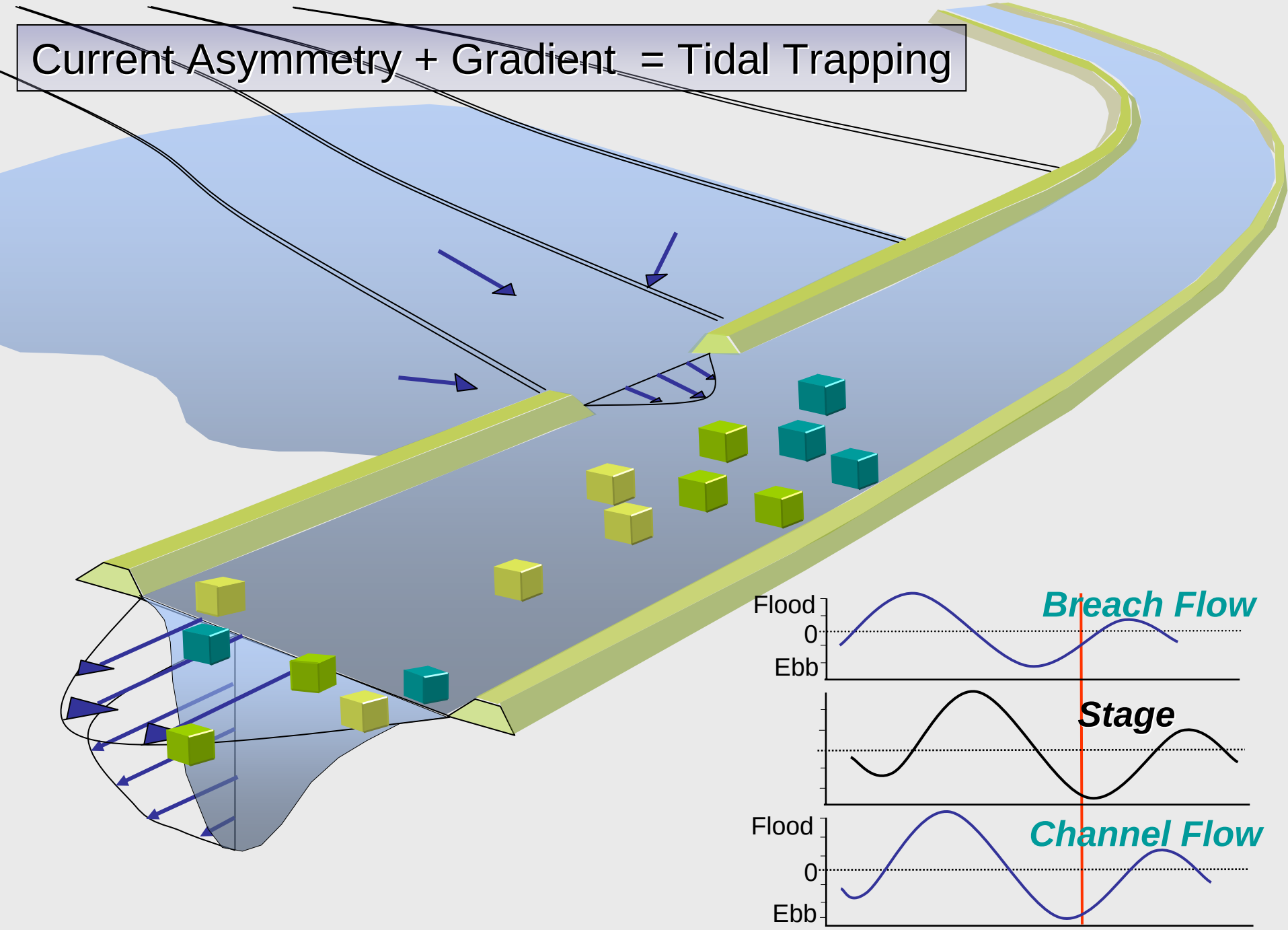
Current Asymmetry + Gradient = Tidal Trapping



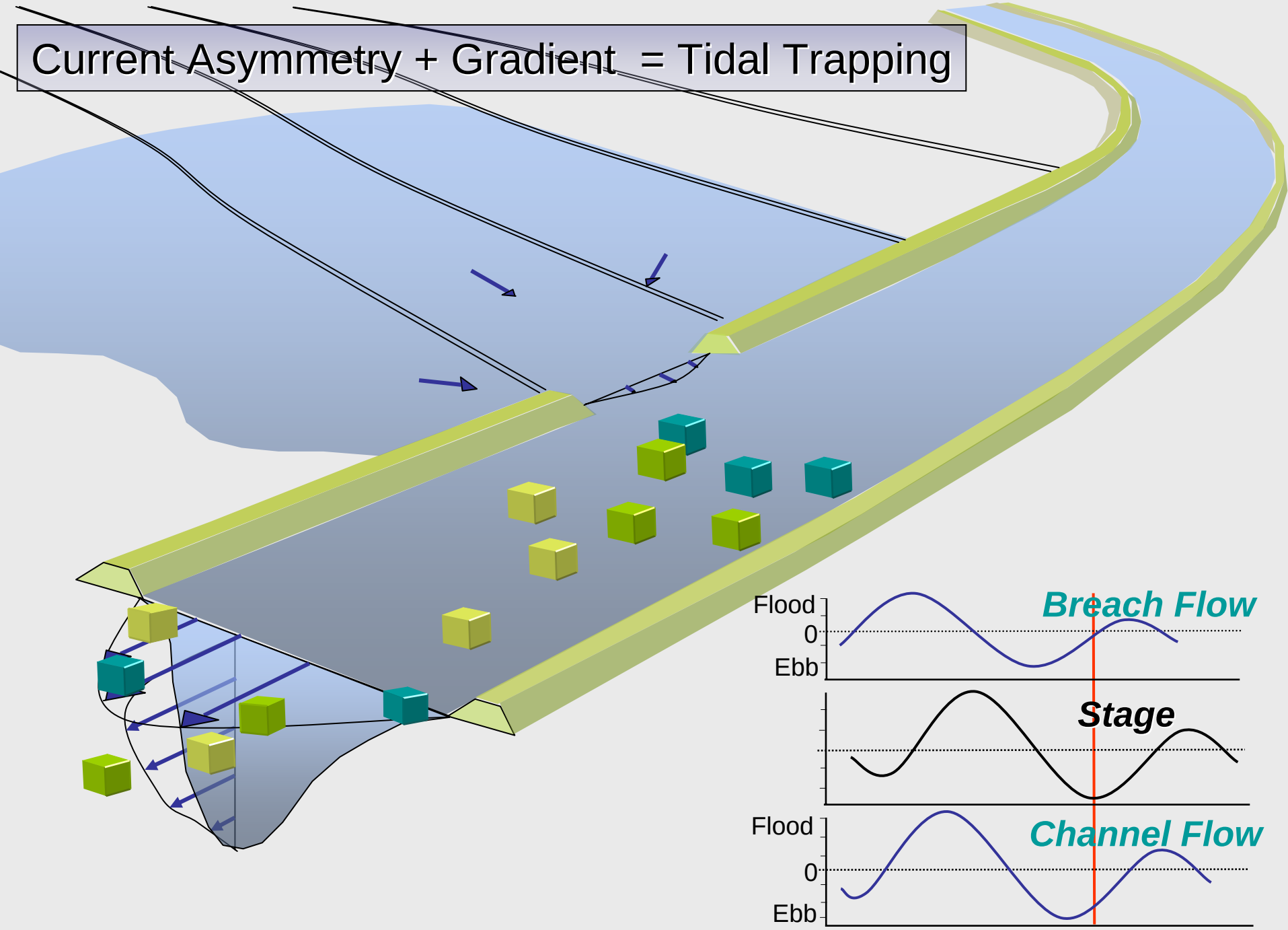
Current Asymmetry + Gradient = Tidal Trapping



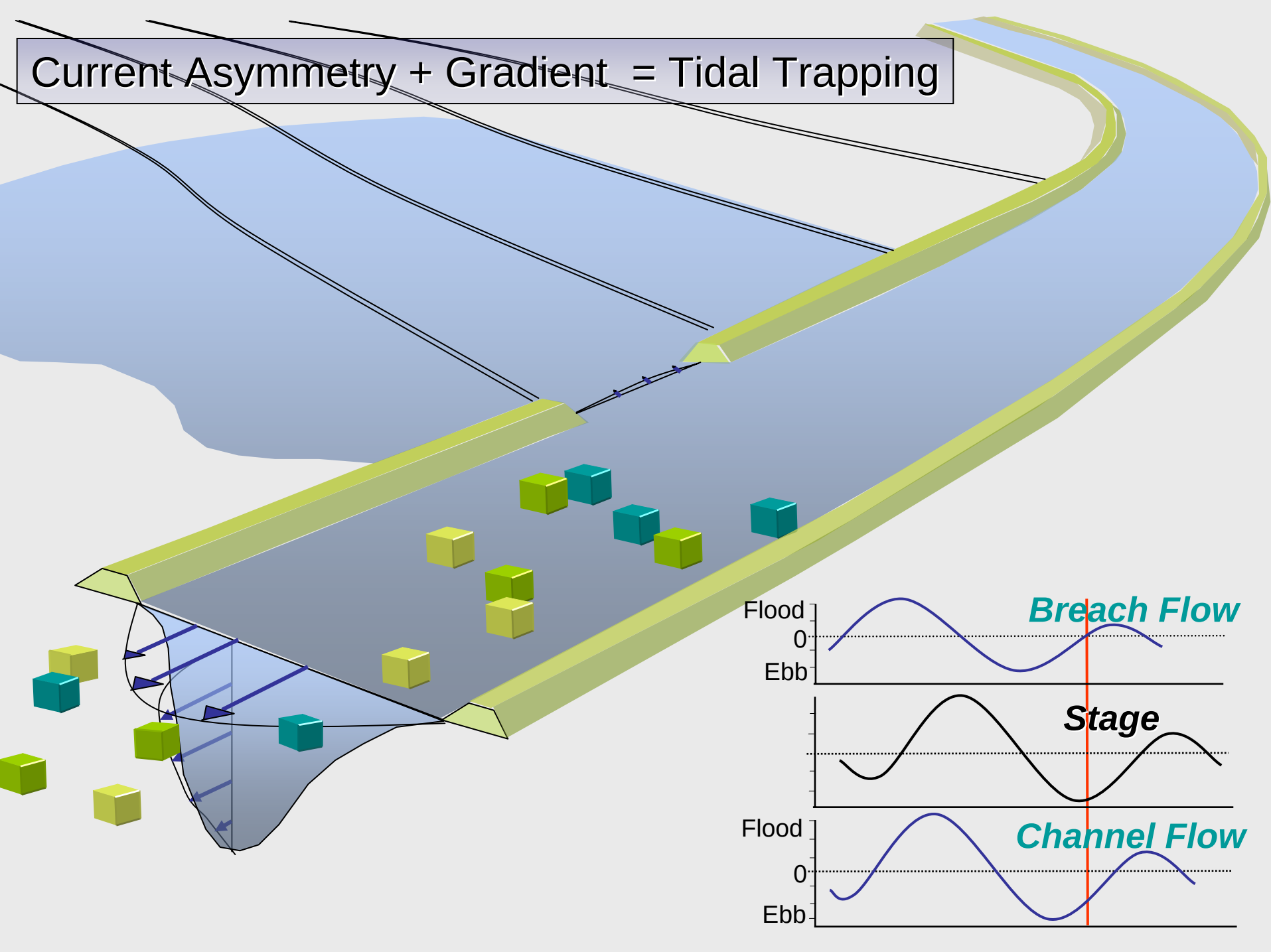
Current Asymmetry + Gradient = Tidal Trapping



