Fish Passage Effectiveness

It's Not Just Counting Fish

Studies on the Deerfield River

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FERC Fish Passage Workshop 11-13-03

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Fish Passage Requirements

- Deerfield River Project
  - No. 4, No. 3, No.2 Developments
  - Settlement Agreement 12-05-94
  - License issued 04-04-97
    - DS Passage within 2 years
    - DS Passage 4/1-6/15 & 9/15 – 11/15
    - Upstream Passage at No.2 based upon returns

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Downstream Passage Devices

- Order Approving plans 8-21-98
- Began operating 4-1-99
- No. 4 Dam

  New surface collection device, migrant pipe, plunge pool and flume
- No. 3 Dam

  Modified sluice gate to bypass
- No. 2 Dam

  New surface gate and flume to dam base

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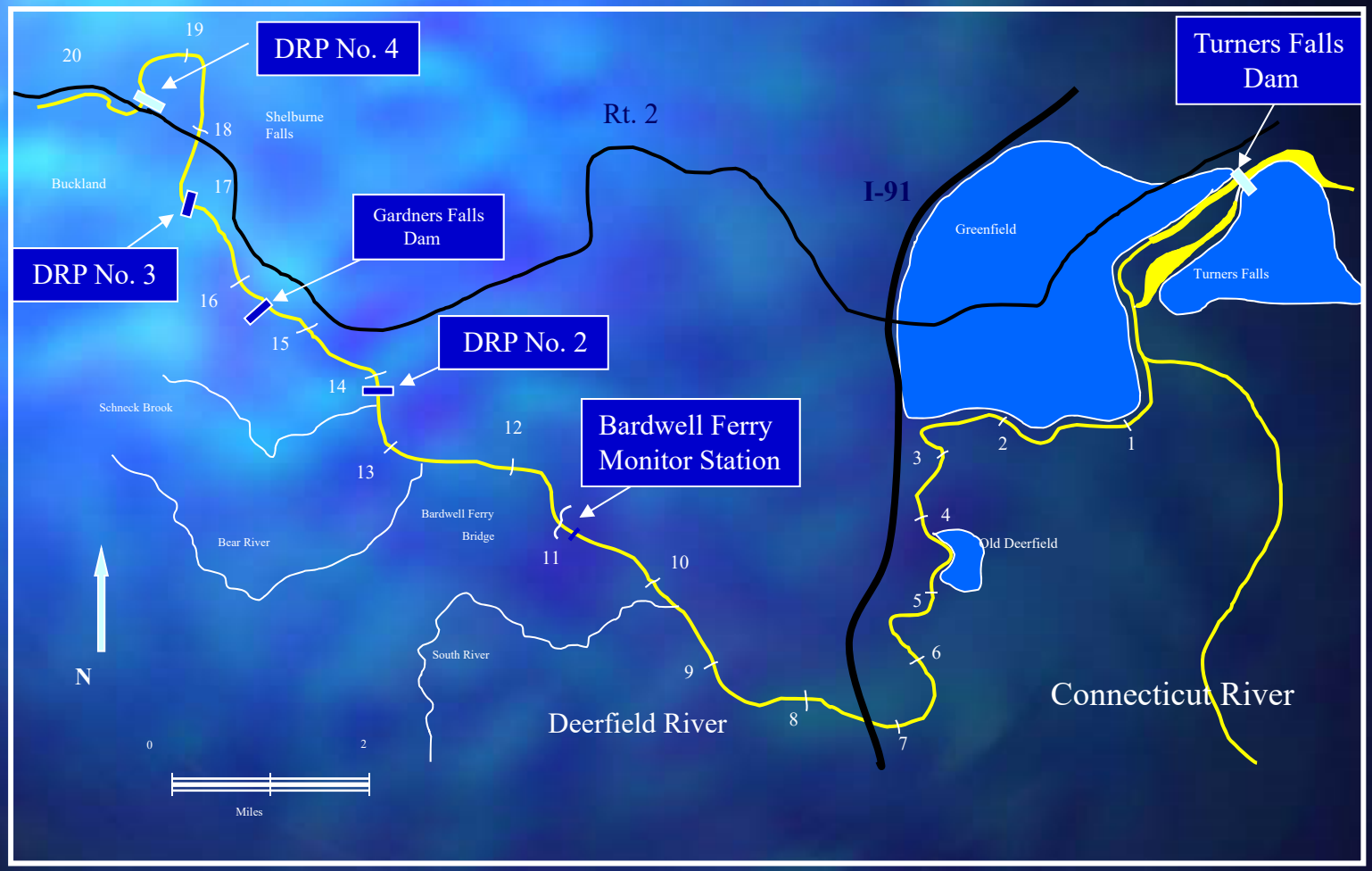
Lower Deerfield River



Deerfield River Project Developments, study area, downstream monitor stations, Gardners Falls Project, and approximate river mile locations.

