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Building a fish passage assessment protocol for New Zealand: implementation of Bayesian network models for estimating fish passage success

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Building a fish passage assessment protocol for New Zealand: implementation of Bayesian network models for estimating fish passage success

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Fish Passage 2018, Albury, 10-14 December 2018

Climate, Freshwater & Ocean Science

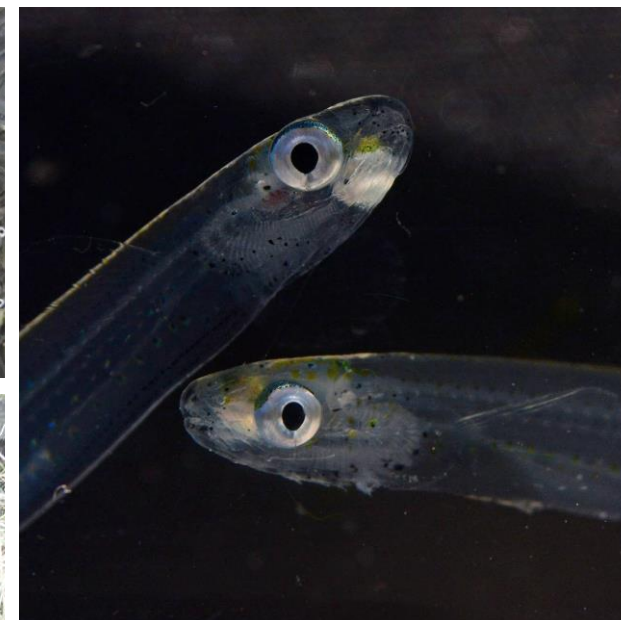


NIWA

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The problem

- Most of New Zealand's widespread native fish are diadromous
- Most undertake migrations as small juveniles
- Seemingly small structures impede passage
- We have no way of quantifying extent of impact



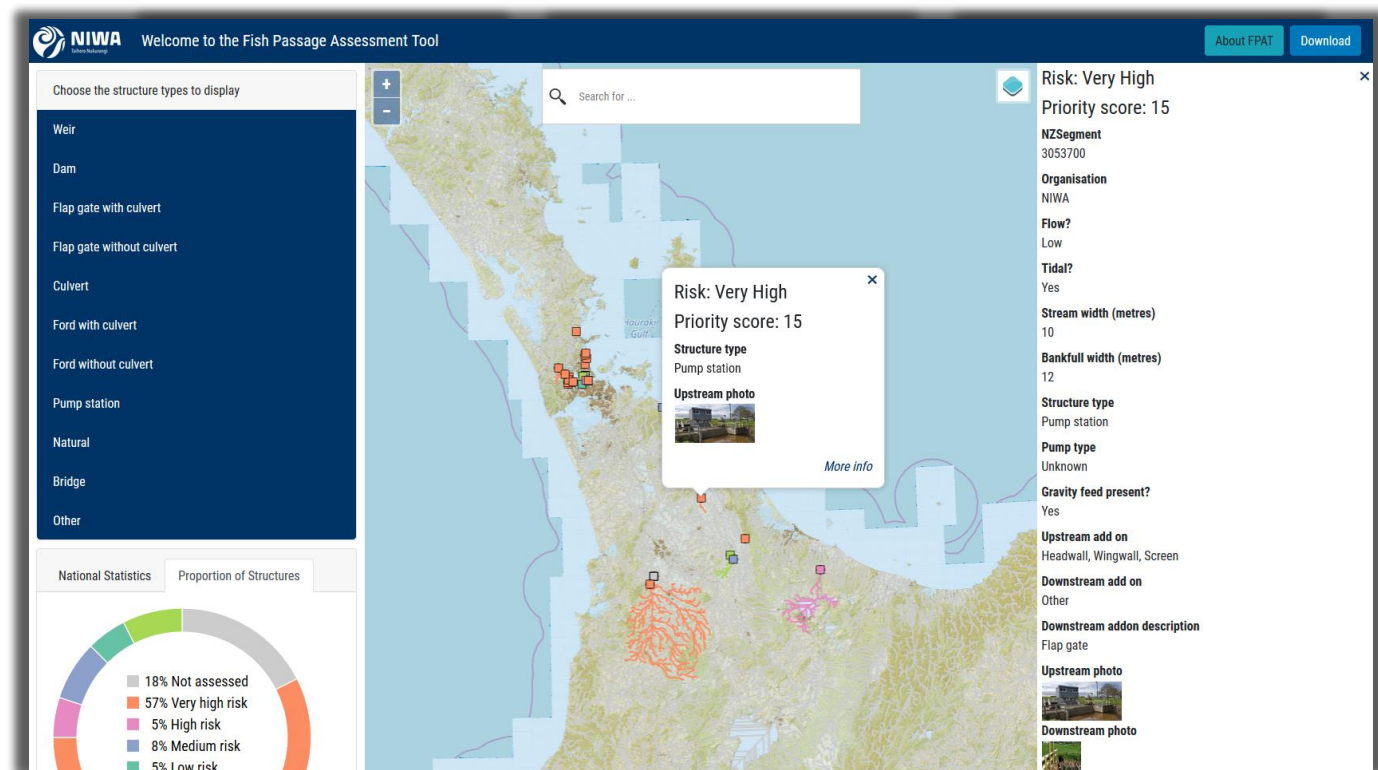
Our challenge

- Develop a tool suitable for rapid inventory and assessment of multiple instream structures
- Account for fact that many structures are partial barriers
- Provide objective way of evaluating fish passage risk