Current Asymmetry + Gradient = Tidal Trapping



Current Asymmetry + Gradient = Tidal Trapping



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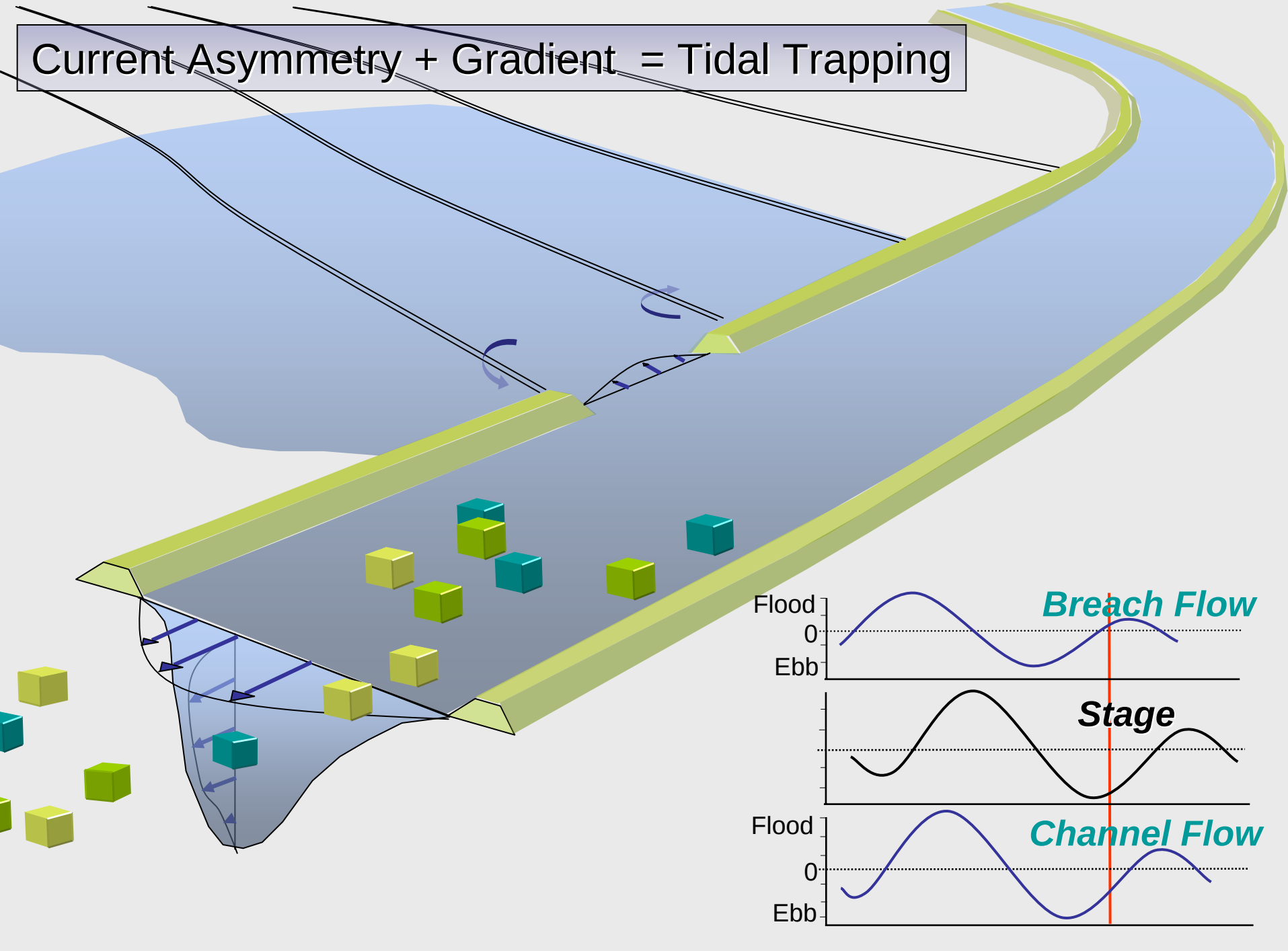

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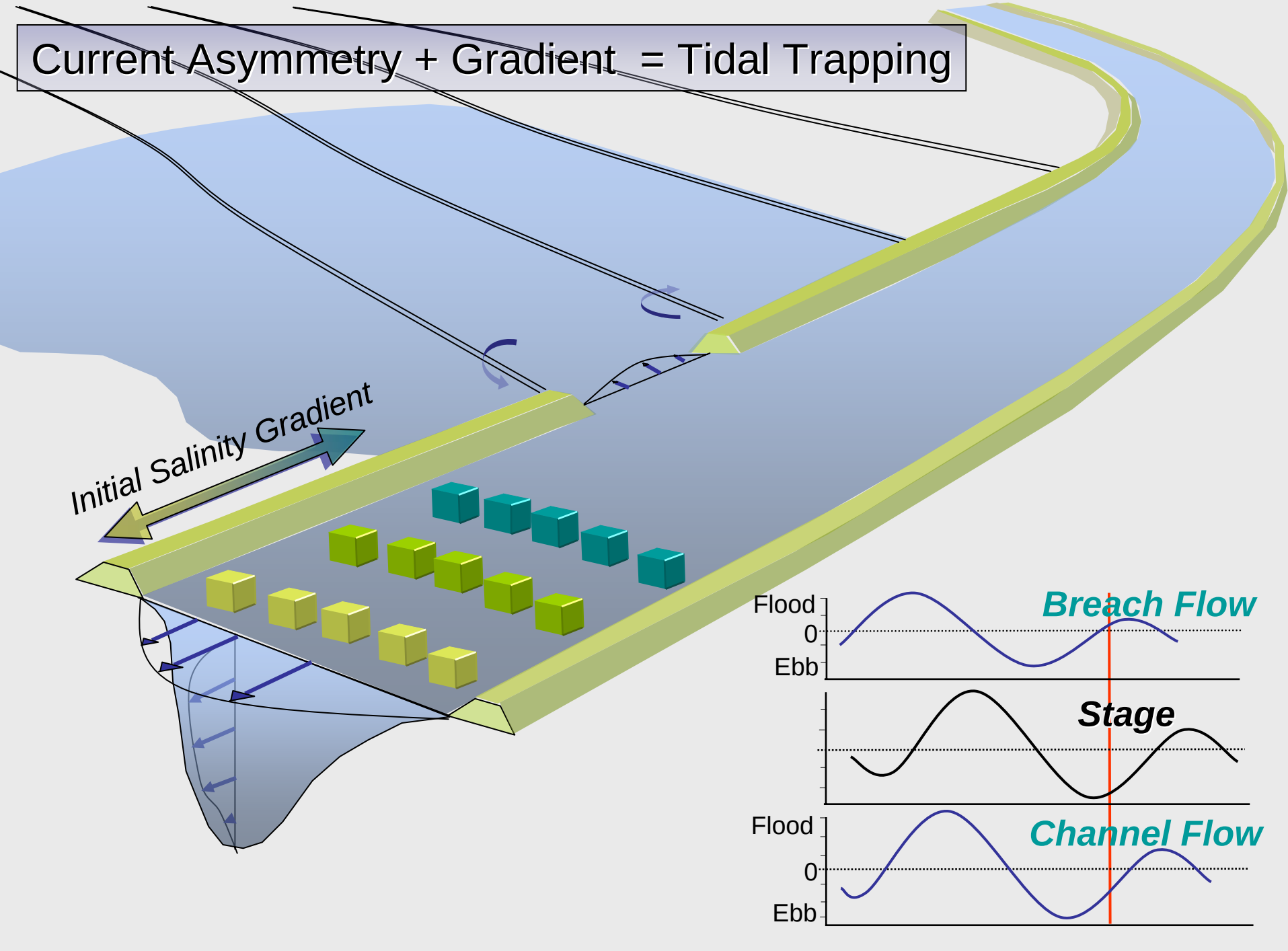