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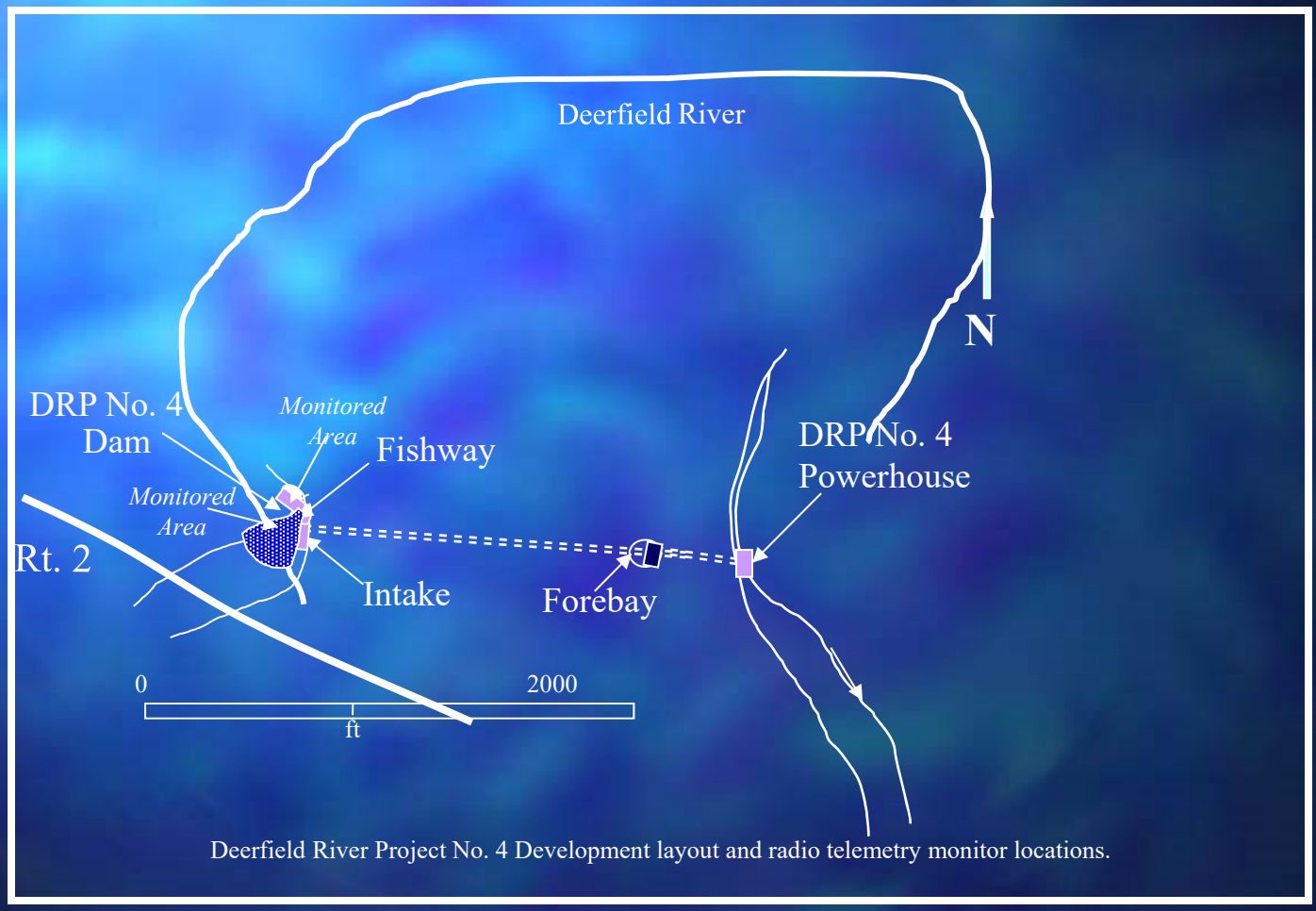
Deerfield No. 4 Development



Deerfield River Project No. 4 Development layout and radio telemetry monitor locations.

