

INDUCED SWEEPING FLOWS AT CWIS FOR REDUCING FISH IMPINGEMENT

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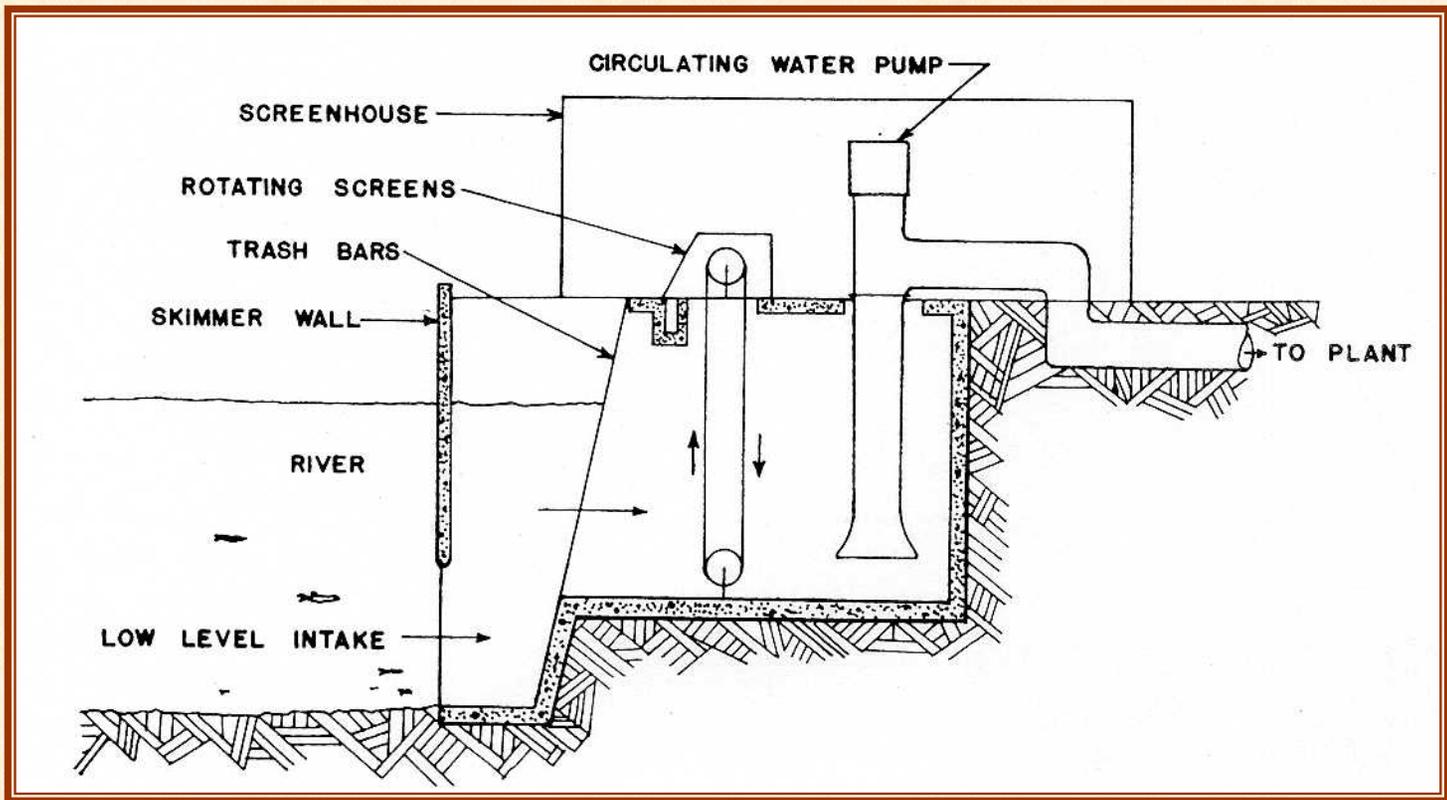
Purpose:

To present: 1) Conceptual plan
2) Research strategy

For simulating fish-protection “sweeping velocities” seen at angled screens at cooling-water intake structures (CWIS) having screens perpendicular with water inflow.

