# The importance of hyporheic and groundwater flow for fishes in the Pacific Northwest

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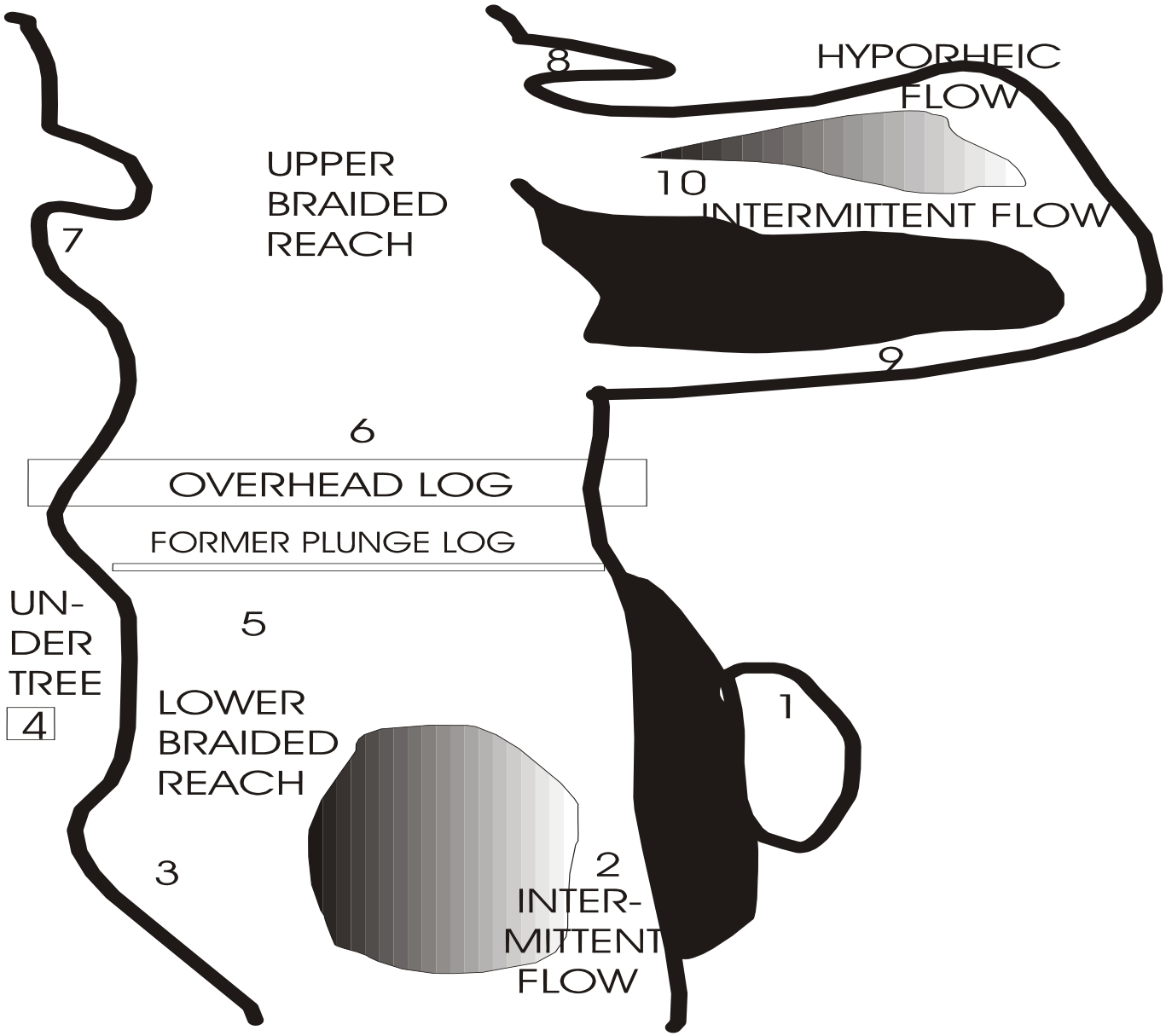
# Habitat Assessments

- Tributaries & off-channel habitats (OCHs)
  - OCHs = side channels & backwaters
  - Underestimated in low-flow season
- Well-forested
  - Braiding
    - Sediment & large woody debris
- Thermographs

# IRELY CR. THERMOGRAPH LOCATIONS



# Coho and Cutthroat Rearing

- Cutthroat
  - Adfluvial (lake-rearing) stock
    - Dominant fish in Irely Lk.
      - Mostly adults
    - Subdominant in Irely Cr.
      - Mostly YOY here
- Coho
  - Anadromous stock shows multiple age classes
    - Age-class break nr. 85 mm TL in Aug. & 90 mm TL in Oct. of ’02
    - YOY ave’d 58 mm TL & yearlings ave’d 97 mm TL in Aug. of ’02
    - Yearlings comprised 21% of immature coho in Aug. of ’02.