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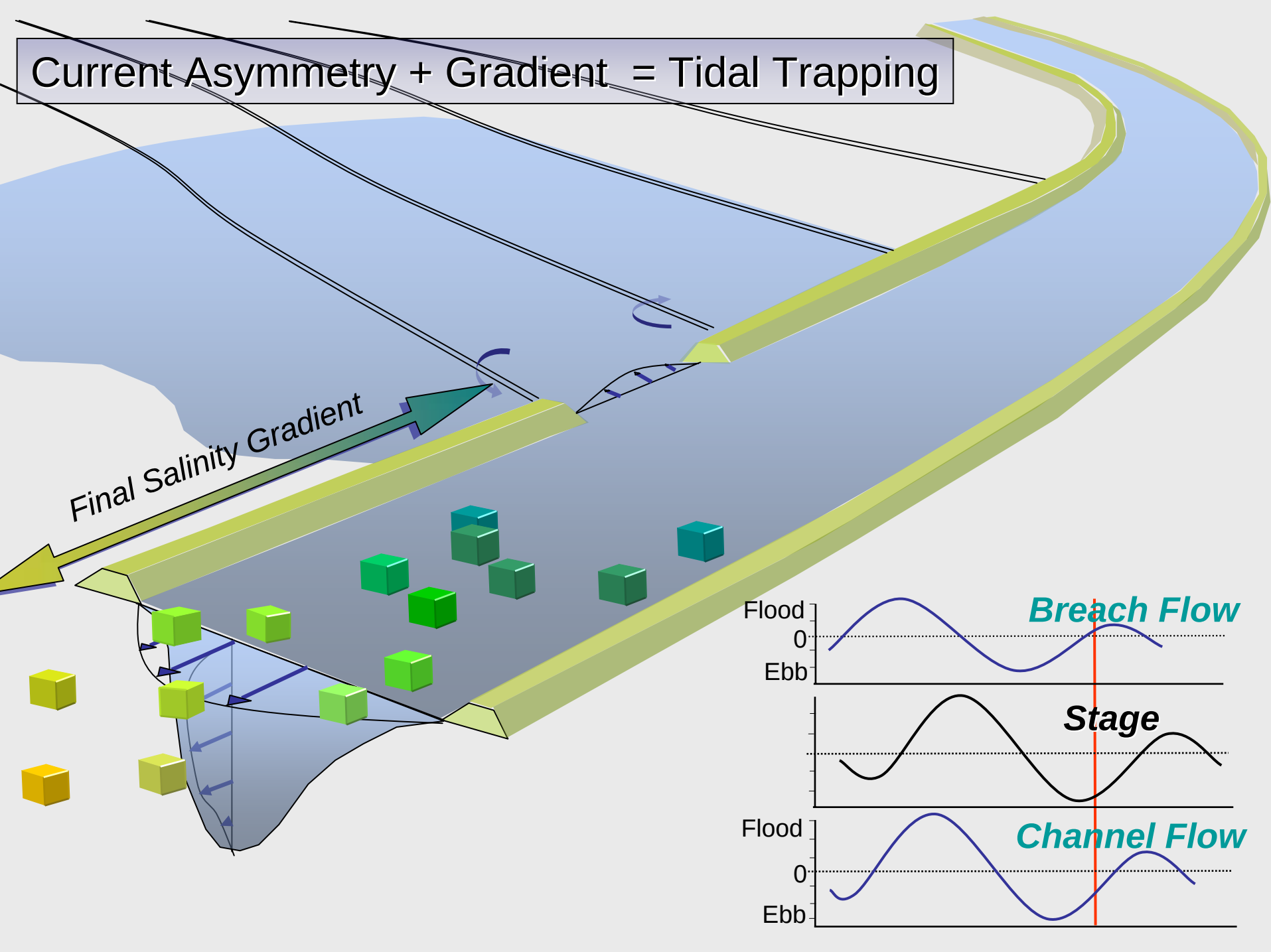
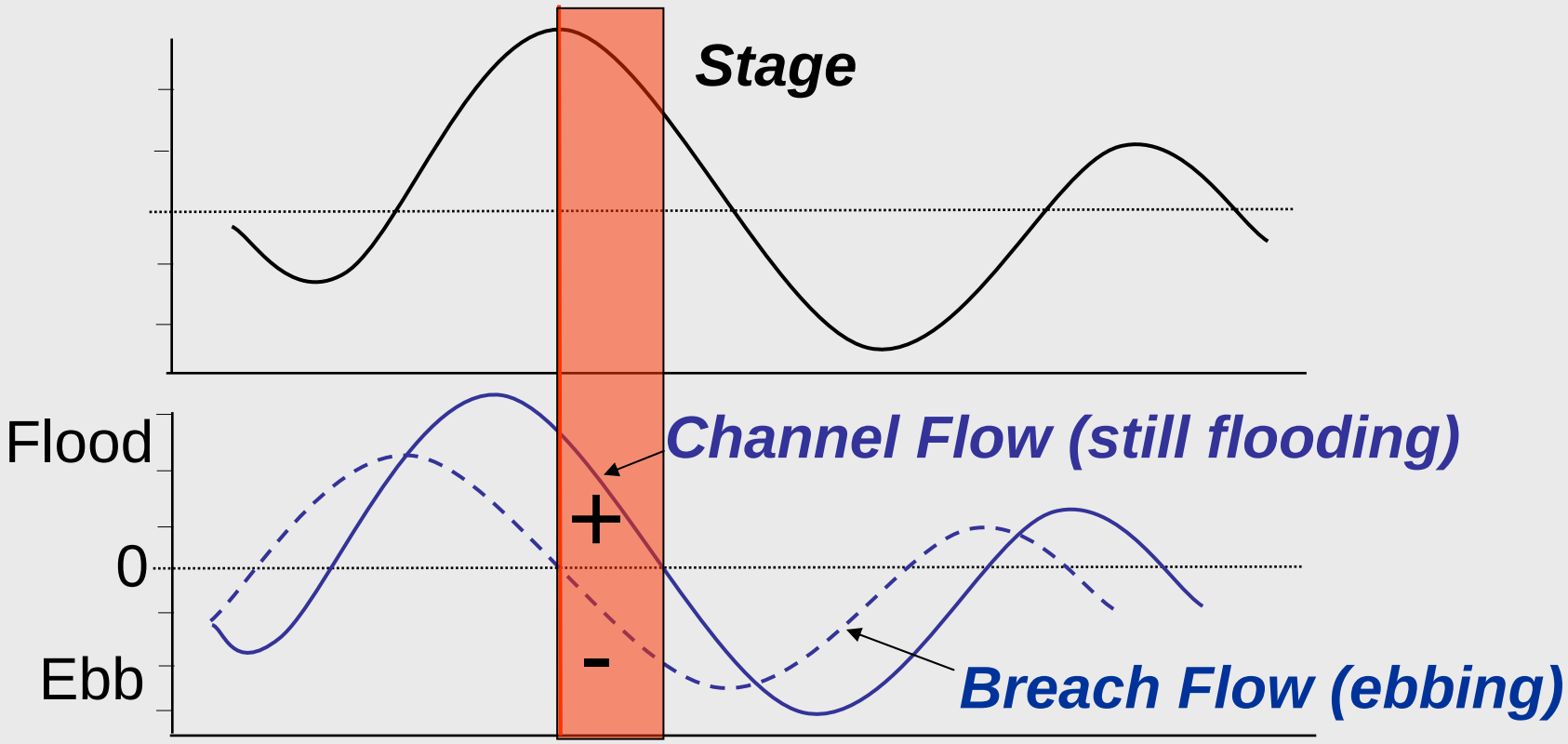
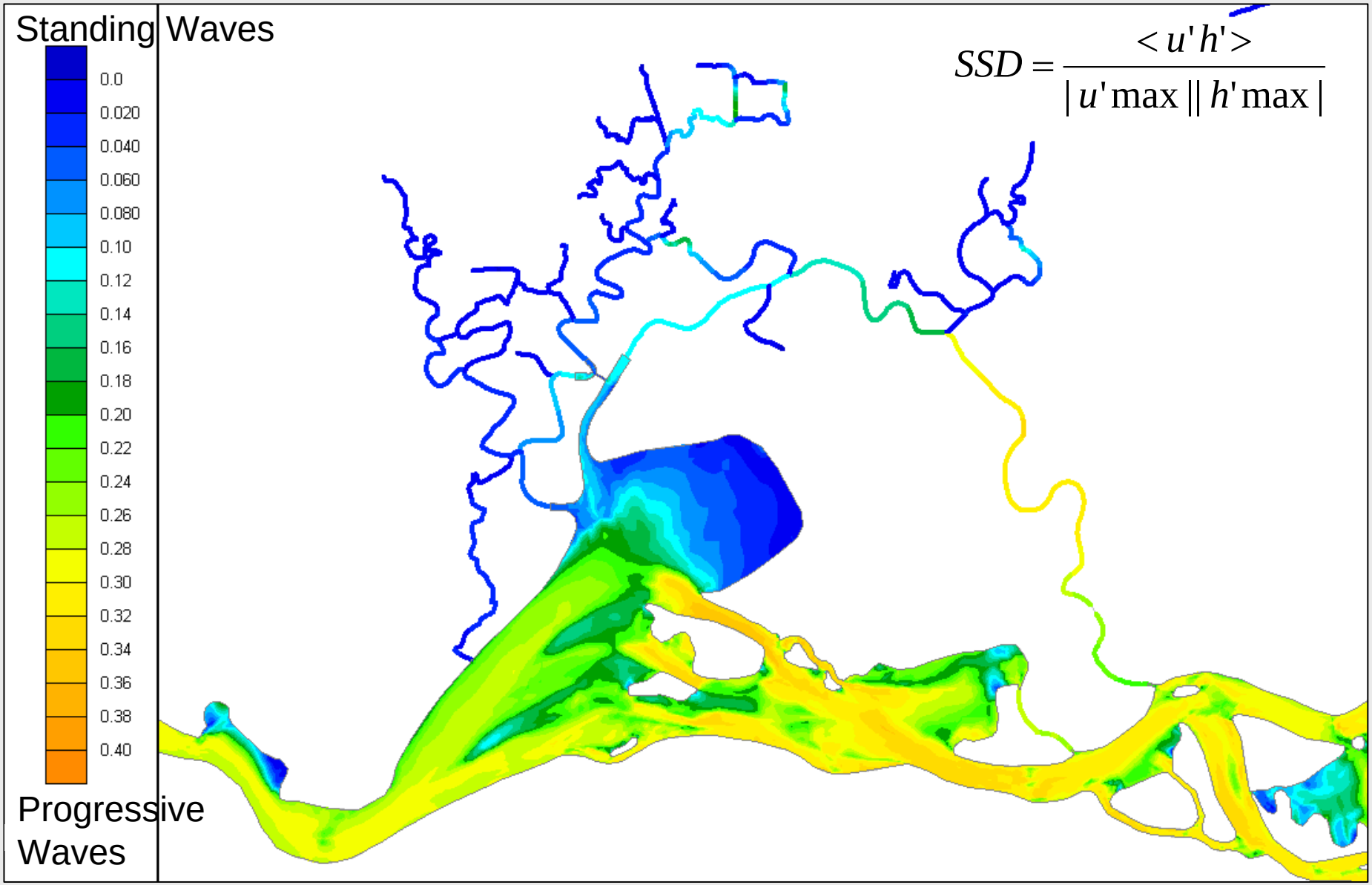


So, we have gradients everywhere.

Where are the current asymmetries?