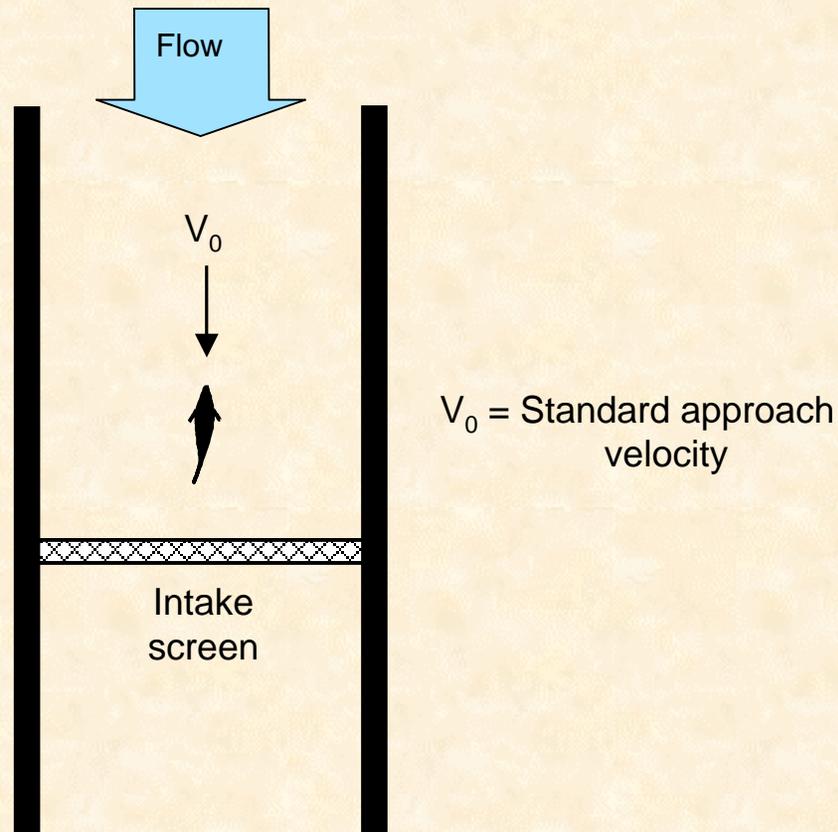
Most CWIS in U.S. use vertical traveling screens perpendicular to flow.

These can have impingement problems, except when screens are close to the river shore.



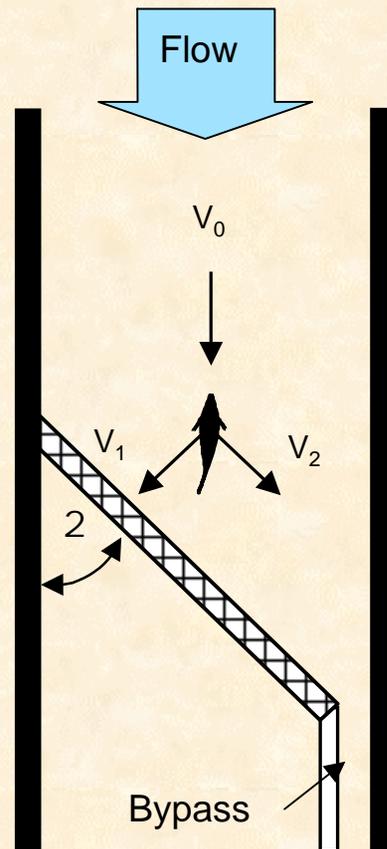
Impingement often results when fish:

- are trapped in intake canals by high velocities,
- become exhausted swimming against the flow,
- fall back onto screens as their only option.



Angled screens are the norm in western U.S., e.g., for irrigation water withdrawals.

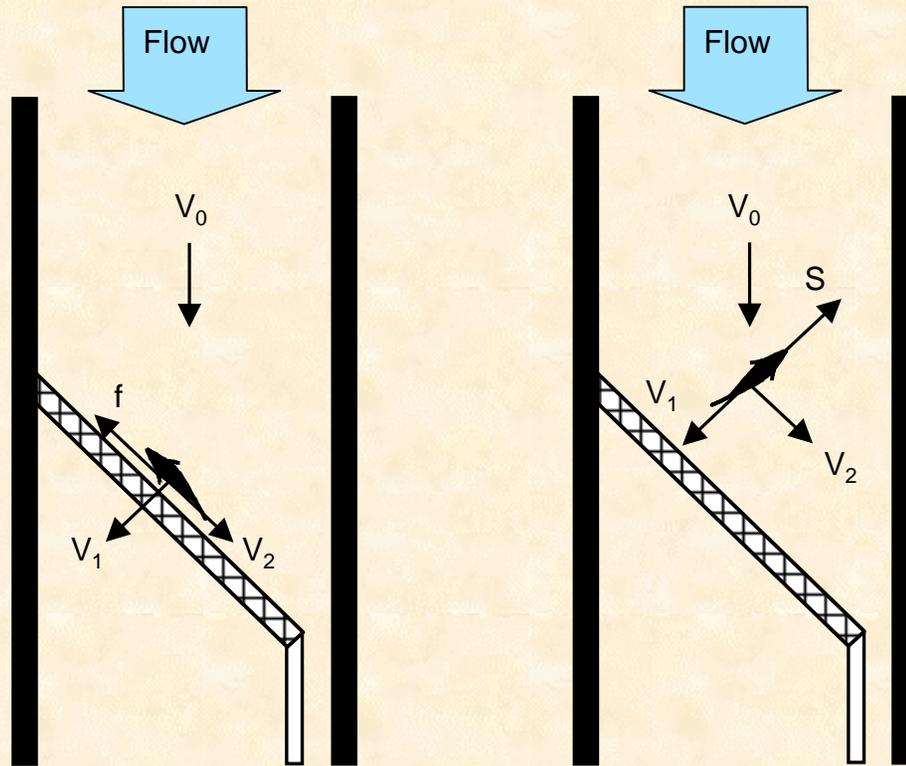
- NMFS and several states have regulatory criteria requiring angled screens.
- Rationale: Fish approaching a screen are swept laterally to a bypass by “sweeping velocity”.