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Deerfield No. 4 Fishway

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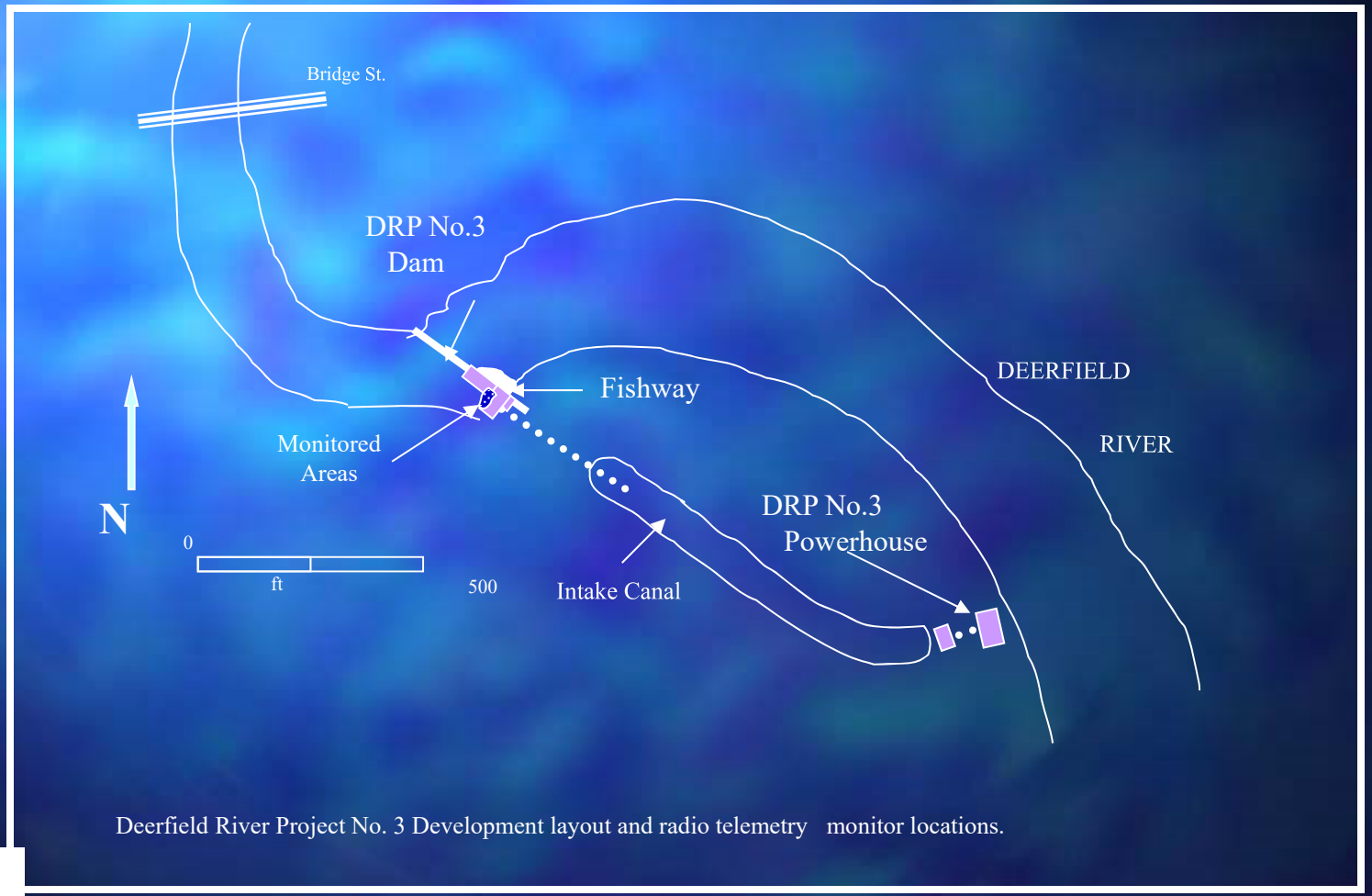
Deerfield No. 3 Development



Deerfield River Project No. 3 Development layout and radio telemetry monitor locations.