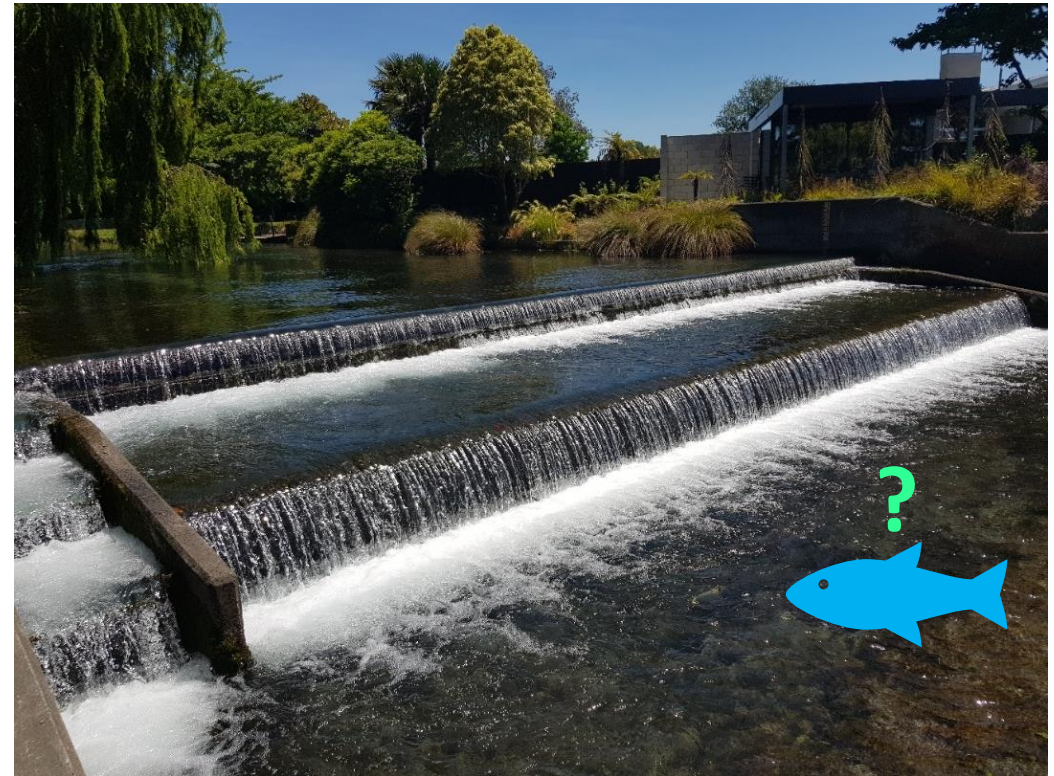
What we've done...

- New NZ Fish Passage Assessment Tool
- Implemented as mobile app
- Web page to display & download data
- Automatic risk rating for common structures
- Environmental reporting & prioritization tools



How do we assess the risk to fish passage?

- History of relying on experts to undertake visual assessments
- Not enough experts with time to assess thousands of structures!
- Few data available
- Reliance on expert knowledge
- Use Bayesian network models to take advantage of knowledge