$$V_1 = \text{Perpendicular component} \\ = V_0 * \text{sine}(2)$$

$$V_2 = \text{Parallel component} \\ = V_0 * \text{cosine}(2)$$

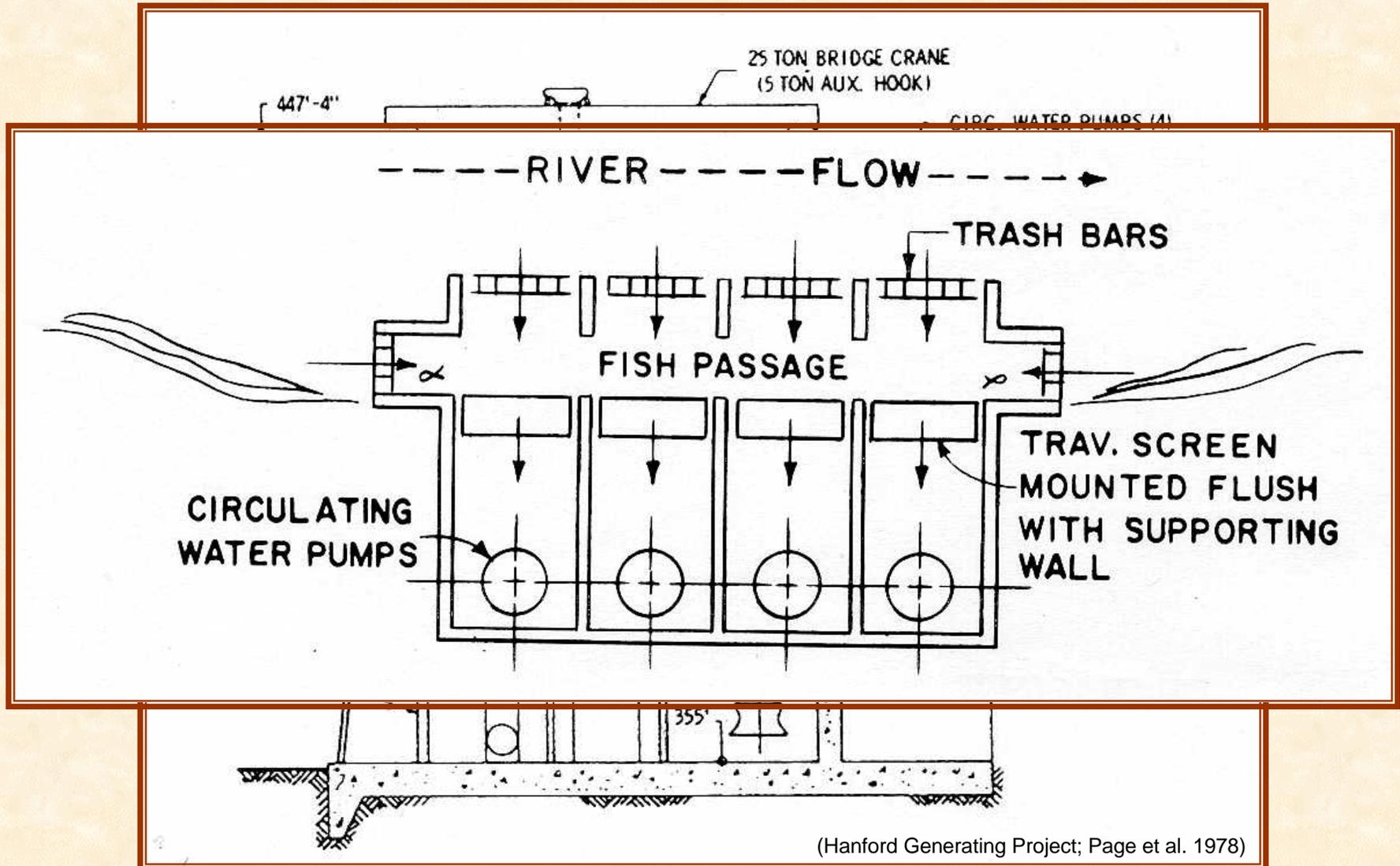
Any fish briefly impinged can also move laterally to a bypass.