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Deerfield No. 3 Fishway

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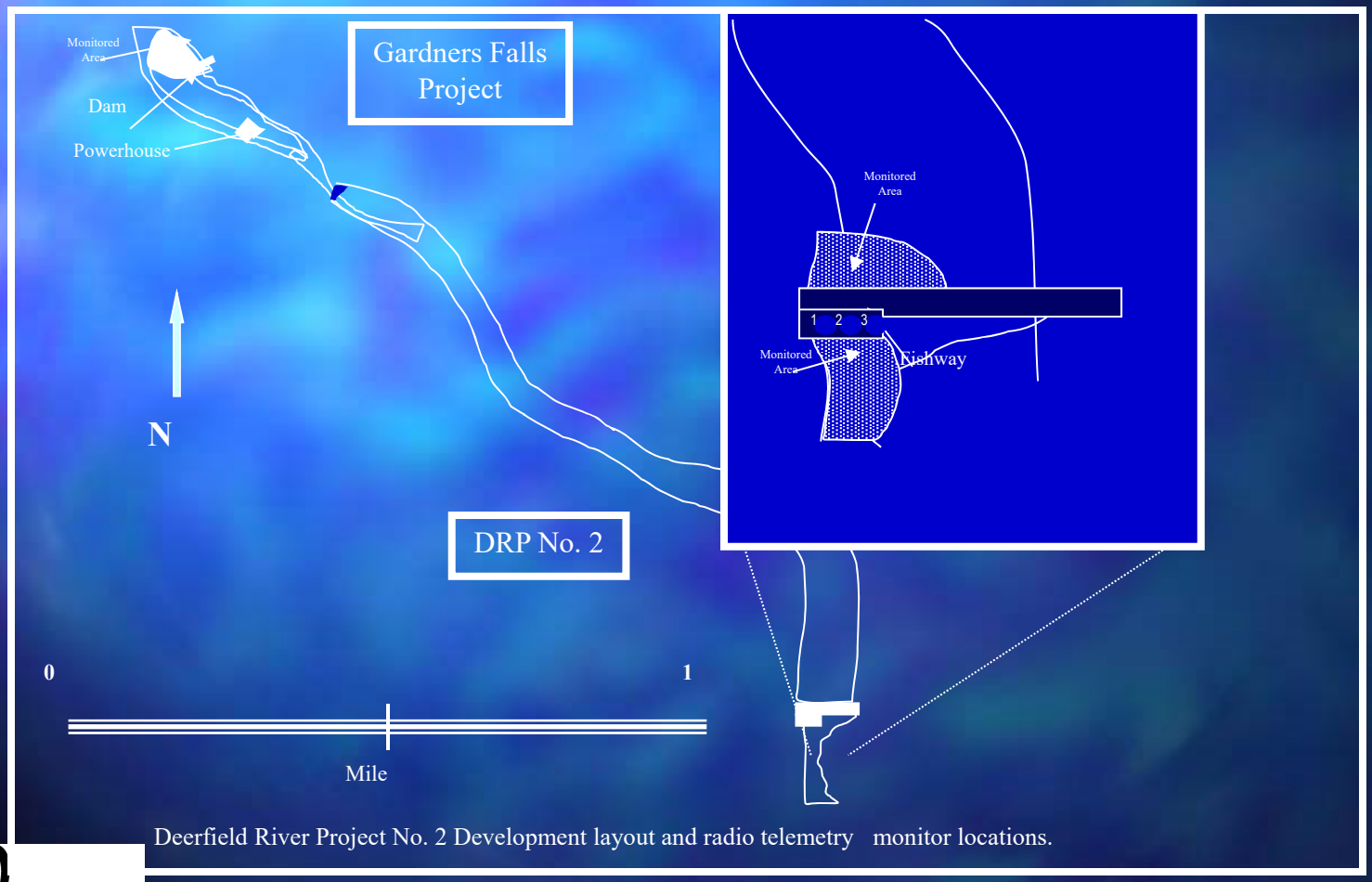
Deerfield No. 2 Development



Deerfield River Project No. 2 Development layout and radio telemetry monitor locations.

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Deerfield No. 2 Fishway

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Evaluation Approach

- Iterative
  - …but not by choice
- Used Radio Tagging to measure
  - … and then some (to solve and determine improvement options)
- Believe we are close to succeeding…

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Radio tagging metrics

% Effectiveness

Fishway effectiveness is a measure of how well the fishway attracts emigrating smolts.

$$E = F/A, \quad \textit{where}$$

E = Effectiveness of the fishway; F = the number of tagged smolts that used the fishway; A = those tagged smolts available in the project vicinity just upstream *(i.e., the total of the number of fish passed through the fishway, turbines and those fish detected near the fishway but that did not pass by any route).*

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Radio tagging metrics

% Safe Passage

Safe Passage through each route was calculated as:

$$S = s/P, \textit{ where}$$

S = safe passage between monitoring locations; s = the number of smolts that is passed via a particular route and were detected at downstream monitor locations or manually located downstream; and P = the total number of tagged smolts that used each available route at a particular development.

- Could only be estimated in a general manner since tagged smolts were not recaptured for examination after passage.
- Tagged fish were monitored for presence at points well downstream of each dam.
- Length of river reach between the dam and the downstream monitor needs to be considered as to the effect predation could have on the results.

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Studies and Modifications
Chronology

- 1999
  - Completed Construction of Facilities
  - 1999 Radiotag telemetry (all 3 dams)
  - Radiotagging Results
    - No.4 - 59% Effective; Safe passage 85%
    - No. 3 – 78% Effective; Safe passage 96%
    - No. 2 – 20% Effective; Safe Passage 55%

Studies and Modifications
Chronology

2000 Modifications

- No. 4 - 1” Bar Racks installed in front of bulkhead
- No. 4 and No. 3 - Log boom relocated
- No. 2 - Flow Inducer installed, minimum flow unit switched to unit nearest fishway
- No. 2 - Flume Support Struts reduced to minimal number, log boom removed

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Studies and Modifications
Chronology

2000 Evaluations

- Flow Inducer CFD modeling
  - Floy-tag visual observation at No. 2

- Radiotag telemetry (all 3 dams)

Studies and Modifications
Chronology

2000 Evaluations

- Flow Inducer Results
  - Surface flows fields were modified and directed
  - Insufficient depth above intakes restricted depth of affected surface flow inducing field
  - At 33%+ station load intake velocities dominated flow fields and velocities
- Radio tagging Results
  - No.4 - 28% Effective; Safe passage 74%
  - No. 3 – 41% Effective; Safe passage 53%
  - No. 2 – 15% Effective; Safe Passage 71%