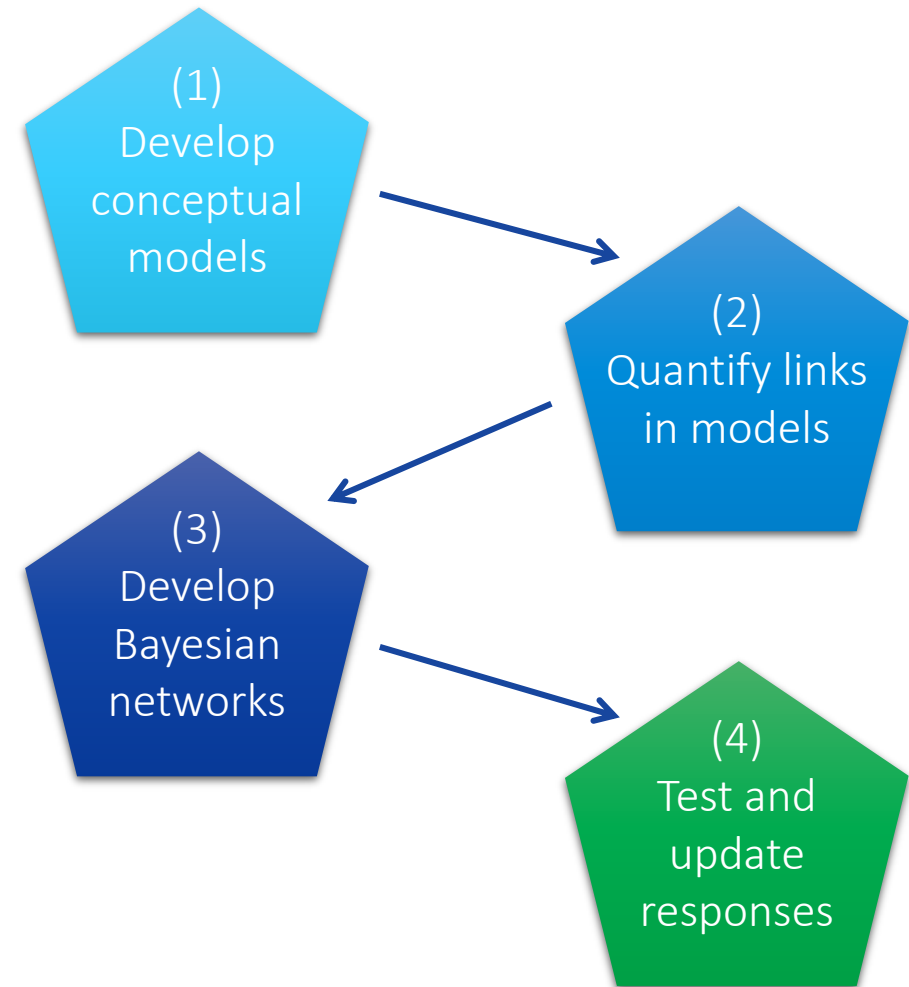


What is a Bayesian network model?

- Bayesian network (BN) models increasingly used to model environmental systems
- Probabilistic graphical models
- Effective for dealing with uncertainty & complexity
- Can integrate a range of evidence types
- Can be updated as new data or knowledge becomes available

BN model development

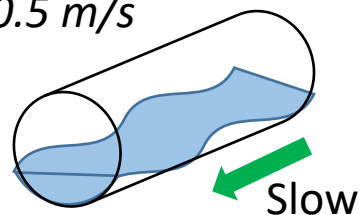
- Develop model structure from conceptual model
- Quantify conditional probabilities
- Create BN model
- Enter evidence & test response
- Validation
- Model updating



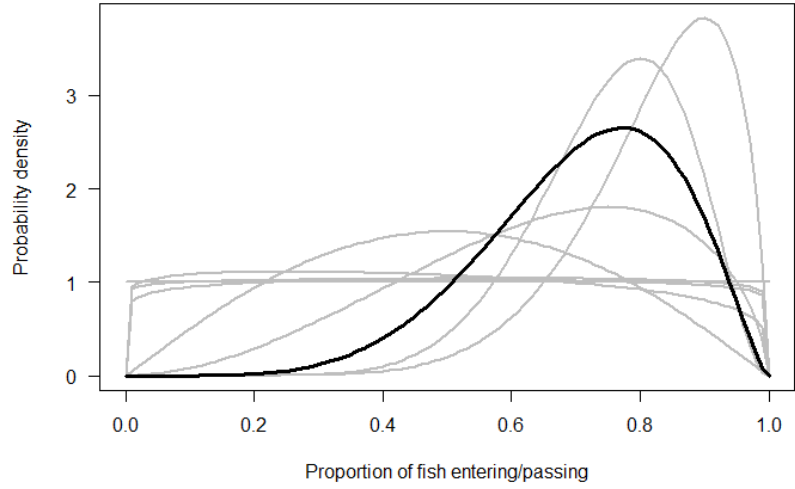
Expert elicitation

- Expert elicitation workshop held over 2 days
- Range of scenarios presented to experts
- Asked a series of questions about the probable percentage passage of juvenile fish at baseflow for each scenario
- Scenarios intentionally lacked specificity, so that the probability distributions covered the variation that might be expected in our data

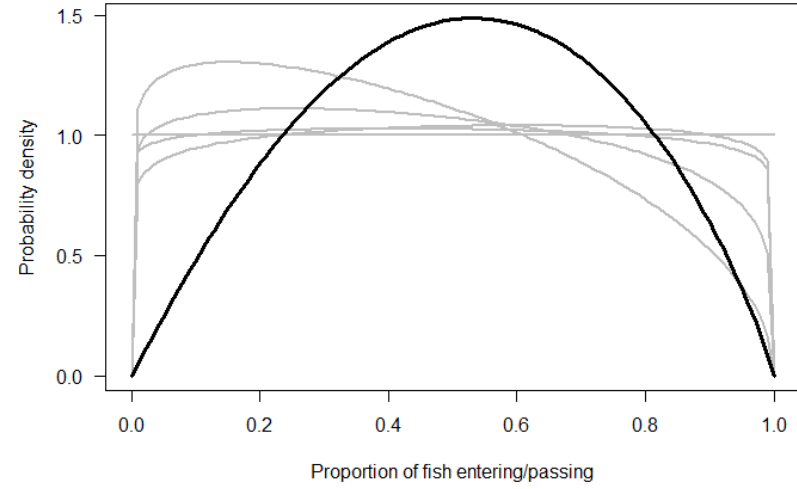
*Mean cross-sectional
velocity <math><0.5\text{ m/s}</math>*