f = Friction against screen

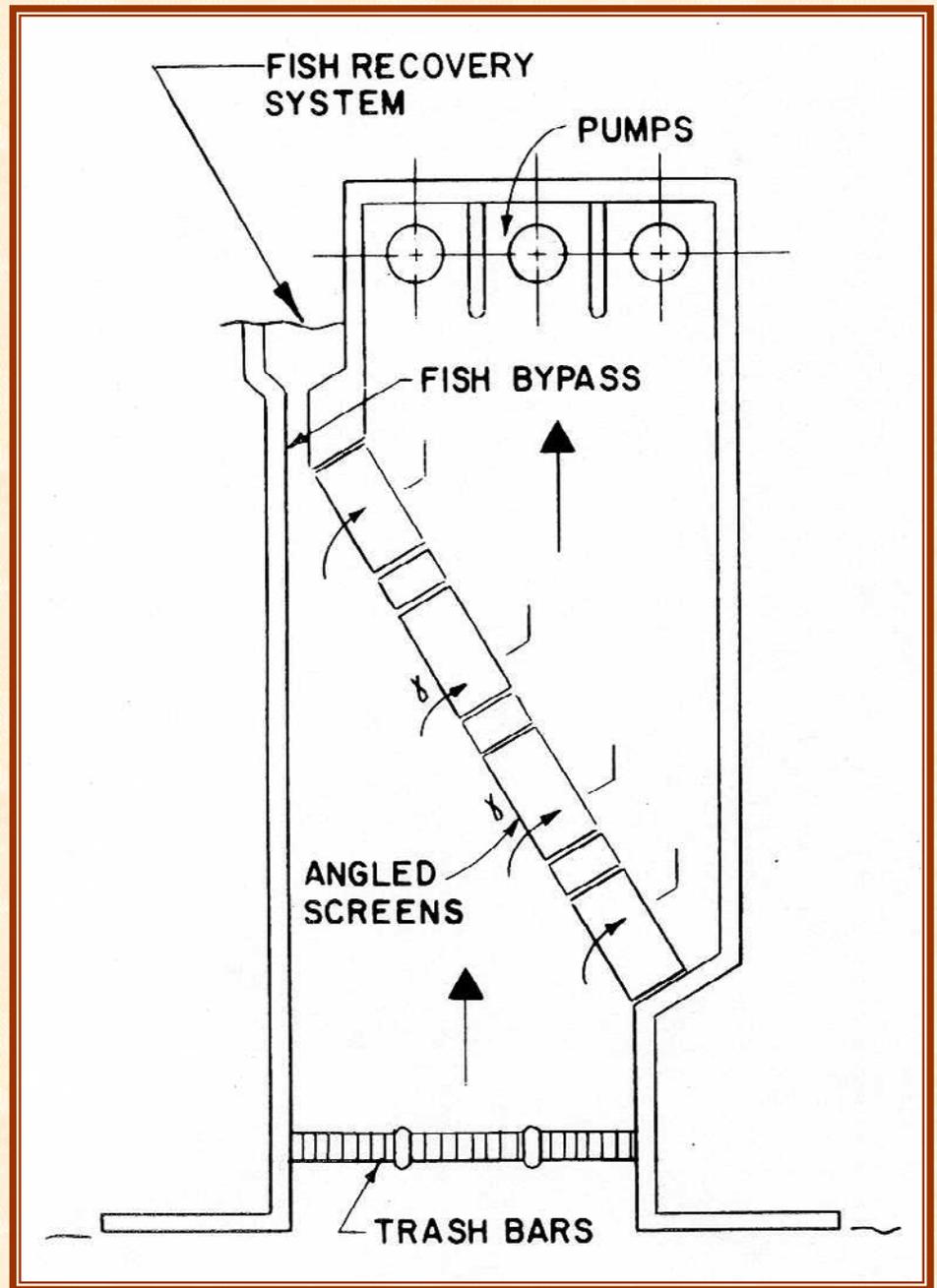
S = Swimming speed

CWIS located on a river shoreline already has a sweeping flow (river flow)



(Hanford Generating Project; Page et al. 1978)

New intakes might be constructed with angled orientation of traveling screens.