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Studies and Modifications
Chronology

2001 Modifications

None

2001 Evaluations

Extensive CFD modeling of flows approaching all 3 dams; follow-up modeling Spring 2002

- Tested at single unit and 3-unit operation
- No. 2 tested at higher 10 foot pond
- CFD modeling not performed for higher spill or inflatable dam configuration and passing spill over crest

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Deerfield No. 2 flow evaluation 1997

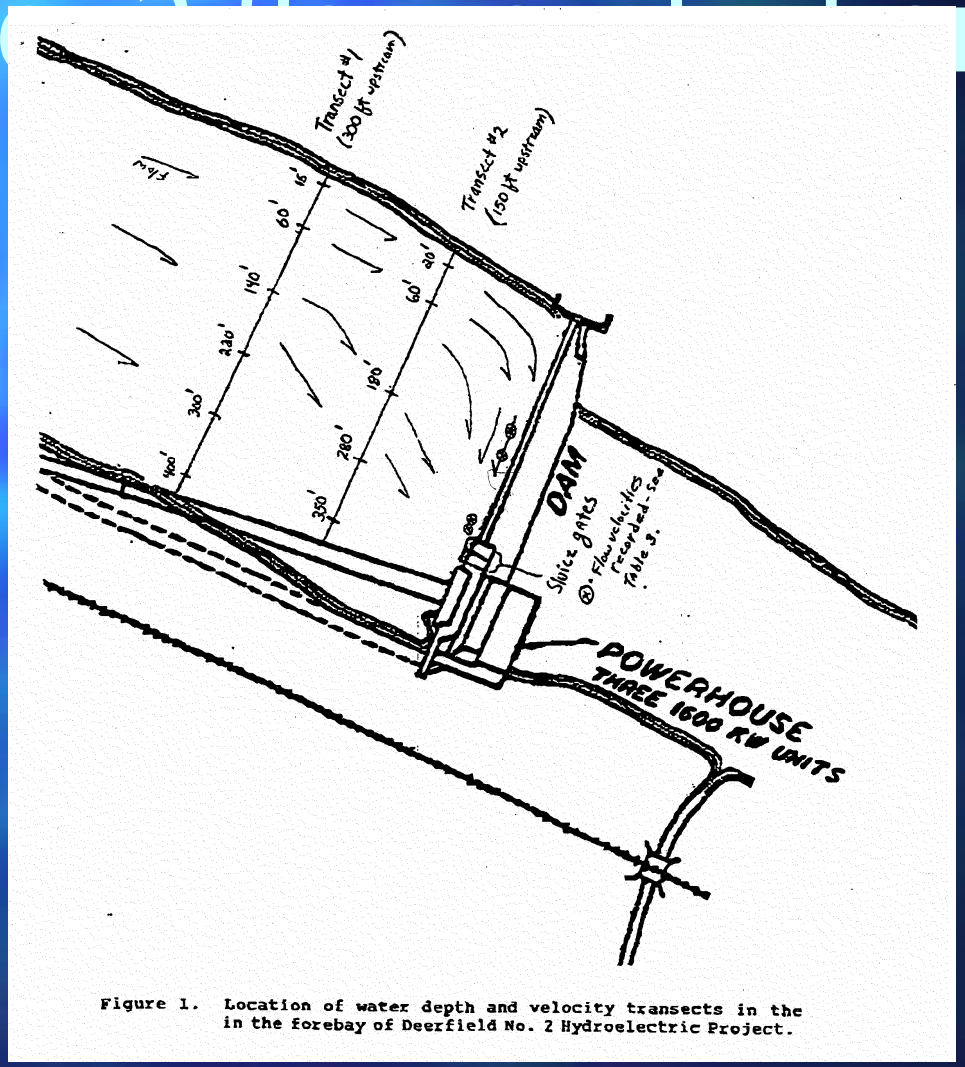

Figure 1. Location of water depth and velocity transects in the in the forebay of Deerfield No. 2 Hydroelectric Project.

