High Resolution Surveying for Fish Habitat Models

Main Author:
Darren May, Environment Southland

Significant Contributions:
Lawrence Kees[1]; Michael McDonald[1]; Lucy Just[1]; Hamish Ogilvie[1]; Abbas Akbaripasand[1]; Murray Hicks[2]; Arman Haddadchi[2]; Evan Baddock[2]; Jochen Bind[2]; Jo Hoyle[2] John Hayes[3]; Ross Dungy[3]; Rasmus Gabrielsson[3]

[1]Environment Southland [2]NIWA [3]Cawthron

Introduction

Digital Terrain Models (DTM) and substrate mapping are requirements of many ecosystem and habitat models and their underpinning hydrodynamic models, but acceptable data resolution to satisfy such models can be a challenge requiring multiple angles of attack. The Net Rate Energy Intake (NREI) model pioneered by Hayes et al. and two-dimensional (2d) Weighted Usable Area (WUA) models are examples. A 1km stretch of the Oreti River, a lowland gravel bed river in Southland, was chosen for a combined NREI/2dWUA study in summer 2016. As well as data on topography and substrate, hydraulic data and measurements of benthic invertebrate and drift density were required for model calibration. Multiple techniques were employed in order to deliver these data at adequate resolution. These techniques required collaboration between organisations and individuals with various skill sets. The utilisation and coupling of a wide range of equipment was also necessary in order to achieve the best models outputs.

Dry Bank/Floodplain Bathymetry

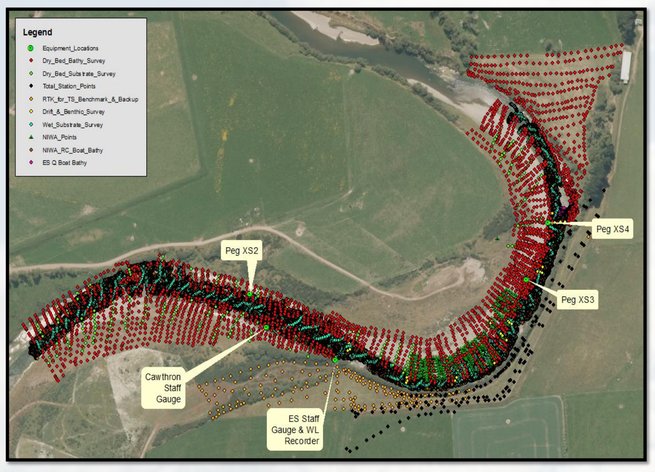
Survey Equipment
- RTK GNSS GPS
- RTK Bridge for poor cell phone reception areas

Survey Method
- Carried out on a 5x5m grid pattern
- Lateral extent of survey grid was from wading depth in-stream out to seasonal floodplain limit
- Longitudinal extent was the whole 1km stretch of the river for the study
- Orthometric height typically constrained within 30-40mm vertical error

Application Within the Model
- Used to constrain nominal lateral extent of river channel
- Boundary layer for the model

Barriers to Success
- Extremely slippery mudstone bedrock
- Poor cell phone reception for receiving positional corrections
- Complicated terrain due to vegetation growth on the floodplain
- Bank side vegetation blocking RTK GPS satellite line-of-sight

Final Survey Map



A complicated Picture

- The final survey map above represents all of the data collected over the study period within the 1km long study reach
- The data can be divided into seven categories
- The surrounding boxes offer a detailed breakdown of the data collection for each category
- This final collection of 40,000+ data points required collaboration of a number of individuals within Environment Southland and also within NIWA and Cawthron

In-Stream Bathymetry

Survey Equipment
- NIWA RC boat
- NIWA Trimble Rover & Receiver
- RTK GNSS GPS mounted on Q Boat
- RTK Bridge for poor cell phone reception
- ADCP
- Bluetooth capable laptop running WinRiver II software

Survey Method
- Continuous GPS data logging while boat in operation
- NMEA GPS stream transmitted via Bluetooth to laptop
- ADCP continuously operated and transmitted via Bluetooth to laptop
- WinRiver II software used to collate ADCP and GPS data
- Data post processed to extract ADCP depth values at each GPS point

Application Within the Model
- Defines depth of river channel helping to constrain flow

Barriers to Success
- Coupling of different hardware and enabling communication and integration
- Some areas inaccessible with boat or by wading