Rebuilding of existing CWIS for angled screens is likely not

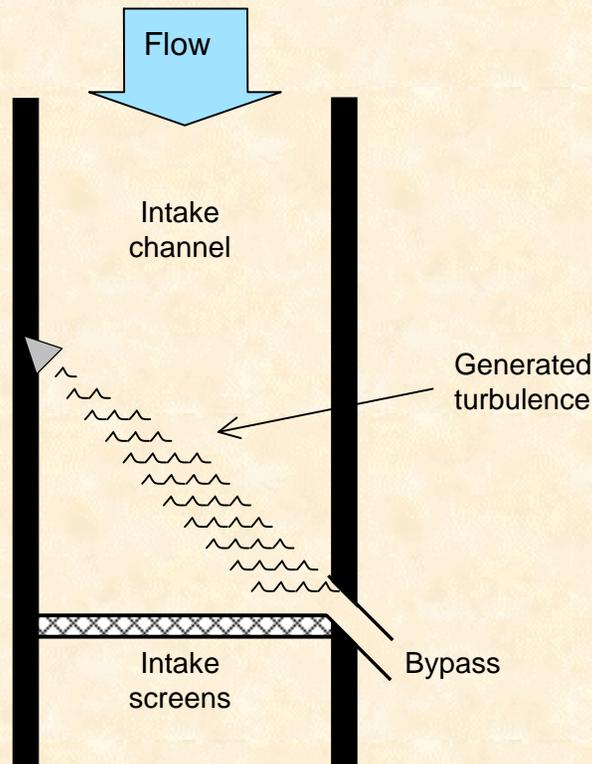
- economically feasible
- physically possible

Therefore, we have sought an alternative technology for CWIS, with roots that have been proven effective.

Suggested solution: Simulate an angled screen's "sweeping velocity" with induced flow.

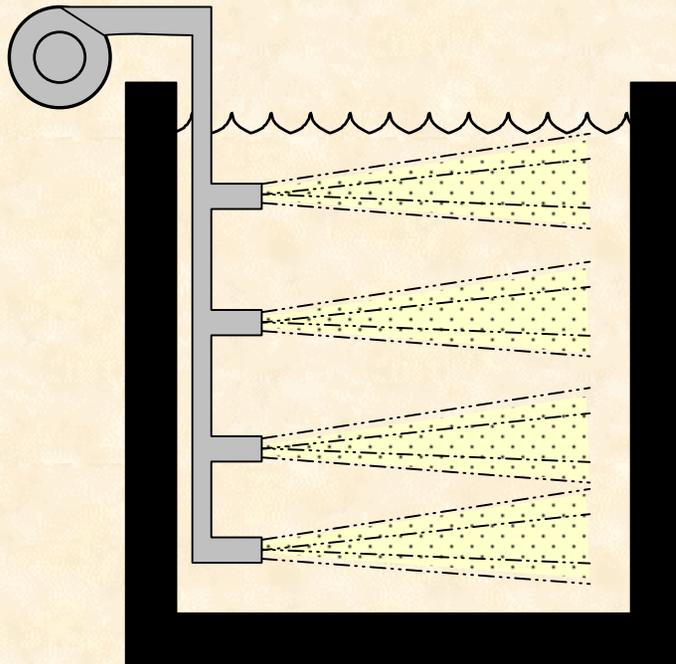
Flow inducers would direct an angled zone of turbulent flow across the face of a perpendicular screen.

Fish would be concentrated on one side and diverted to a bypass.

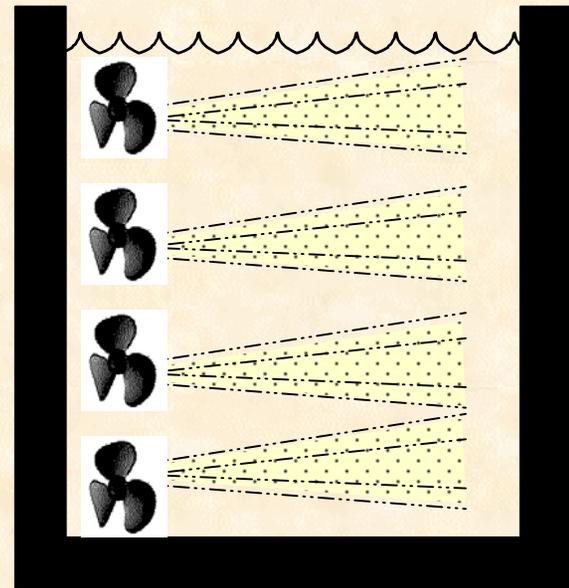


Flow could be induced by pumps or propellers.