# Classification of Forested Wetland Off-Channel Habitats

- Lateral-macrohabitat typing
  - Thermally modulated habitats
    - Main channel (MC)
    - Main-channel braided (MB)
    - Side channel (SC)
  - Partially modulated habitats
    - Connected backwater (CB)
    - Transitional habitats
      - SC/CB
      - CB/IB
  - Variable habitats
    - Isolated back-water (IB)

# Classification of Forested Wetland Off-Channel Habitats

- Hydraulic-mesohabitat typing
  - Deep to shallow pools & runs; fast to slow riffles

# Classification of Irely Creek Tributaries

- Groundwater influence
  - Thermal dynamics
- Headwater elevation
  - Floodplain-seep vs. hillslope origin
- Stream & substratum size
- Barriers
  - Including mouth intermittency
- Salmonid spawning
  - 0-2 spp.

# Spawning & Rearing Salmonid Densities

- Coho spawning in mainstem & tributaries
  - Highest for tributaries with extensive floodplain habitat
    - Larger in size (lacking barriers)
      - Often contribute much of mainstem flow during droughts
    - Heavily spring-fed
      - Year-round temperature = 2.5-12$^{O}$C
      - Temp. comparable to mainstem when the latter nr. 6-8$^{O}$C
    - Gravel-bedded
  - Ca. 243 January spawners in ’02, 85 in ’03, & 35 in ‘04
    - Nov.-Jan. spawning
    - Likely sparse spawning in ‘01 (drought yr.)
  - Dominance of small-fish numbers
    - 85-94% during Oct.-Nov. ’02
    - Possible presence of 2+ fish during 2001

# Spawning & Rearing Salmonid Densities

- Cutthroat spawning in mainstem & 1 U/S tributary
  - Side-channel & especially main-channel habitats
    - Upslope conditions conducive to hyporheic downwelling
  - 24 redds in ’01, 45 redds in ’02, & 8 each in ’03 & ‘04
    - Drought & waterfall-washout effects
    - Ca. 27% of total January-May salmonid spawning in ’02; only 16% in ’03 but 31% in ‘04.

# Depth Segregation

- Larger fish in deeper pools (Oct.-Nov. ’02)
  - Coho ave’d 67 mm TL in medium pools
    - TL in shallower pools ave’d 51-59 mm
    - Overall ave. TL = 51-58 mm
      - Only smaller fish in Nov.

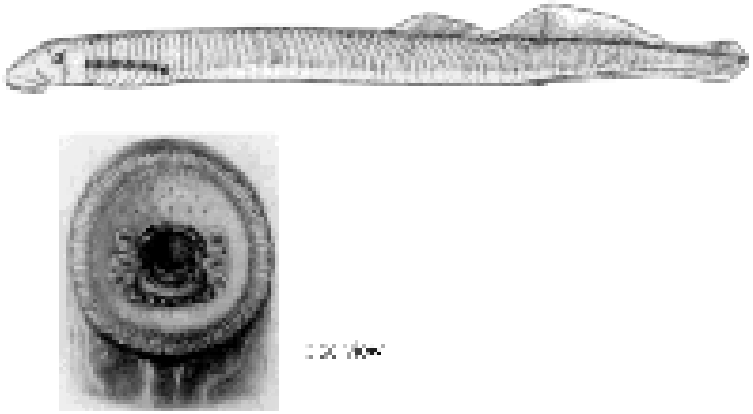
- Other fishes in shallow pools during Oct.-Nov. ‘02
  - YOY cutthroat ave’d 45 mm TL
  - YOY sculpins ave’d 36 mm TL