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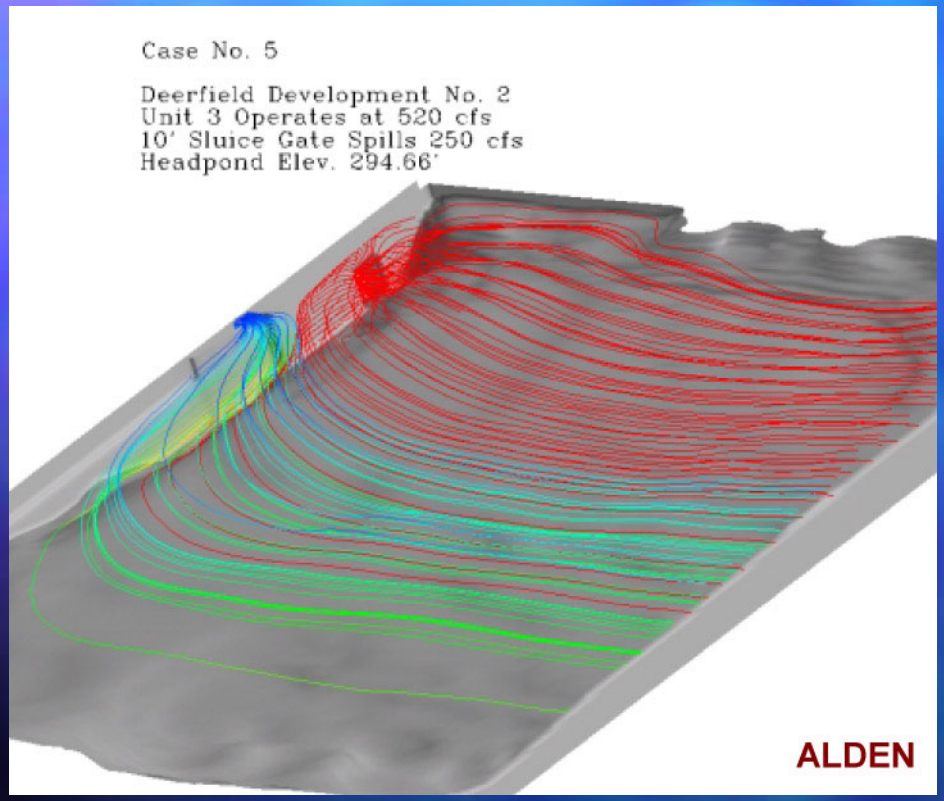
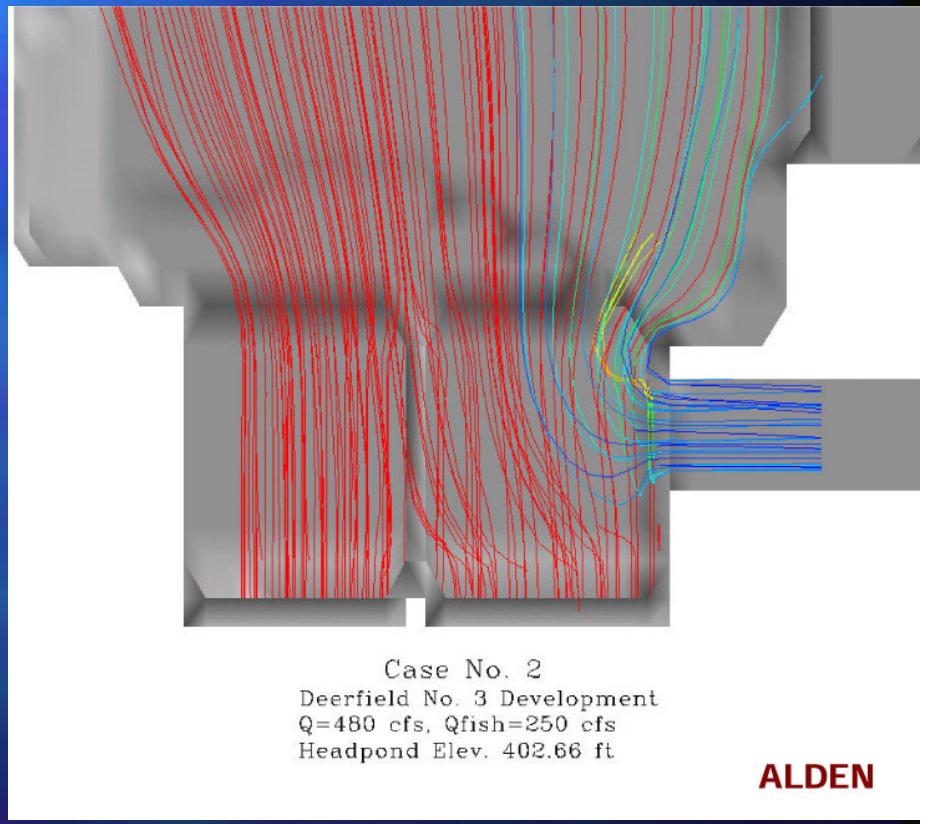
CFD Flow Evaluation 2001-2002





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CFD Flow Evaluation
Conclusions

- Flow vectors approaching intakes are not affected by presence of bypass option unless immediately in front of bypass.
- Velocities too high for fish to overcome when in the field in front of intake racks.

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Studies and Modifications (cont.)

2002 Modifications

- Altered Operation to increase flows through fishways; reducing generation from 6p-7a
- No. 4 - Moved deep trash boom away from fishgate
- No. 3 Modified trashracks; removed trashboom
- No. 2 Increased depth of pond 6’
- No. 2 Increased flow through fishgate
- No. 2 Sluice gate option studied

Studies and Modifications (cont.)