Pump

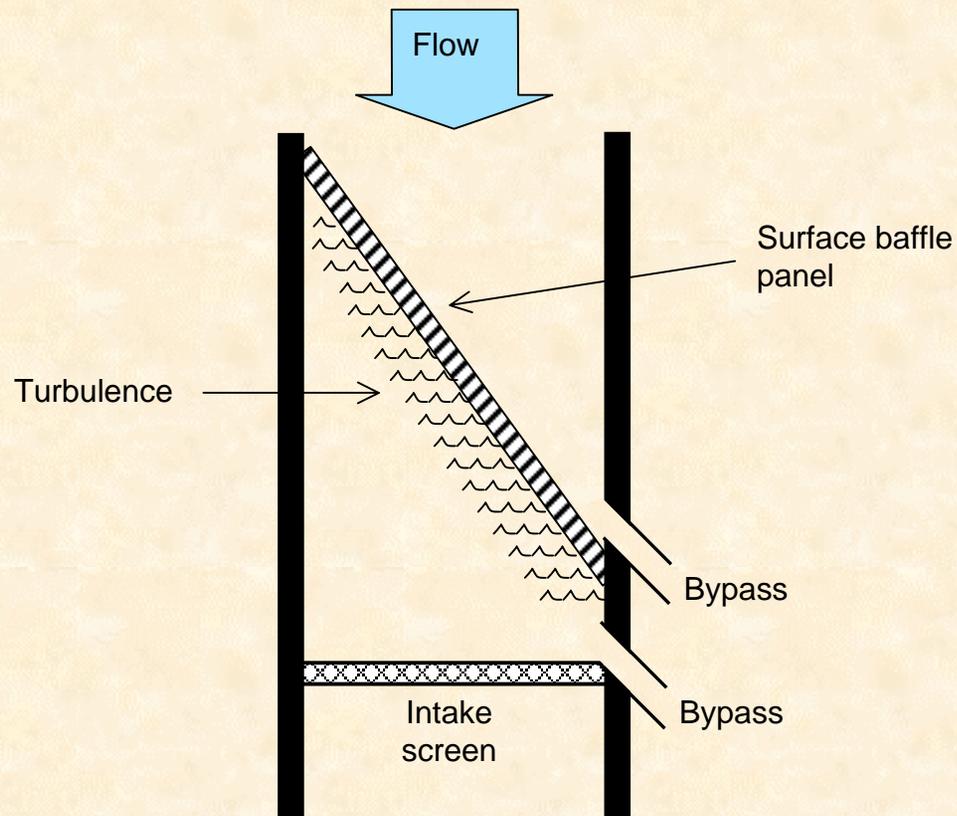


Fans

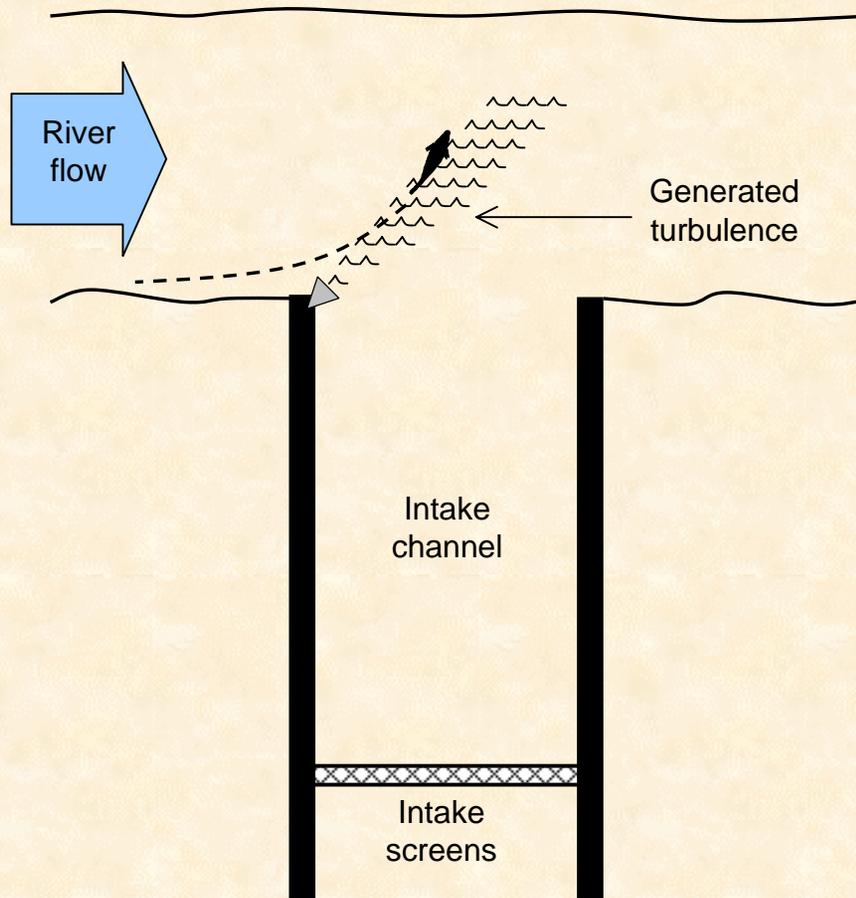


Baffle panels may provide guidance.