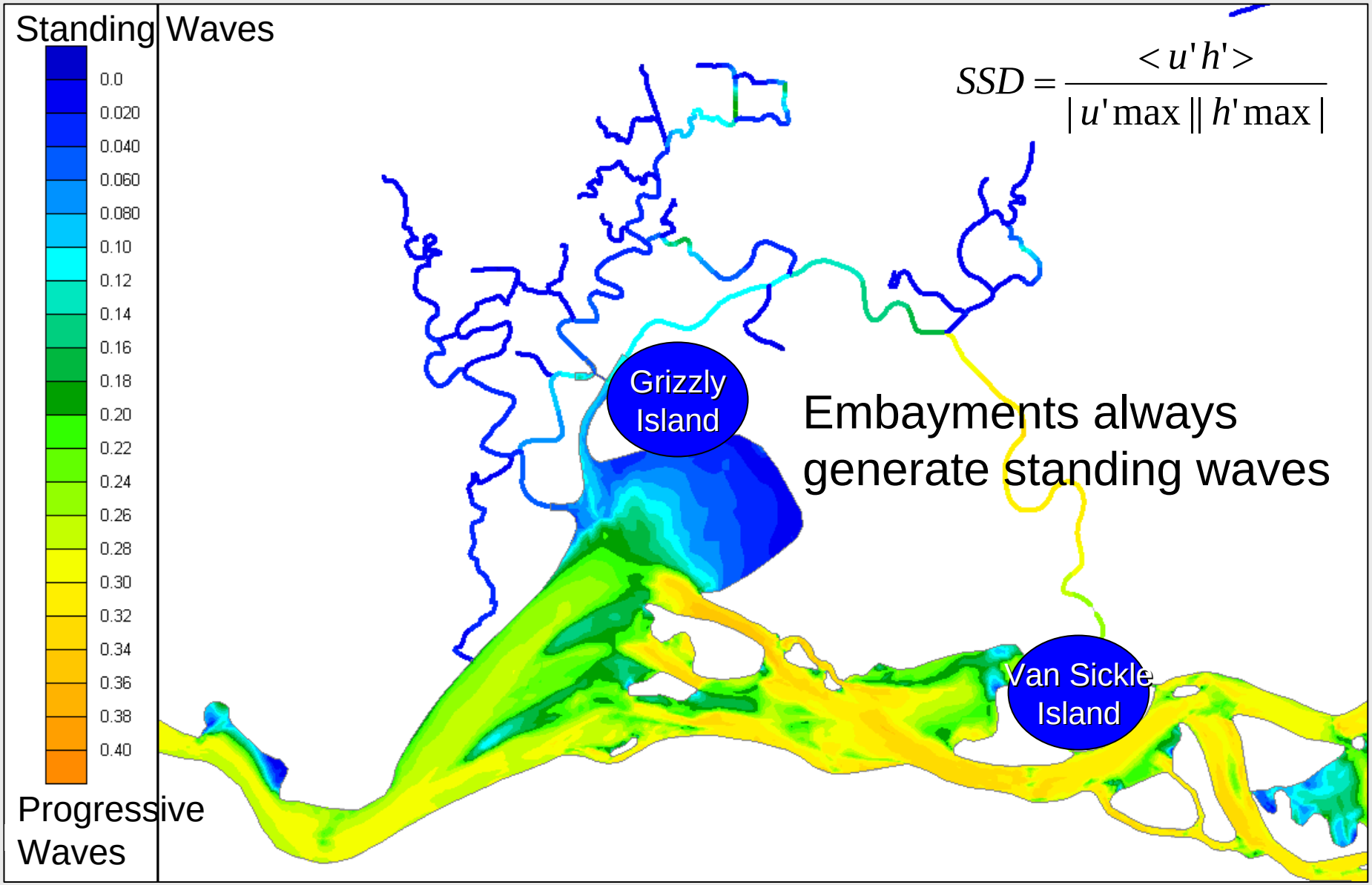


Tidal Trapping may occur wherever standing waves and progressive waves are proximate.

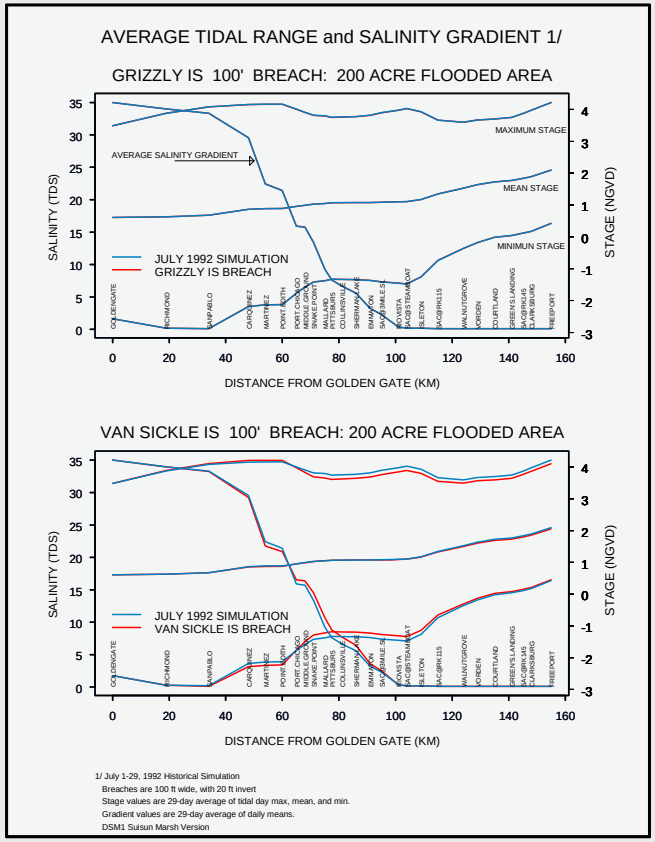


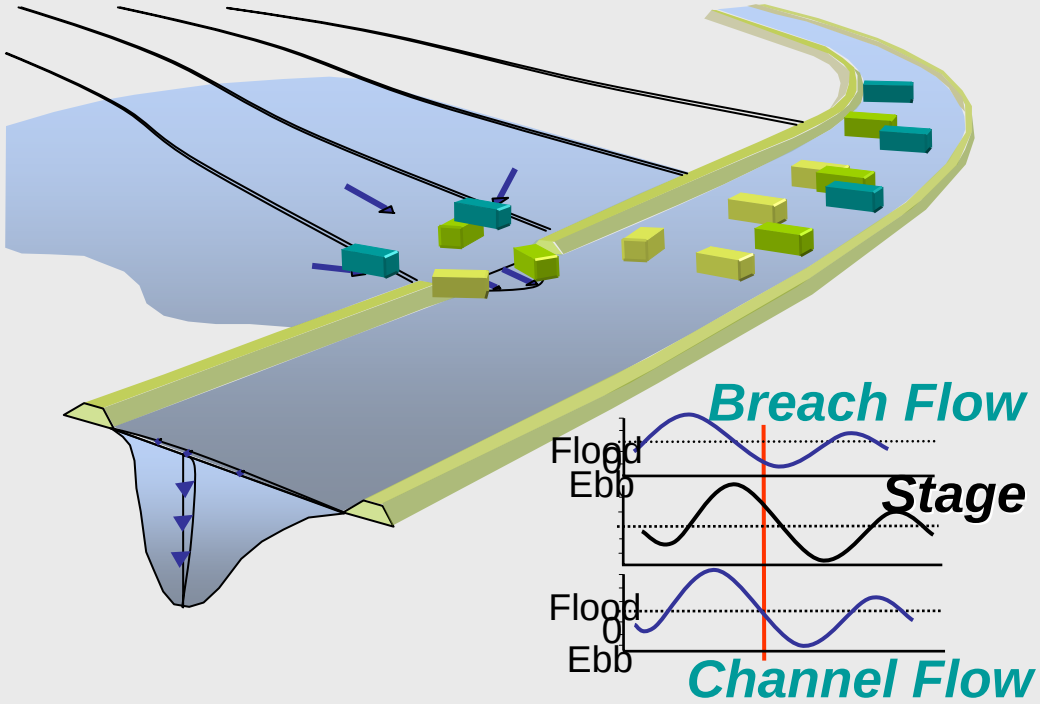
$$SSD = \frac{< u'h' >}{|u'\max||h'\max|}$$

Siting Restoration Projects (levee breaches)



Combination of tidal energy damping and tidal trapping

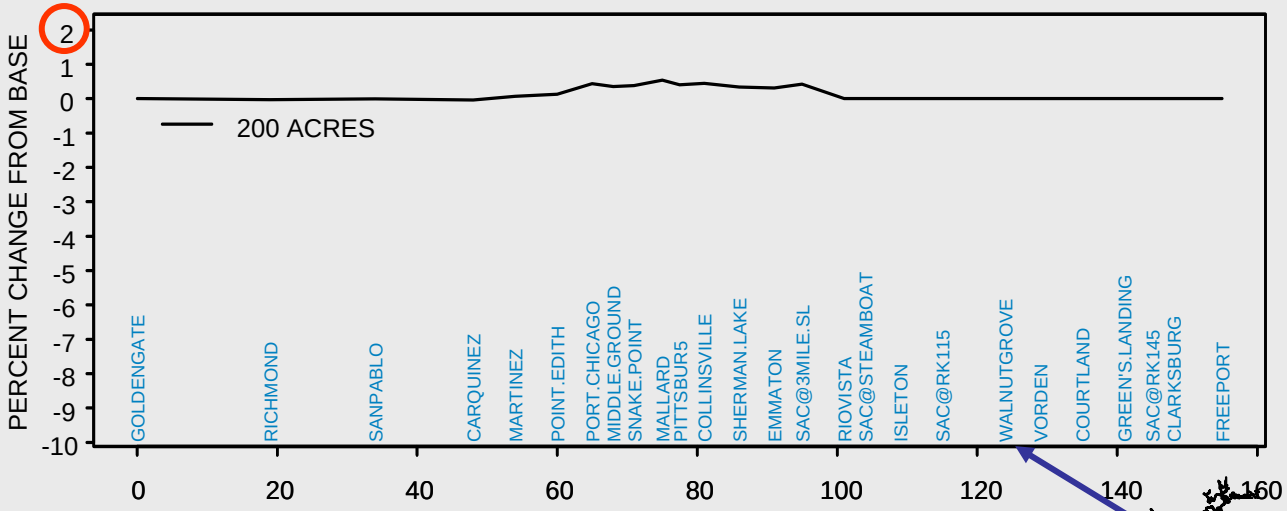




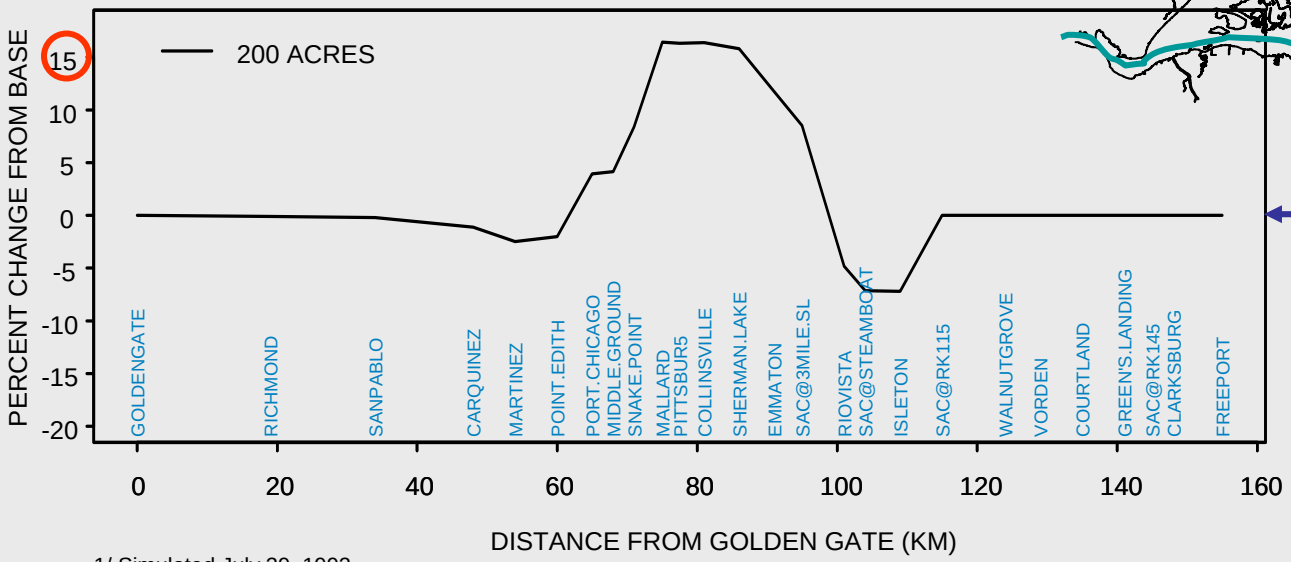
Tidal energy damping *versus* Tidal trapping