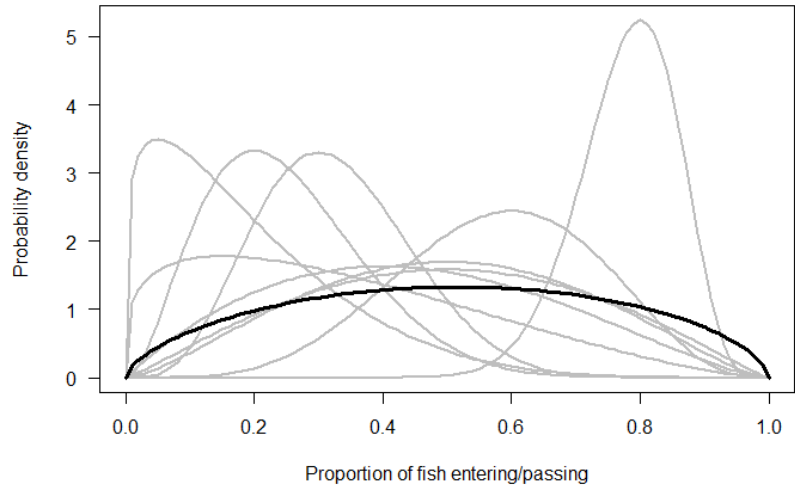
Question 16



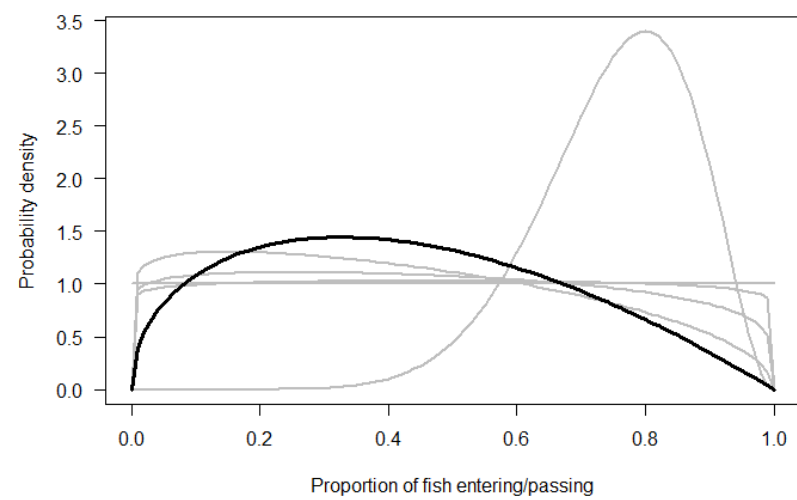
Question 21



Question 39

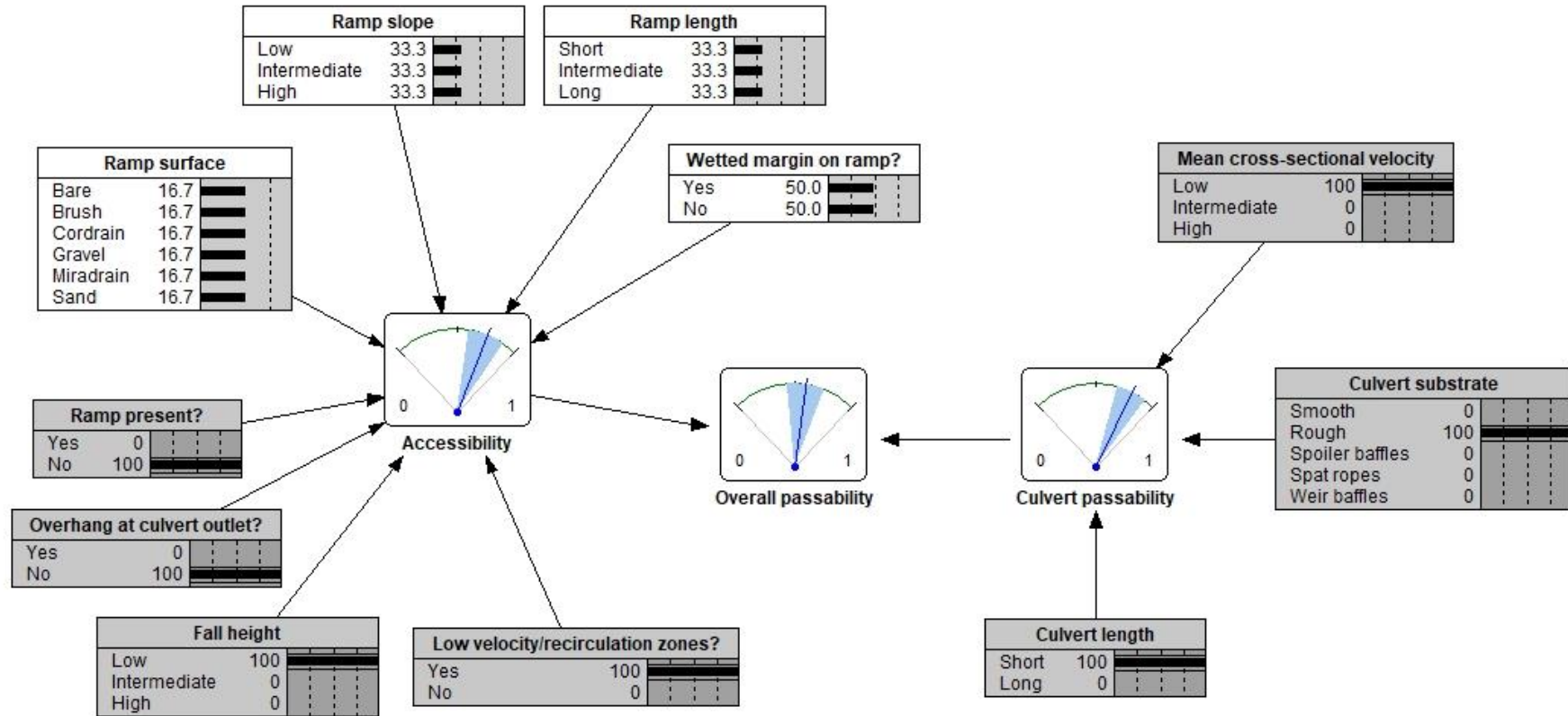