Some fish would be diverted along the face of the panels and others in the turbulent wake.



Induced turbulent flow can be installed at the entrance of an intake canal, to divert fish from the canal.

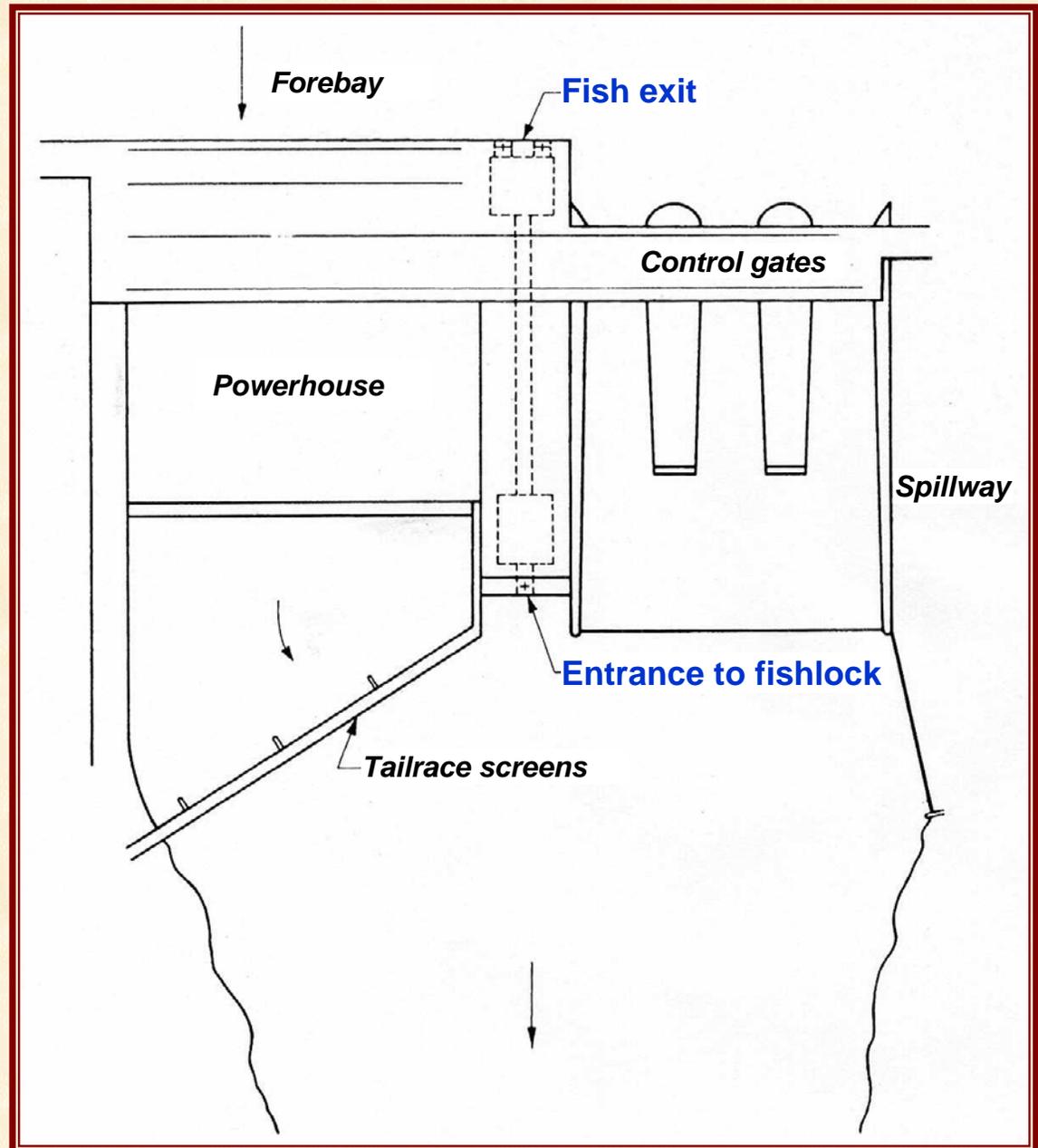


Fish bypasses

- Assorted proven technologies are available
- Fish lifts may be most feasible

Most often used at hydropower dams

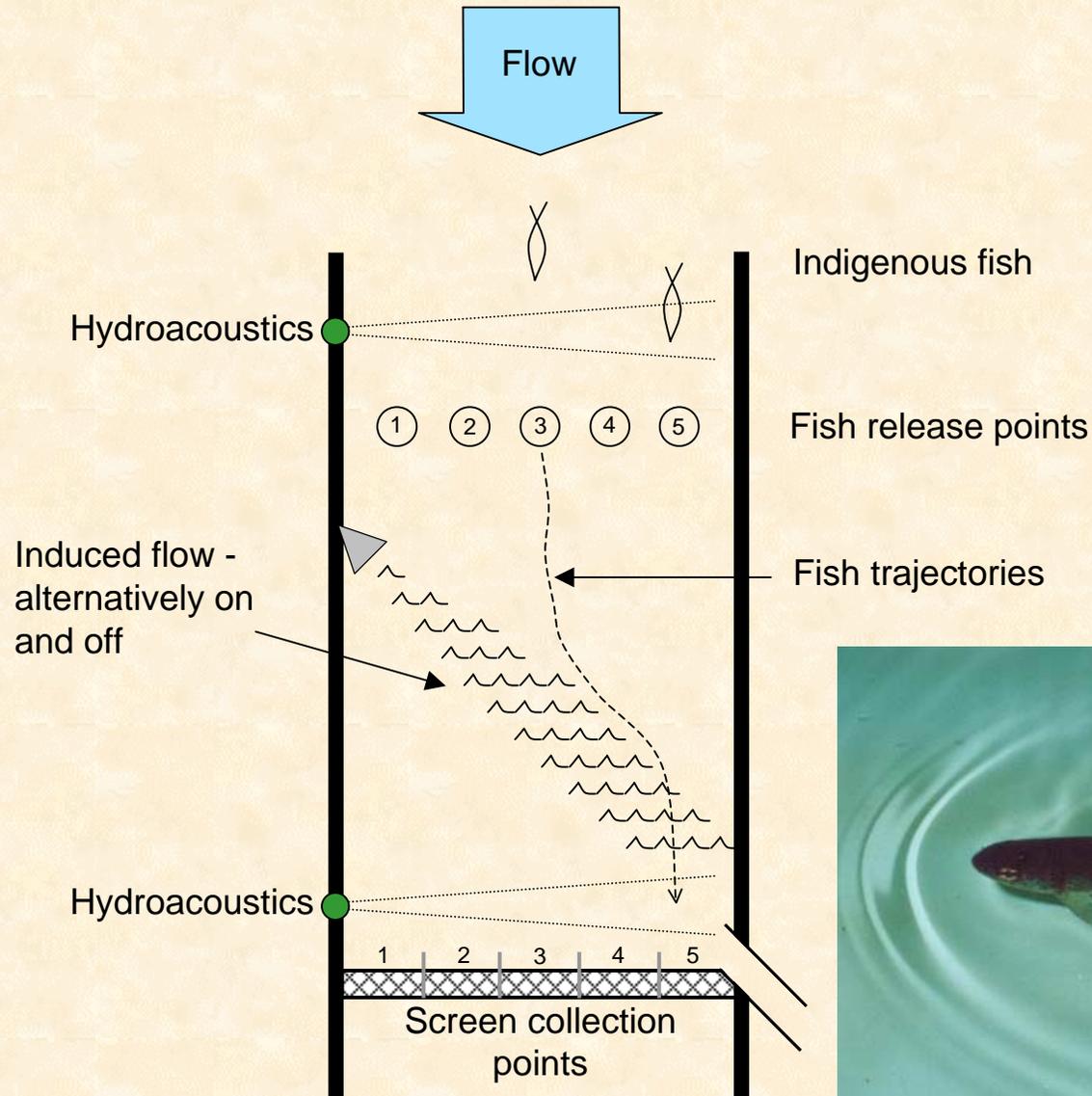
- Vertical lift
- Ramp lift
- Archimedes screw



Testing and Evaluation

- Know the impingement history of sites and biology of impinged species
- Develop conceptual designs for inducing sweeping velocities
- Conduct CFD modeling of background and induced hydraulic patterns (numerical “experiments” to test alternative flow induction devices and placement strategies)
- Conduct flume tests
- Develop field experiments

Elements of an experiment



Conclusions

1. We believe a technology using induced sweeping flows would provide a potentially effective and relatively inexpensive remedial measure for retrofitting existing cooling-water intake systems to reduce impingement.
2. The concept is based generally on (1) the proven effectiveness of angled screens in the Northwest designed to meet federal and state criteria for sweeping velocities and fish bypasses, and (2) low impingement rates of river shoreline CWIS.
3. The concept of induced sweeping flow, although untested at CWIS, seems to have sufficient promise to justify further analysis and initiation of laboratory flume and field testing.

Acknowledgements:

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