TIDAL DAY AVERAGE SALINITY ALONG SACRAMENTO RIVER AXIS

GRIZZLY ISLAND 100' LEVEE BREACH

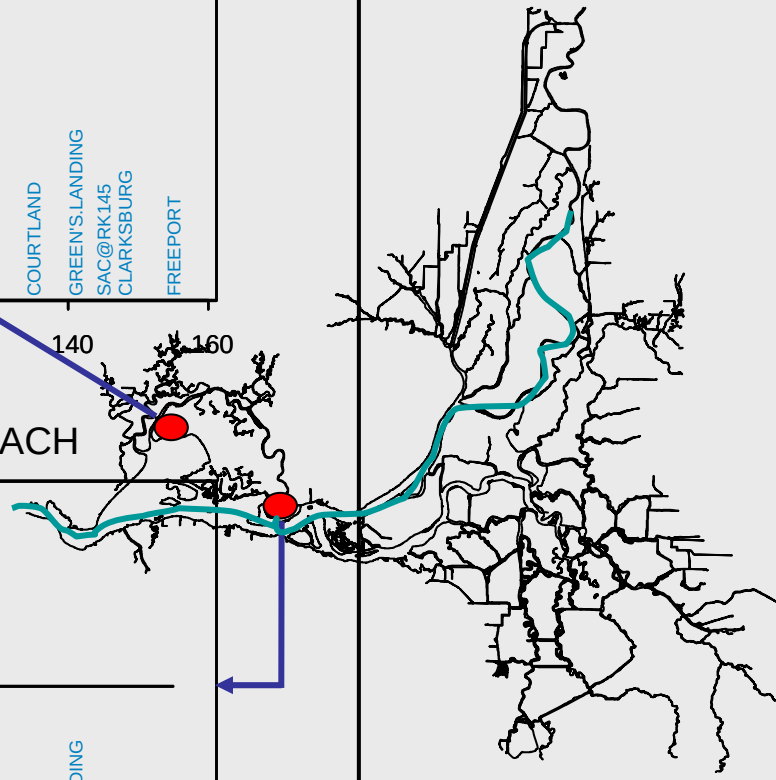


VAN SICKLE ISLAND 100' LEVEE BREACH



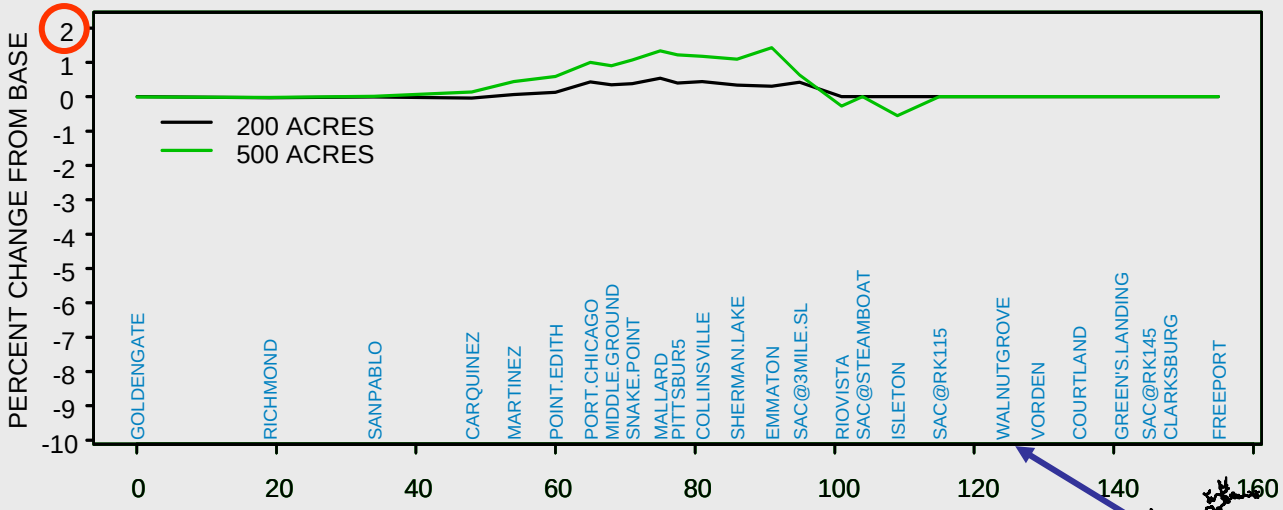
1/ Simulated July 29, 1992
DSM1 Suisun Marsh Version

Tidal trapping +
Energy damping



TIDAL DAY AVERAGE SALINITY ALONG SACRAMENTO RIVER AXIS

GRIZZLY ISLAND 100' LEVEE BREACH



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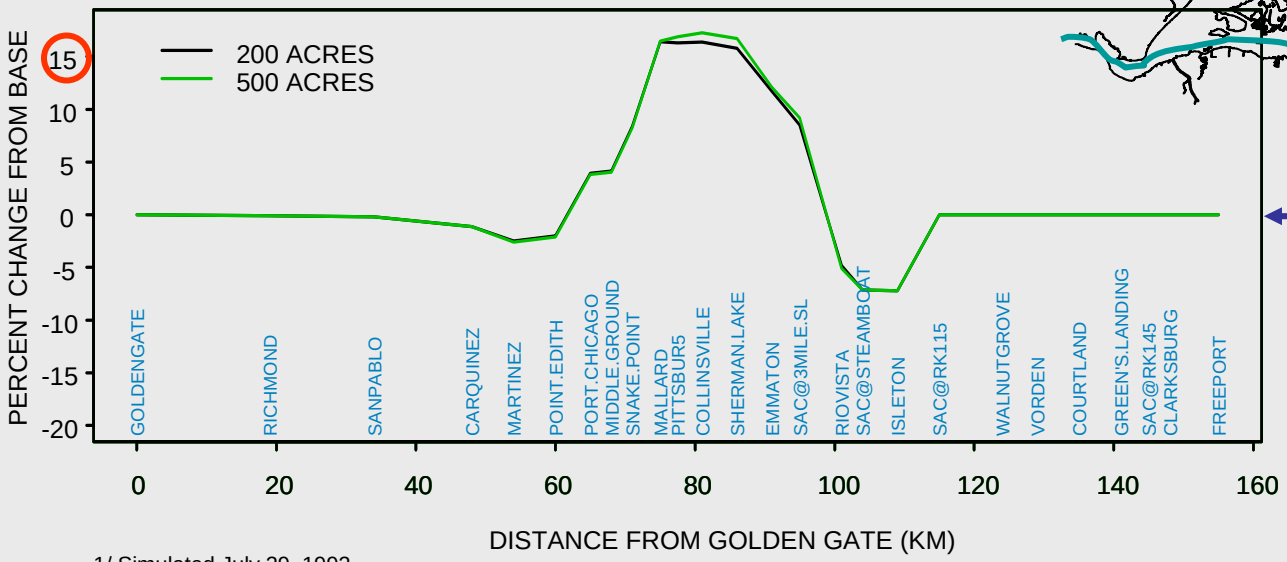

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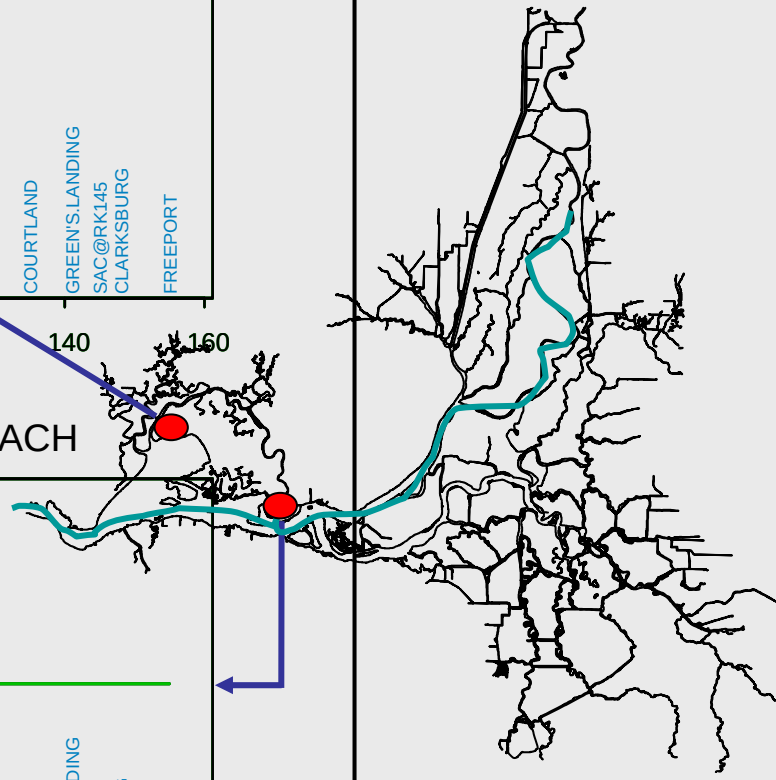
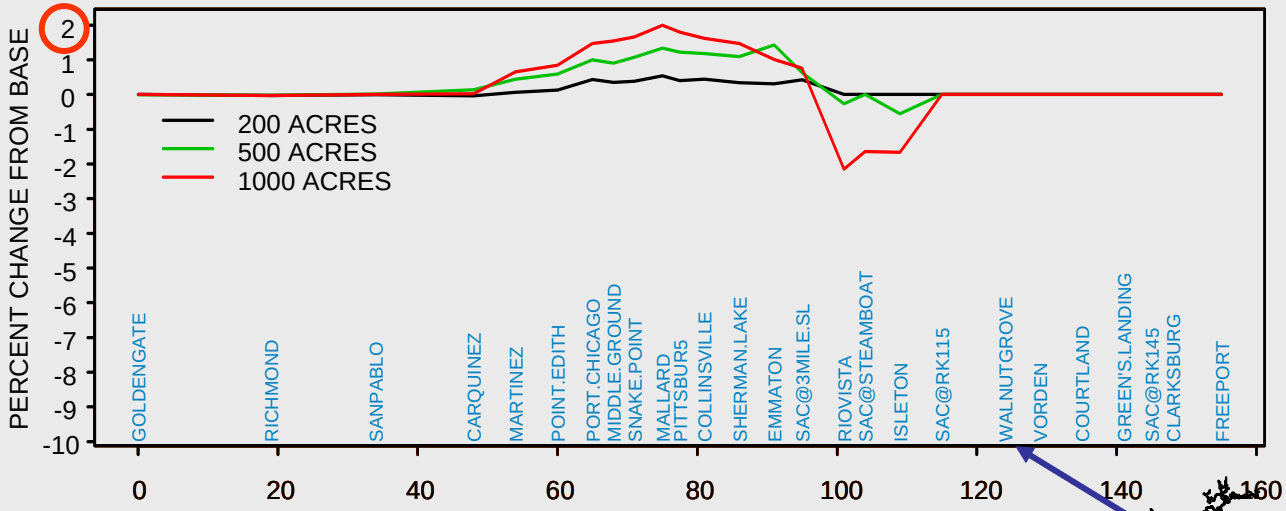
DSM1 Suisun Marsh Version