2002 Evaluations

- Radiotag telemetry (all 3 dams); operations scenarios evaluated
- No. 3 Underwater camera assessment to determine stream-reared migration timing
- 2002 Fall PIT Tagging upstream tributaries for Spring 2003 evaluation

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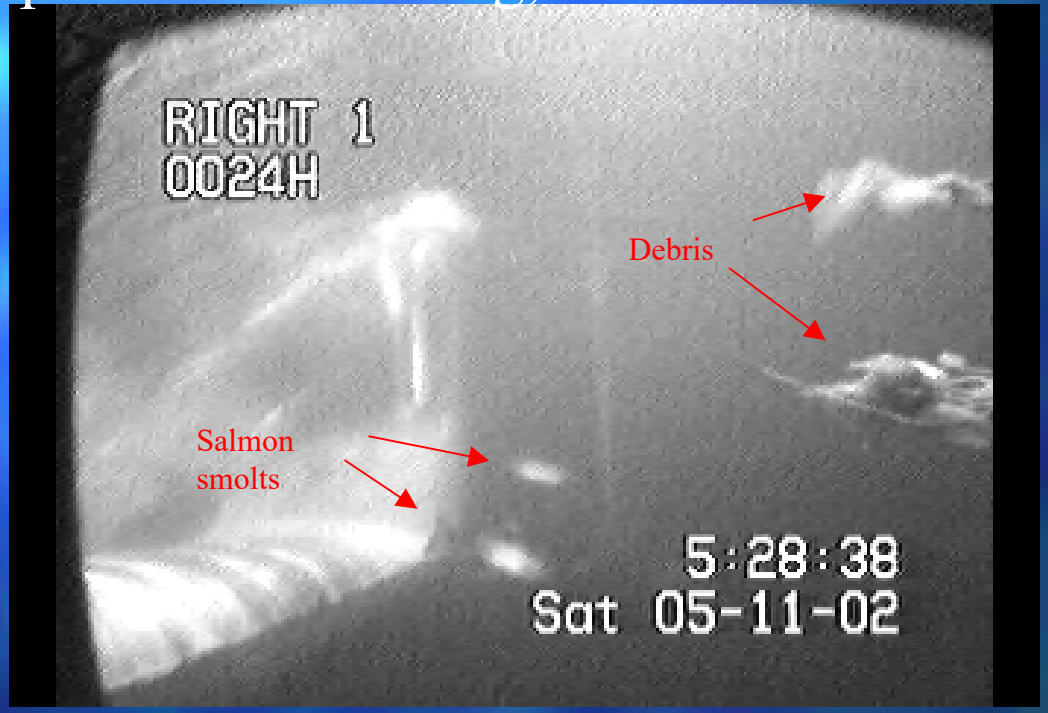
Studies and Modifications (cont.)

2002 Evaluations Results

- No. 3 Underwater camera assessment
  - Poor visibility at night (infrared); good during day
  - 28 smolts identified over 2880 continuous hours
  - Seasonality – temperature 8-12 C; 5/10-5/20; high natural runoff
- Radiotag telemetry
  - No.4 - 57% Effective; Safe passage 96%
  - No. 3 – 77% Effective; Safe passage 96%
  - No. 2 – 44% Effective; Safe Passage 96%
  - Sluice Gate more effective than fishway
  - High flows affected study; impairing analysis of results between various operating scenarios

No. 3 Underwater Camera Assessment (2002)

Time-lapse video recording, set to record at 5 frames/second



Two Atlantic salmon smolts using the DRP No. 3 bypass during observed peak of the run. Notice smolts are using the bypass approximately mid-stream.

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No. 3 Underwater Camera Assessment (2002)

Marked hatchery smolt (left) and unmarked wild salmon (right) using the DRP No. 3 bypass during spring 2002.

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Studies and Modifications (cont.)

2003 Modifications

- No. 4 Trash boom redesigned and installed 1’ depth (vs. 5’ previously)
- No. 4 operated to maintain 2’-3’ drop into collector
- No. 3 Trash rack modified – bar spacing 1’ & 2’
- No. 2 Alternative passageway (sluice gate) studied

2003 Evaluations

- Repeated Operational Scenarios/Radiotagging study
- No. 4 Pit tag monitoring

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Studies and Modifications (cont.)

- 2003 – Repeated Operational Scenarios/Radiotagging study
- No. 4 - PIT-tag monitoring

Studies and Modifications (cont.)