Question 23

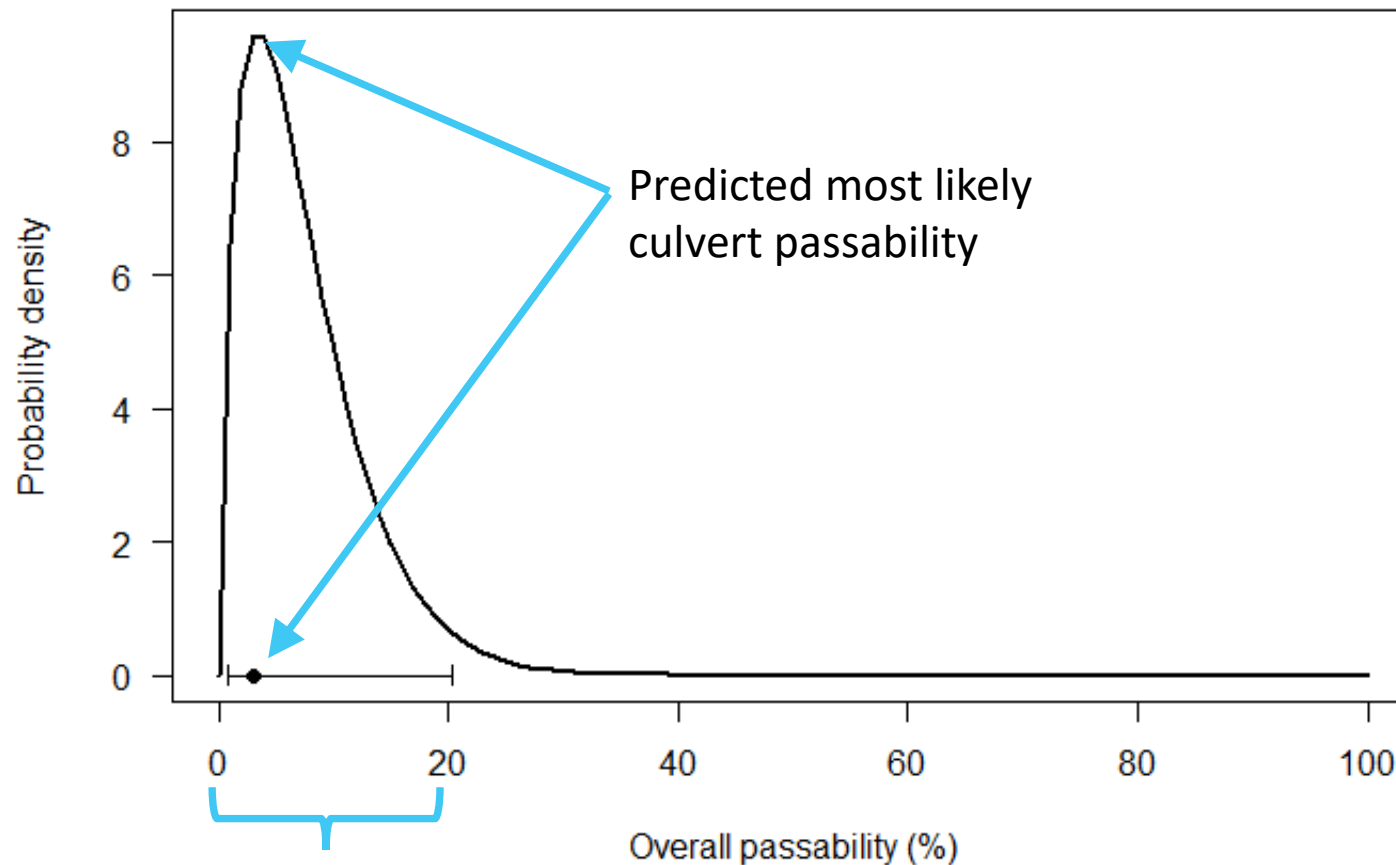


BN model

- Populate conditional probability tables & compile model
- Can then use the model to evaluate evidence