Tidal trapping +
Energy damping



TIDAL DAY AVERAGE SALINITY ALONG SACRAMENTO RIVER AXI

GRIZZLY ISLAND 100' LEVEE BREACH



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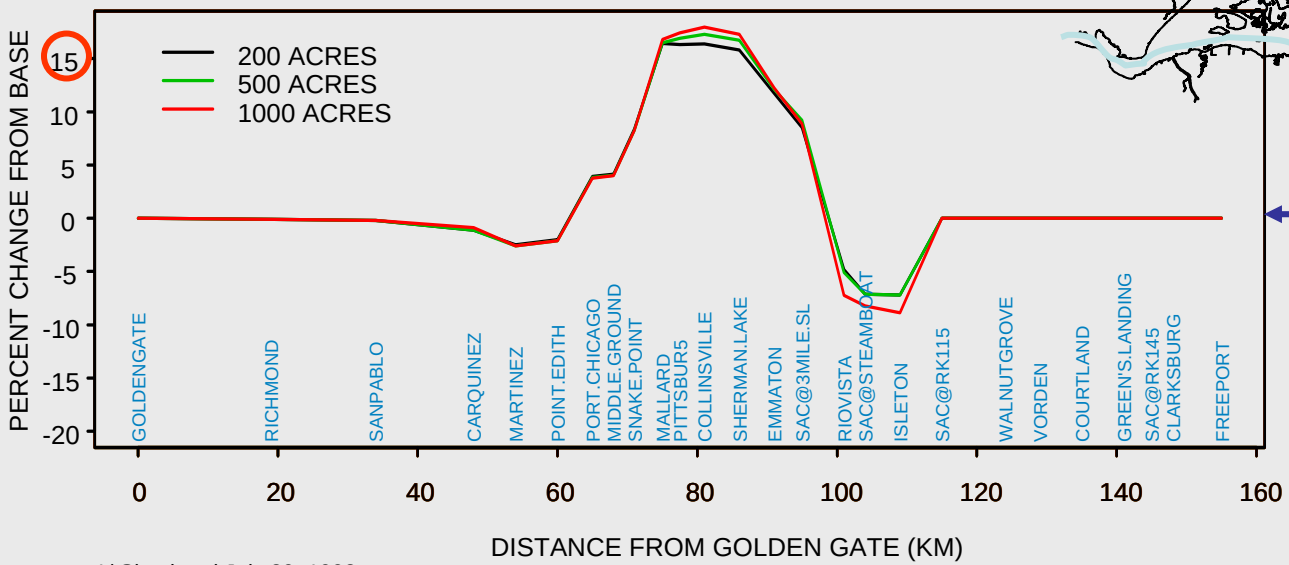

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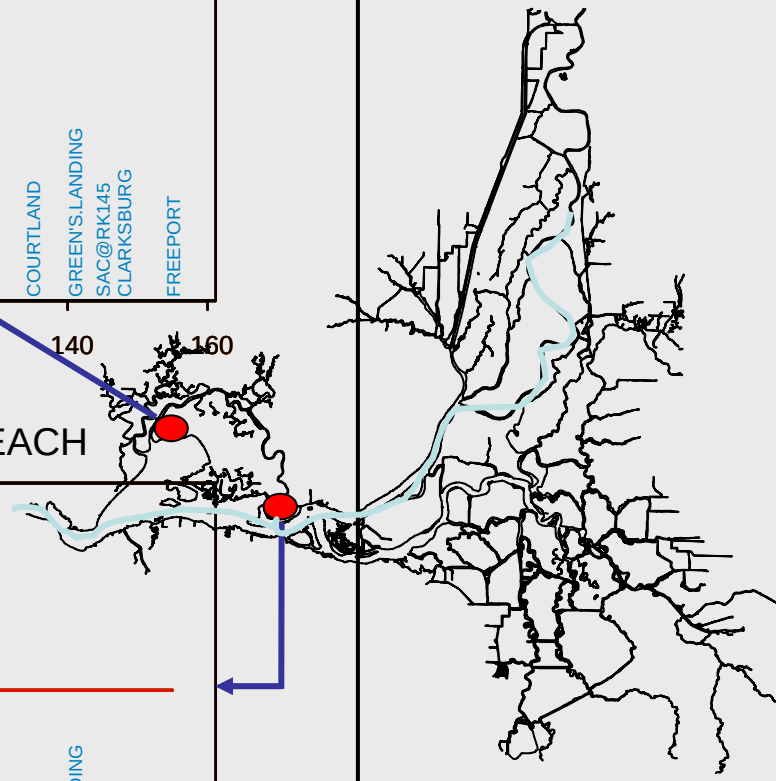
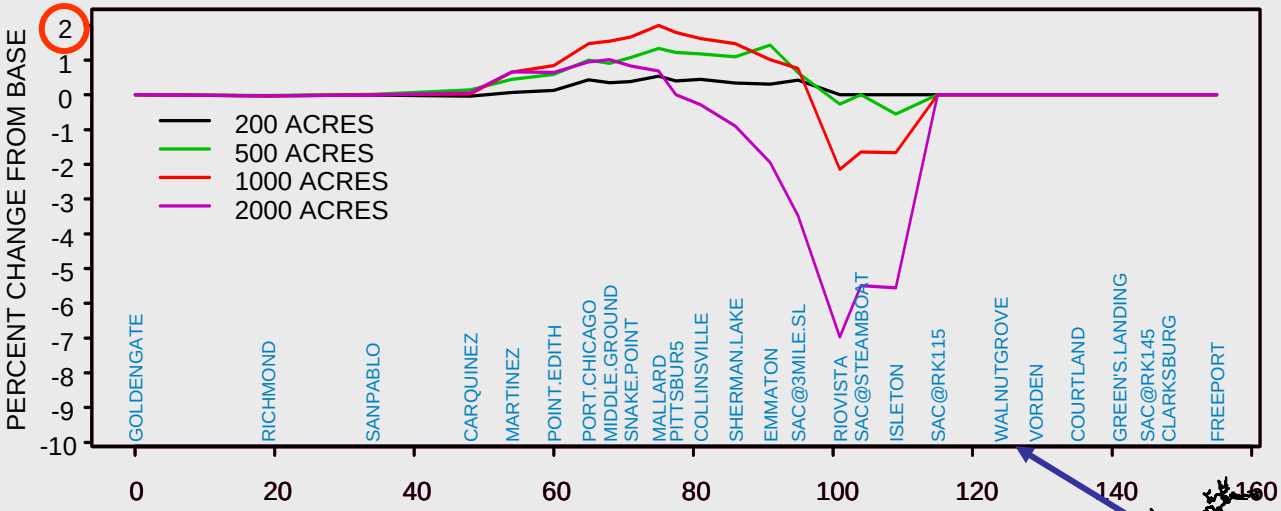
DSM1 Suisun Marsh Version

Tidal trapping +
Energy damping



TIDAL DAY AVERAGE SALINITY ALONG SACRAMENTO RIVER AX

GRIZZLY ISLAND 100' LEVEE BREACH



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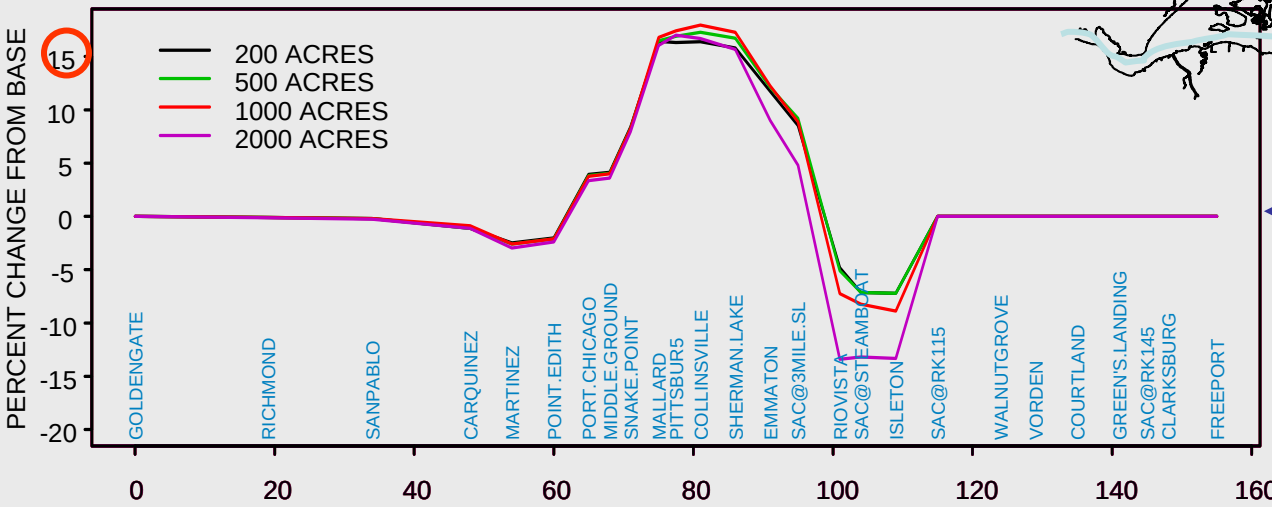