2003 Evaluations Results

- Radiotag telemetry
  - No.4 - 57% Effective; Safe passage 93%
  - No. 3 – 73% Effective; Safe passage 90%
  - No. 2 –
    - Fishway 32% Effective; Safe Passage 90%
    - **Sluice gate 81% Effective; Safe Passage 97%**
    - Combined/overall – 60% Effective; Safe passage 81%
- No. 4 Maintaining drop into collector restricted flow to about 60% of maximum capacity
- No.2 Sluice Gate clearly more effective than fishway
- Some high flow, but did not skew results

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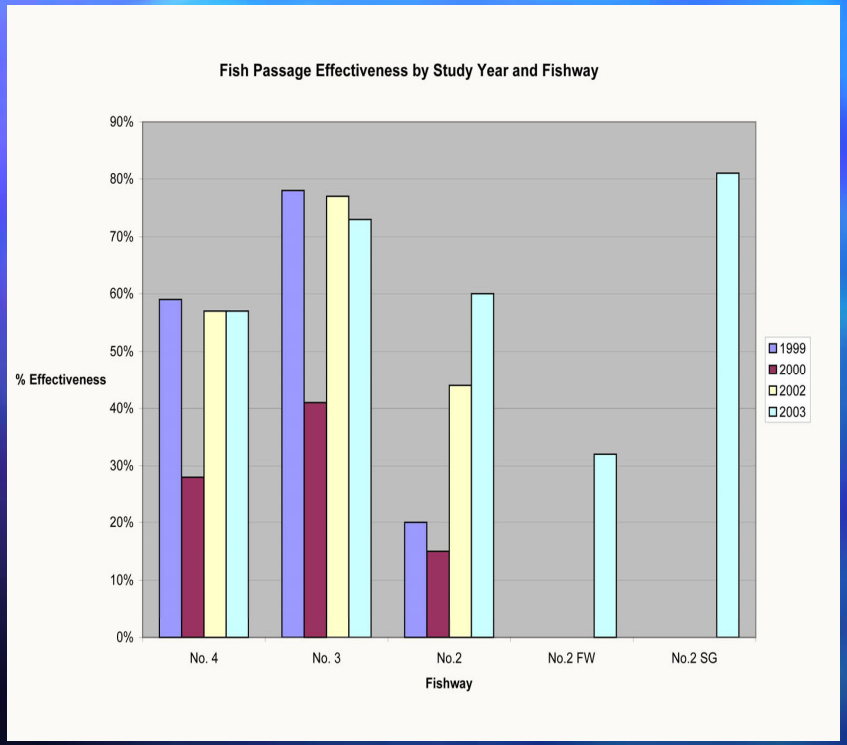
Studies and Modifications (cont.)

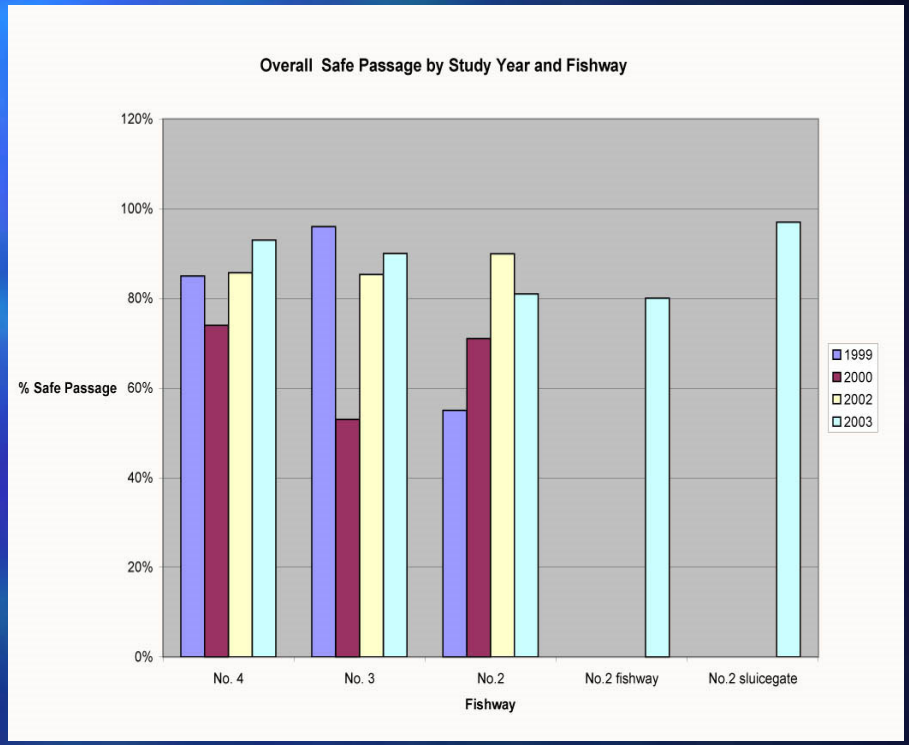
2003 Evaluations Results

PIT Tag Monitoring

- Limited number of fish found, shocked and tagged in previous Fall
- May have been late
- No Pit tagged fish hit monitor

Summary of Radiotagged Results





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Summary of Radiotagged Results

- Passage preference for evening/ early morning hours
- Site specific issues
  - Flow vectors and velocities toward intake significant
  - Racks spacing variable has not been significant
- Flow ratios significant
- Overall Safe passage should be equally considered as meeting passage objective
- Operational changes can affect passage effectiveness; seasonal specificity and time of day can reduce the cost

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