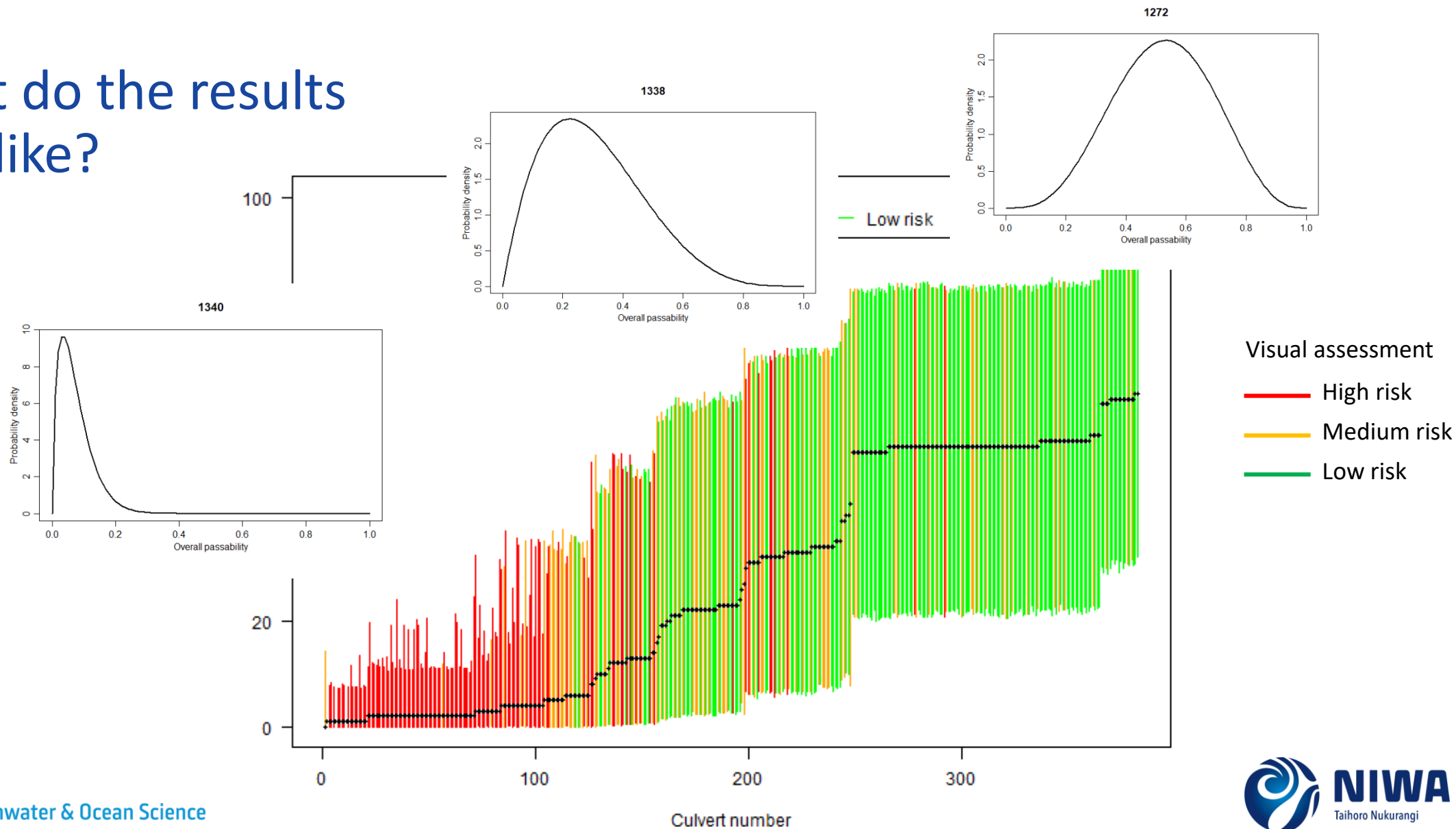


BN model outputs