# Other Fishes in Irely Creek

## Lamprey (western brook sp.)

Main-channel spawning here

Likely using OCHs



## Prickly sculpins

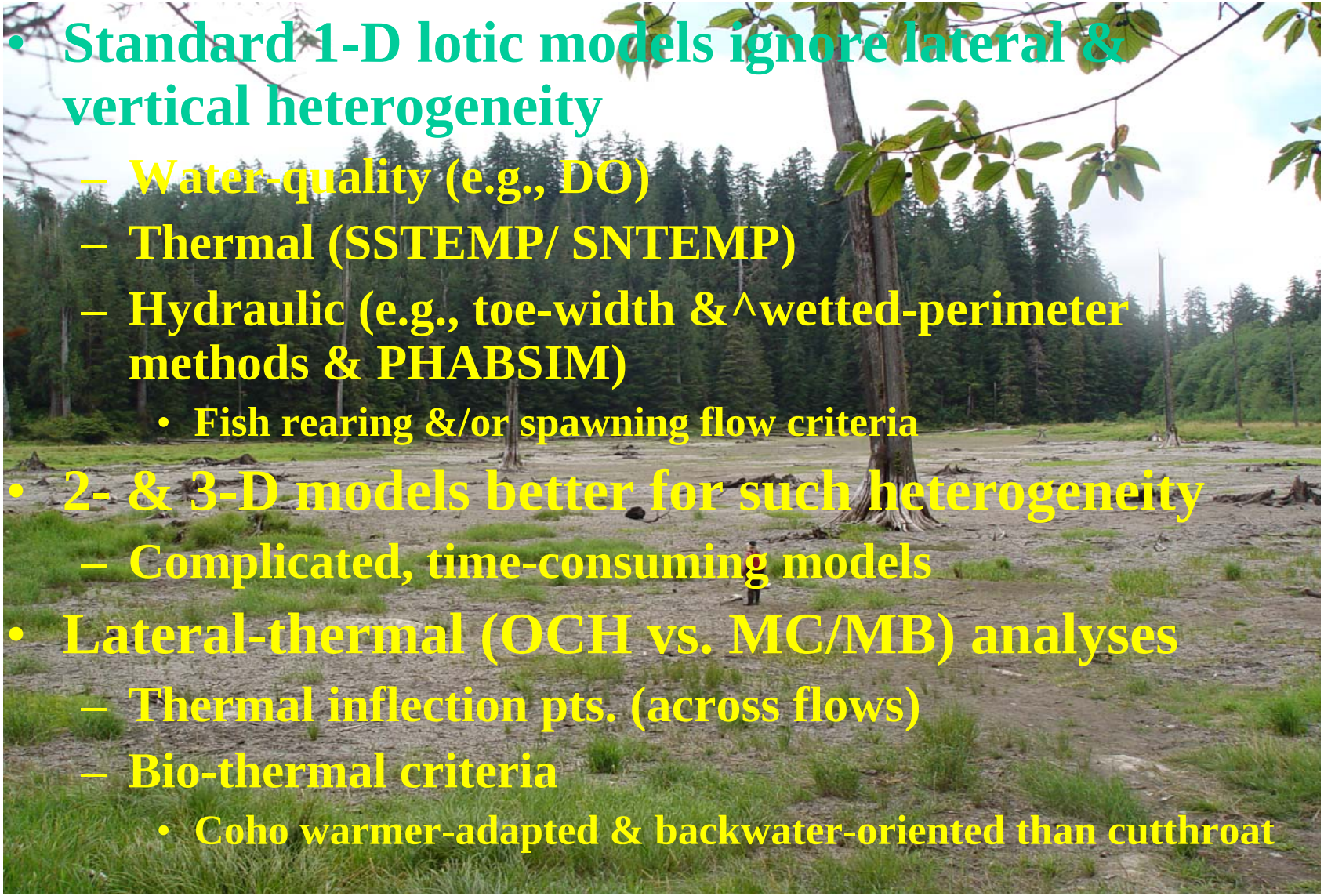
Sometimes use OCHs here

Eat various zoobenthic taxa

# Effects of Droughts: Autumn ’02 & Summer/Fall ‘03

- Irely Lk. dried out down to middle Big Cr.
  - Dying sculpins, crayfishes, & dragonfly nymphs here
  - Unusual (decadal?) event
- Possible large-fish refuge in the flatter,deeper reach near Irely Lake?
  - Both immature coho & cutthroat of various sizes here
  - Perennially flowing in many reaches
- Middle Big Cr. (intermittent fish passage)
  - Hyporheic flow during non-winter flows
  - Coho inmigrations into Irely Cr., trout/char into Irely Lk., & chinook into middle Big Cr.
  - Well-forested watershed probably compensates.

# Instream-flow modeling problems



- Standard 1-D lotic models ignore lateral & vertical heterogeneity
  - Water-quality (e.g., DO)
  - Thermal (SSTEMP/ SNTEMP)
  - Hydraulic (e.g., toe-width &^wetted-perimeter methods & PHABSIM)
    - Fish rearing &/or spawning flow criteria
- 2- & 3-D models better for such heterogeneity
  - Complicated, time-consuming models
- Lateral-thermal (OCH vs. MC/MB) analyses
  - Thermal inflection pts. (across flows)
  - Bio-thermal criteria
    - Coho warmer-adapted & backwater-oriented than cutthroat