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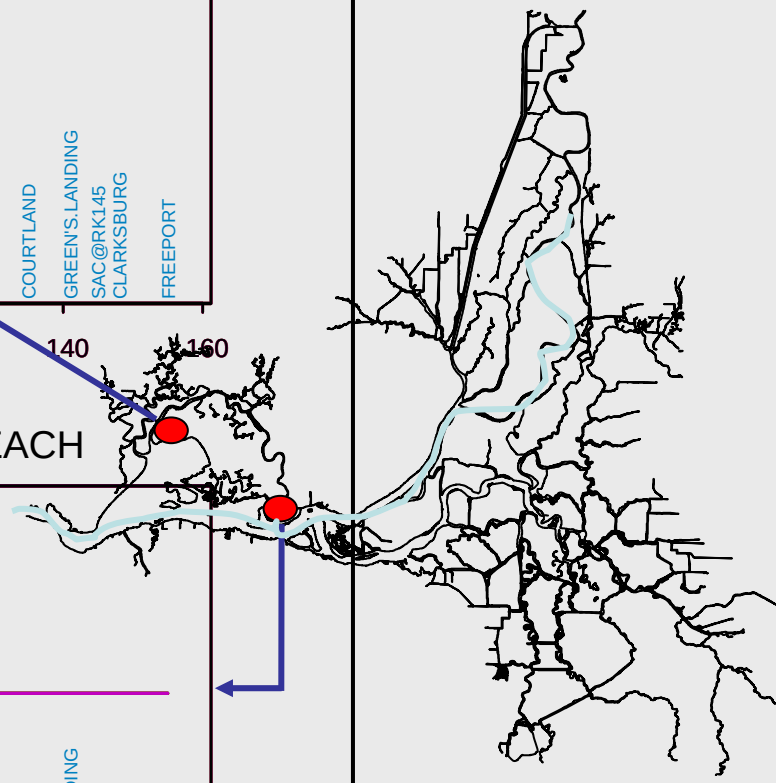
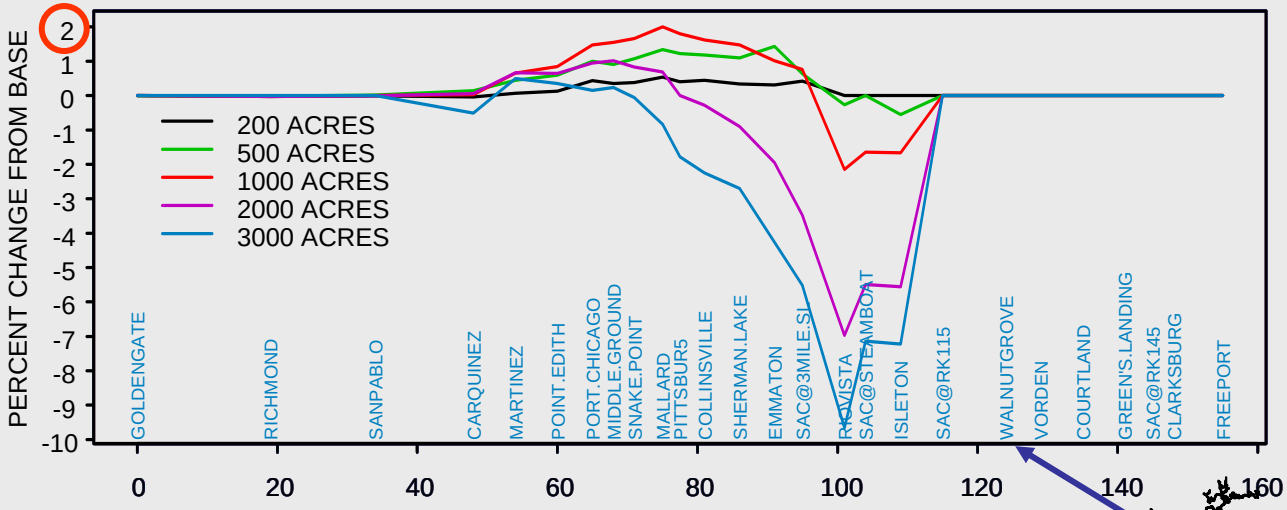
DSM1 Suisun Marsh Version

Tidal trapping +
Energy damping



TIDAL DAY AVERAGE SALINITY ALONG SACRAMENTO RIVER AXIS

GRIZZLY ISLAND 100' LEVEE BREACH



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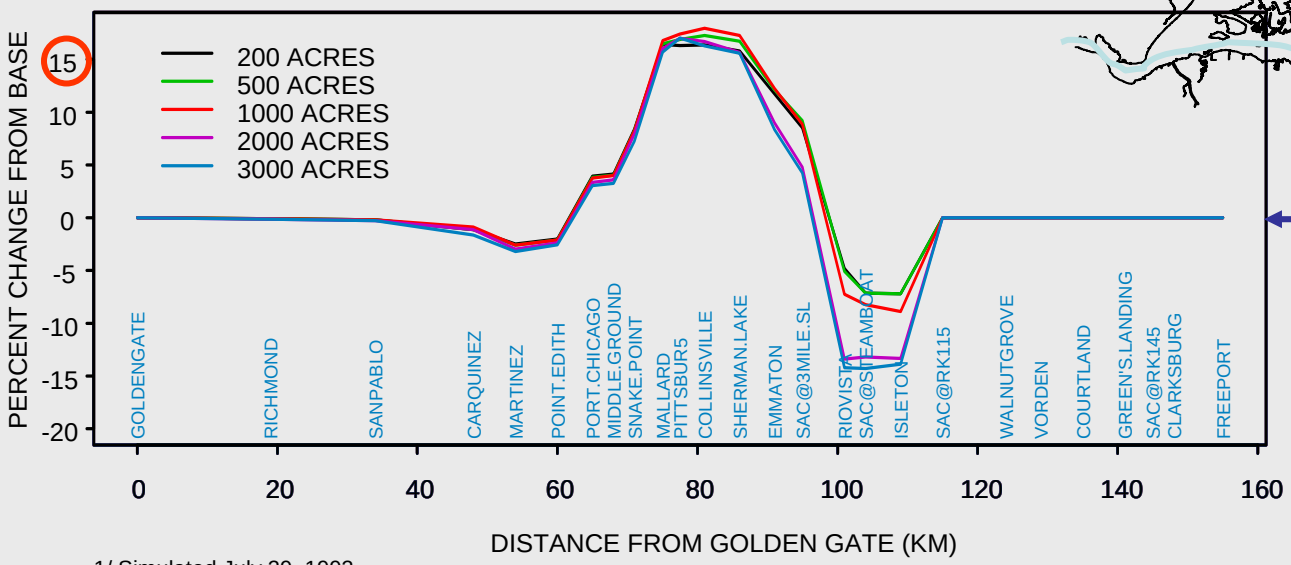

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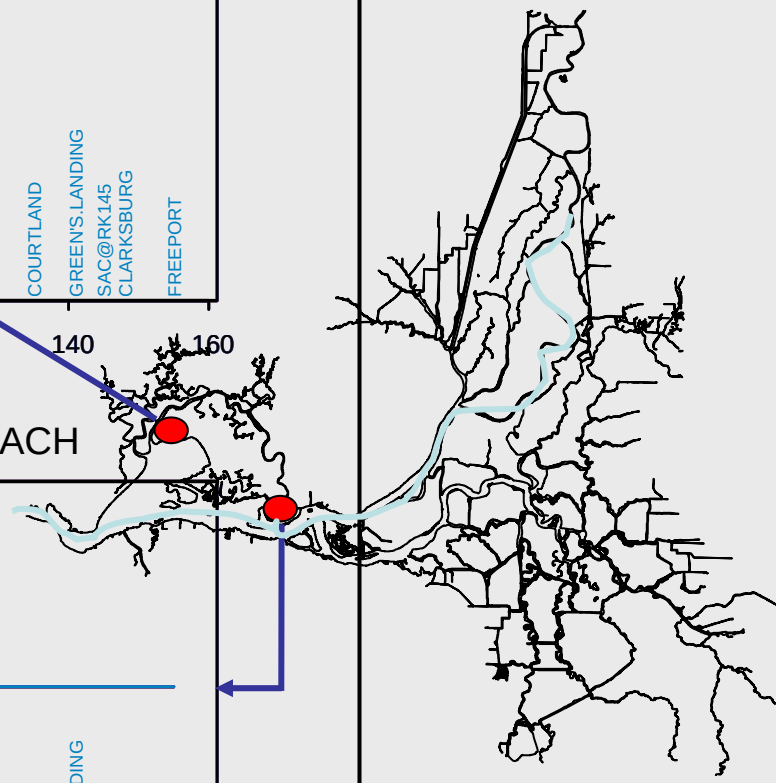
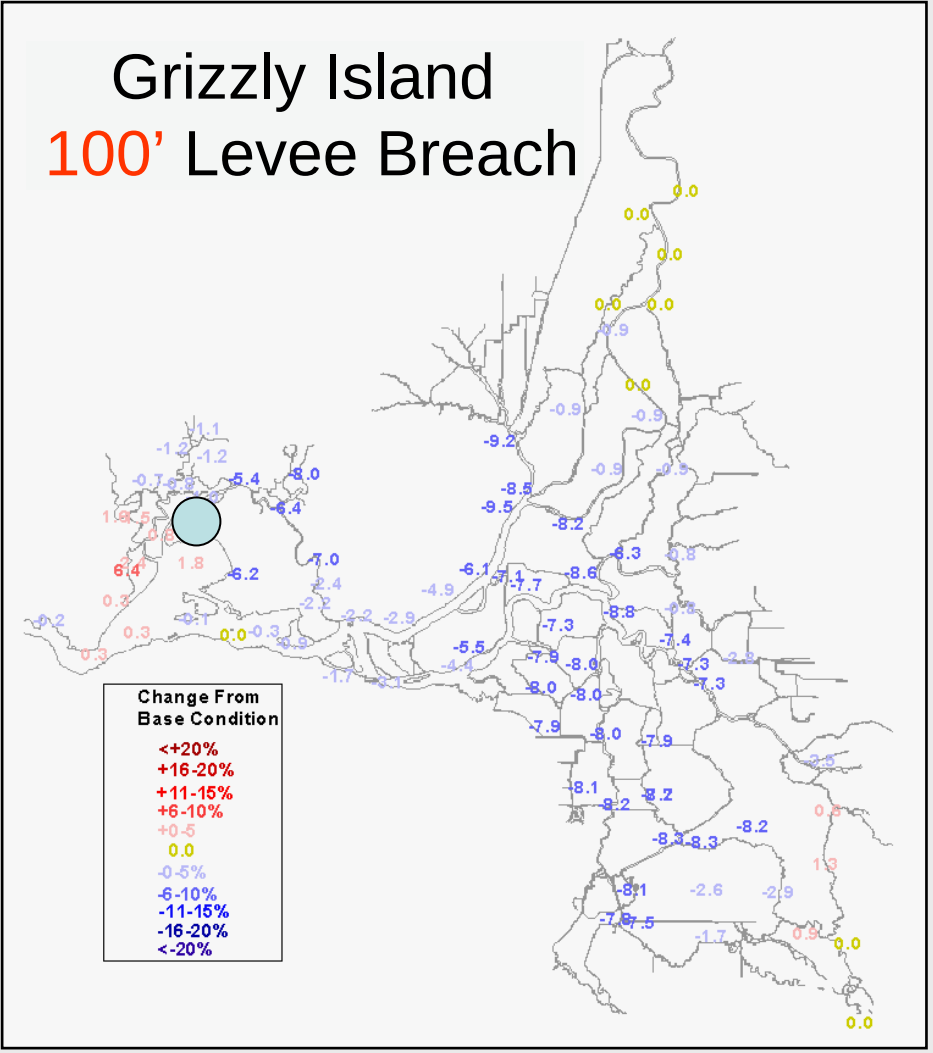
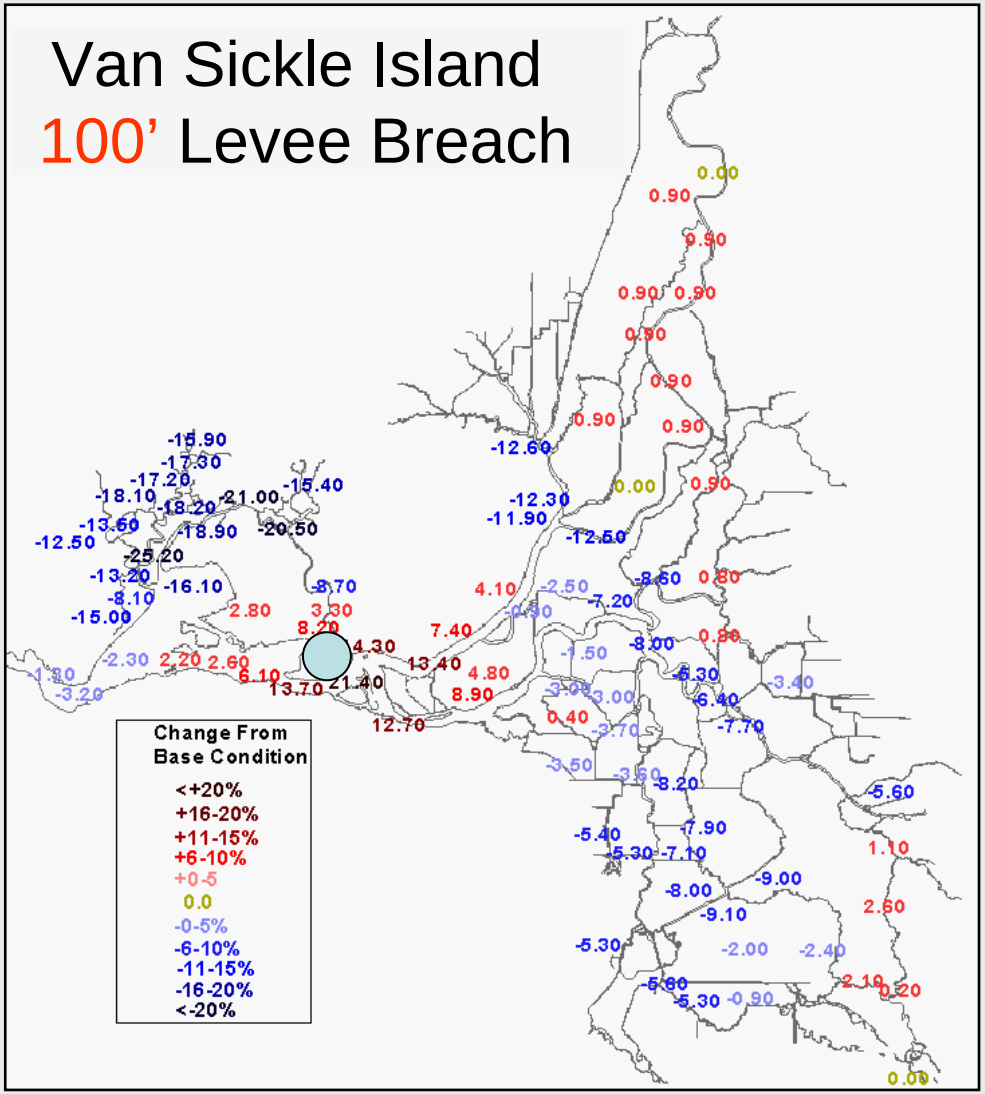
DSM1 Suisun Marsh Version