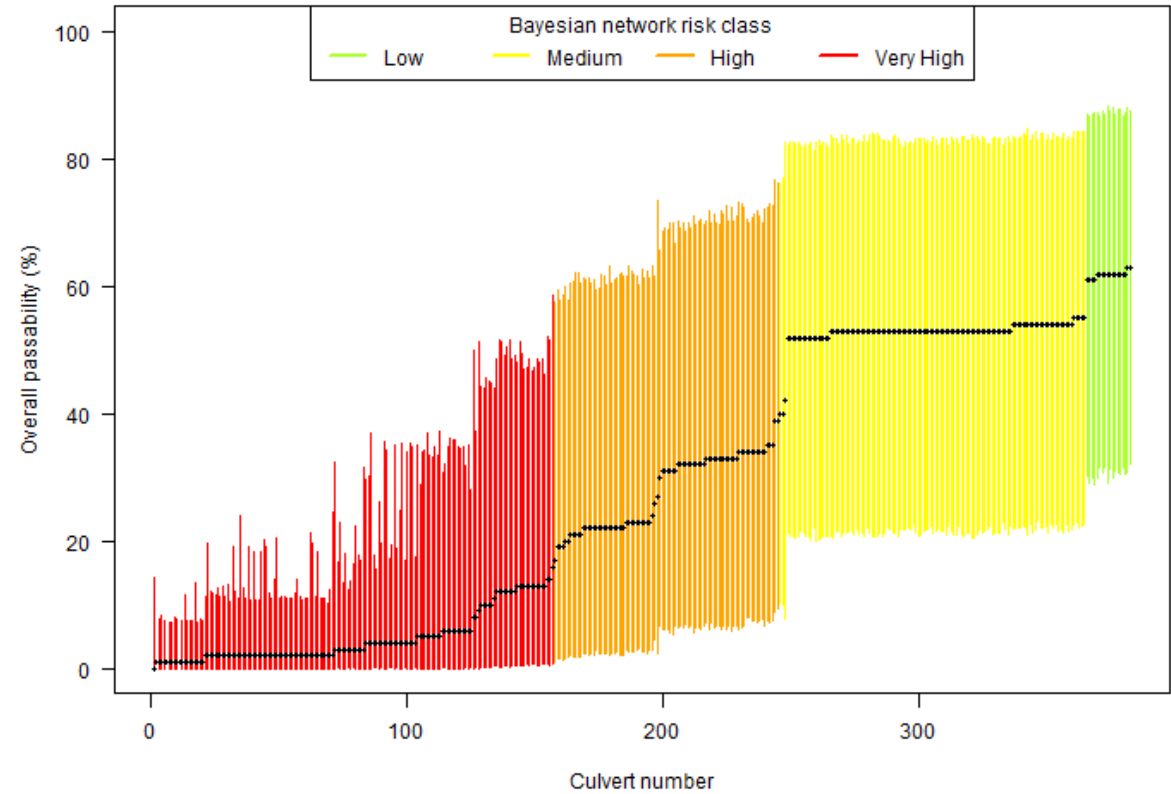
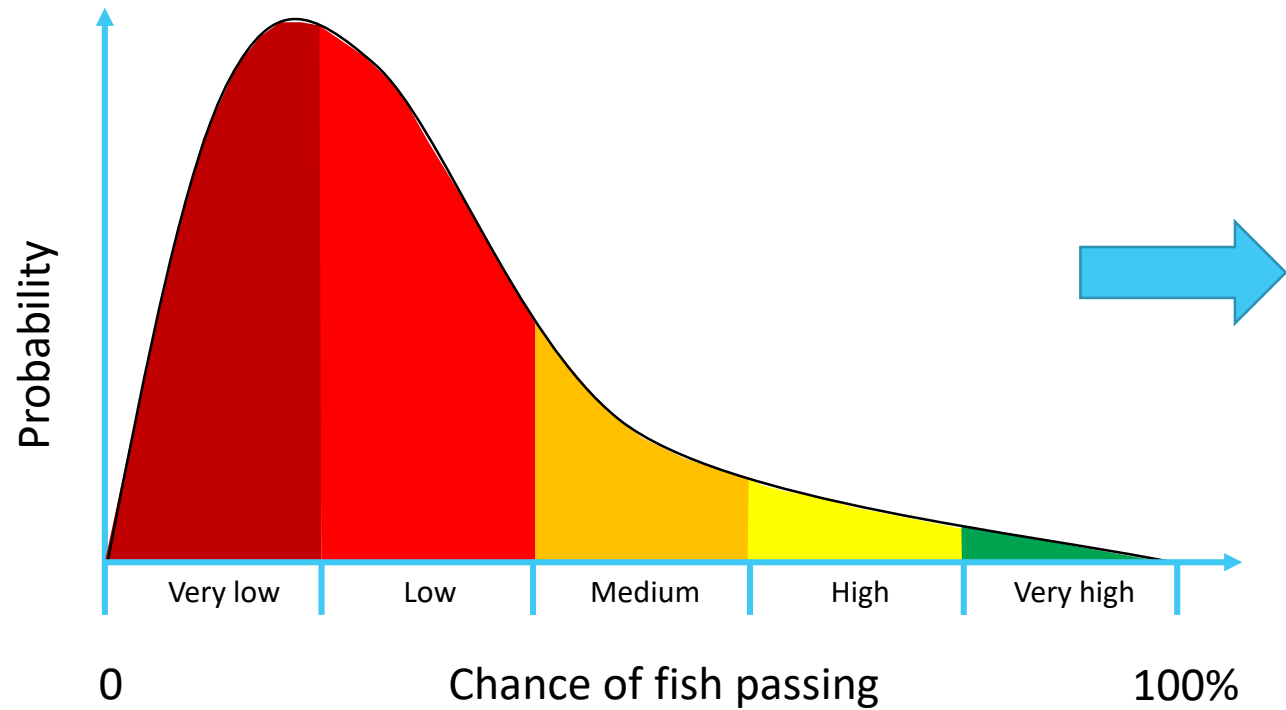