Tidal trapping +
Energy damping

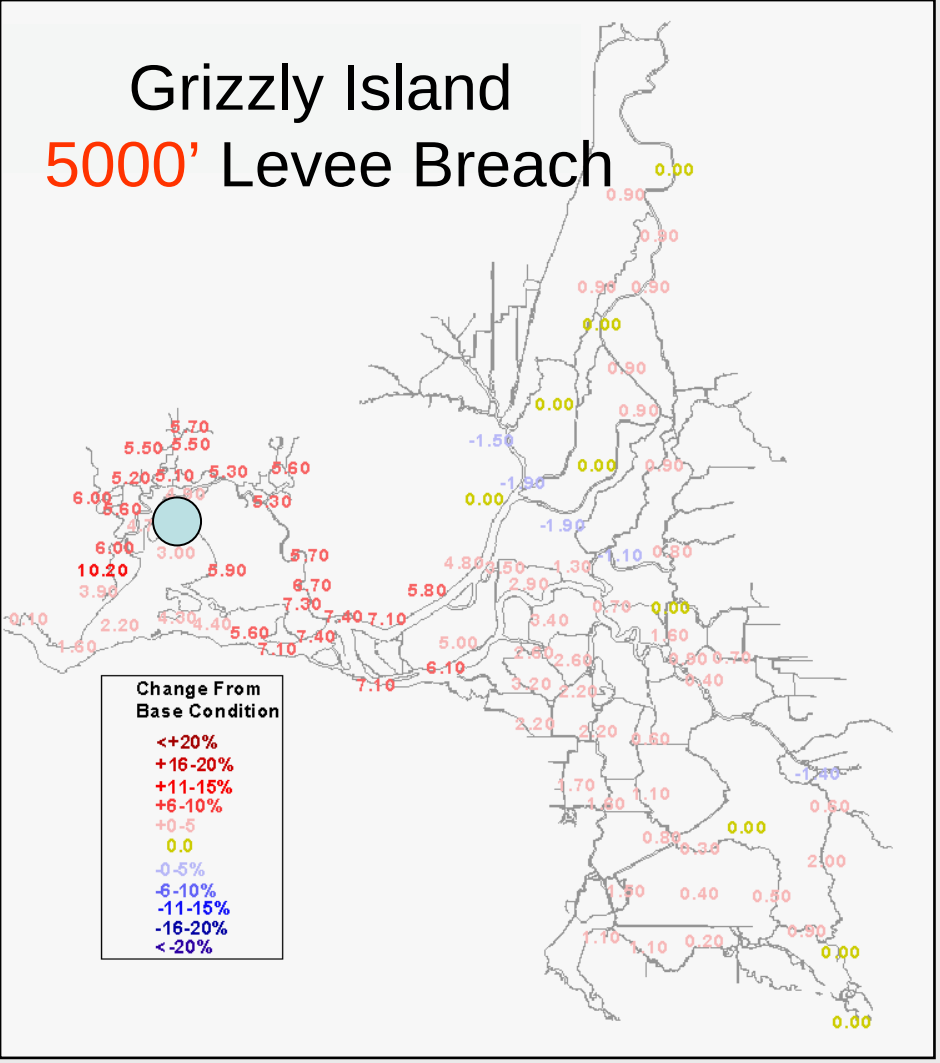


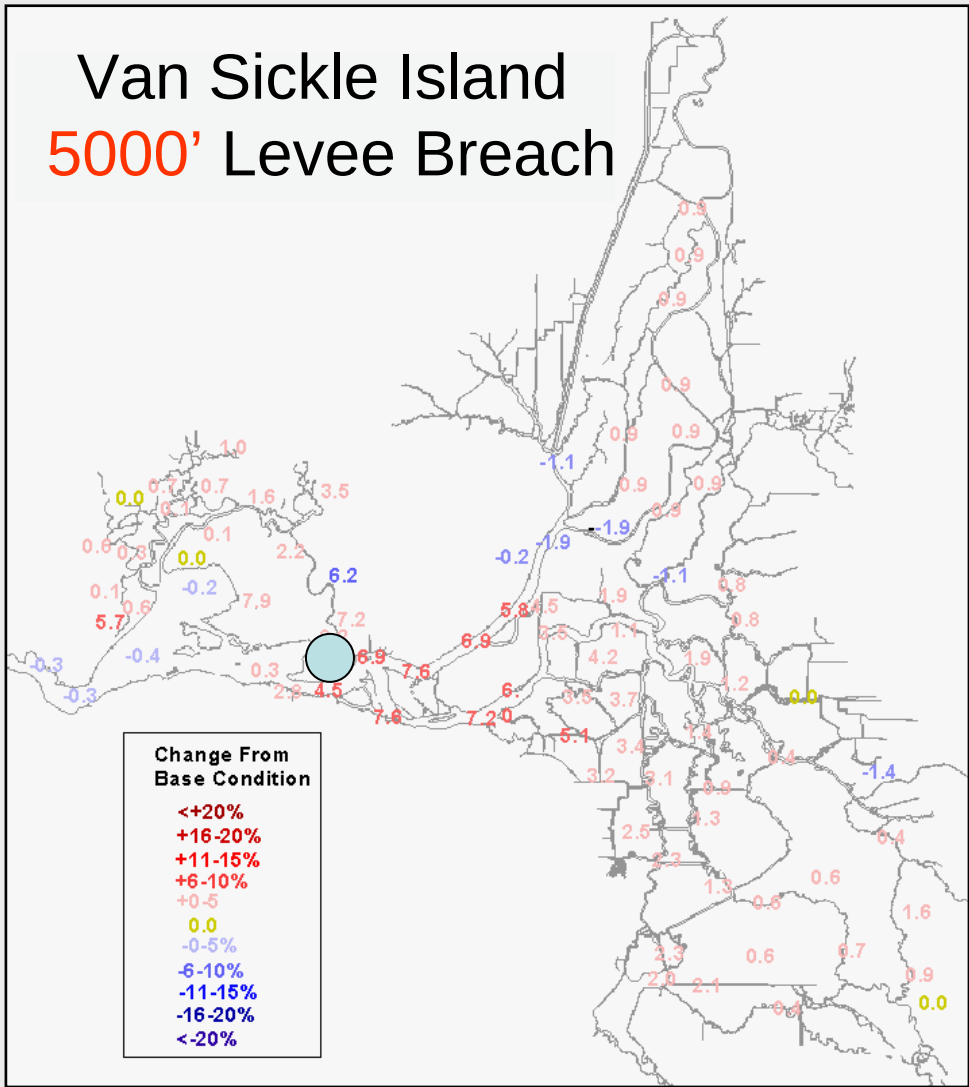
Tidal trapping + energy damping





Tidal trapping + energy damping





Thank you