Range encompassing 95% of predicted most likely outcomes (95% highest posterior density interval)

What do the results look like?



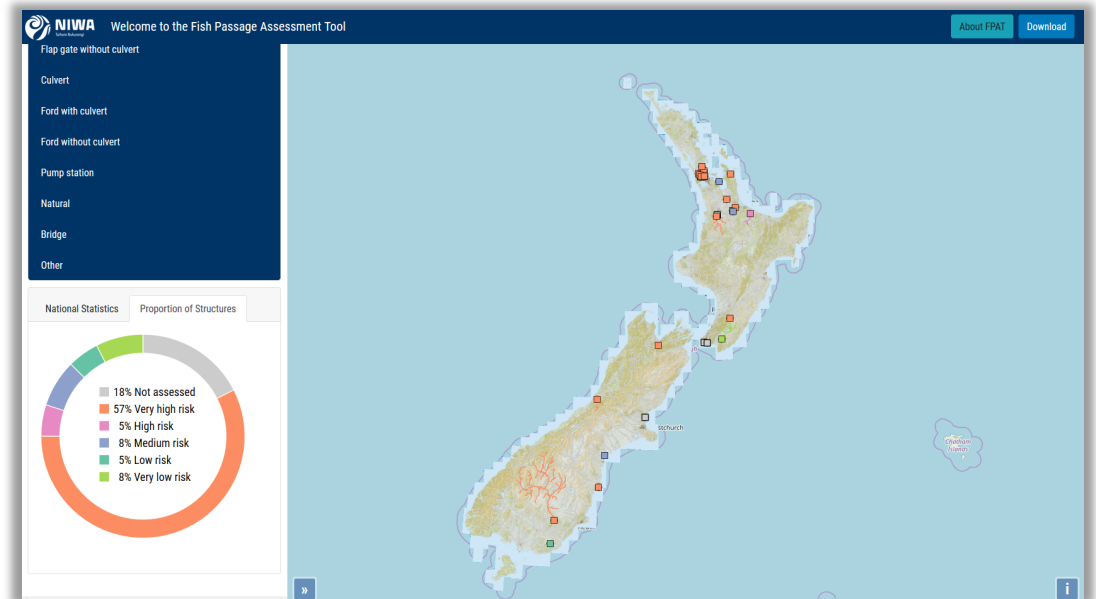
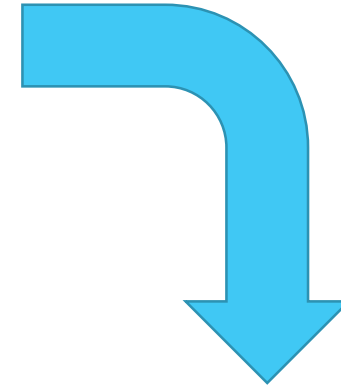
Allocating risk classes in the model



Where to from here?

- BNs offer a practical tool for integrating expert knowledge & data
- Now we have to get people to use the app!
- Can we validate the model?
- Will it help change behaviour?

The screenshot shows the 'Fish Passage Assessment' app interface on a mobile device. The title bar is dark blue with a back arrow and the text 'Fish Passage Assessment'. Below the title bar, there are several input fields: 'Location' with a coordinate field showing '-37.822072° 175.76315°' and a location icon; 'Date & time' with the value '14 Nov, 2018 15:04'; 'Previous survey point' with a text description and a square icon; 'NZSegment*' with a text description and a location pin icon; 'Organisation*' with a text description; 'Flow?*' with a dropdown menu; 'Tidal?*' with a dropdown menu; and 'Stream width (metres)*' with a text description. At the bottom, there is a navigation bar with three icons: a home icon, a square icon, and a back arrow.



Acknowledgements

We are grateful to all the experts who contributed to the expert elicitation workshop: Richard Allibone, Jacques Boubée, Bruno David, Brendan Hicks, Don Jellyman, Alton Perrie & Dave West.

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Thank you

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