Dry Bank/Floodplain Bathymetry TS

Survey Equipment
- RTK GNSS GPS
- RTK Bridge for poor cell phone reception areas
- Trimble laser guided Total Station

Survey Method
- RTK used to benchmark Total Station location
- Total Station placed on raised flood bank
- Prism pole placed under vegetation to obtain xyz location not achievable by RTK

Application Within the Model
- Used to further constrain nominal lateral extent of river channel and bank height

Barriers to Success
- Maintaining laser guided line-of-sight difficult within thick bank foliage
- Steep bank a challenge to negotiate

In-Stream Substrate

Survey Equipment
- Inflatable raft
- RTK GNSS GPS
- RTK Bridge for poor cell phone reception
- Fish-Phone for under water photography
- Underwater viewer

Survey Method
- Survey carried out on 20x5m grid on an inflatable raft
- Each survey point geo-referenced with RTK GPS
- Substrate viewed and categorised by bedrock, grain size, gravel size
- Under water photo taken

Application Within the Model
- Used, along with local depth and velocity from 2d hydrodynamic model, to classify habitat suitability for mulitple taxa at base flows
- Indicates near-bed flow characteristics

Barriers to Success
- Survey grid was approximate due to drifting of raft caused by river flow
- Stabilisation of raft for setting for viewing in-stream substrate difficult especially in areas of swift flow

Dry Bank/Floodplain Substrate

Survey Equipment
- RTK GNSS GPS
- RTK Bridge for poor cell phone reception areas

Survey Method
- Carried out on a 20x5m grid pattern
- Lateral extent of survey grid was from wading depth in-stream out to seasonal floodplain limit
- Longitudinal extent was the 1km study reach
- Substrate categorised by bedrock, grain size, gravel size or vegetation

Application Within the Model
- Used, along with local depth and velocity from 2d hydrodynamic model, to classify habitat suitability for multiple taxa at high flows
- Indicates benthic flow characteristics

Barriers to Success
- Extremely slippery mudstone bedrock
- Poor cell phone reception for receiving positional corrections
- Complicated terrain due to vegetation growth on the floodplain
- Categorisation somewhat subjective

Water Level Recorder

Survey Equipment
- Water level recorder
- Flow Tracker
- Q Boat
- ADCP
- WinRiver II Software

Survey Method
- Continuous water level record for 3 month duration
- Repeated manual flow tracker gauging
- Q Boat gauging

Application Within the Model
- Produces a flow rating curve enabling the model to work at differing flow rates

Barriers to Success
- Limited gauging and flow record
- Delayed equipment removal and data download due to high autumn flows

Drift/Benthic Survey

Survey Equipment
- Drift nets
- Inflatable raft
- RTK GNSS GPS
- RTK Bridge for poor cell phone reception

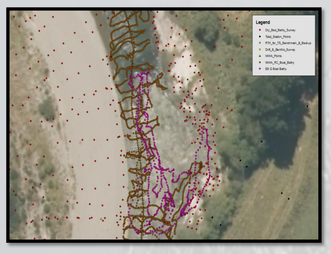
Survey Method
- Drift nets deployed at geo-referenced location in-stream
- Collected 24 hours later
- Invertebrates studied and counted

Application Within the Model
- Indicates abundance of food sources at specific locations within the study area

Barriers to Success
- Extremely slippery mudstone bedrock
- Stabilisation of raft for setting and collection of drift nets was challenging in areas of swiftly flowing water

Areas for Improvement

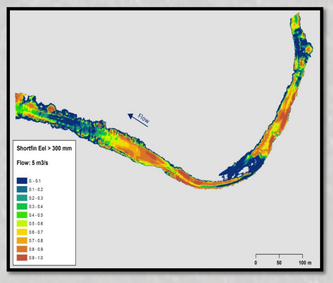
Areas Unsuccessfully Surveyed
- The picture to the right shows an area of the upper study reach that remained unsurveyed despite repeated attempts at wading and passage of the Q Boat
- Wading out to obtain bathymetry readings with the RTK was tried multiple times but ultimately was deemed too hazardous due to a combination of slippery bedrock and swift channel flows
- Some gaps were filled in with the Q Boat but pressure waves over the undulating bedrock (picture below right) put the Q Boat and attached equipment at risk and resulted in damaged steering
- A solution needs to be found in future for problem areas like this although in this case the missing bathymetry did not have a large detrimental effect on the model

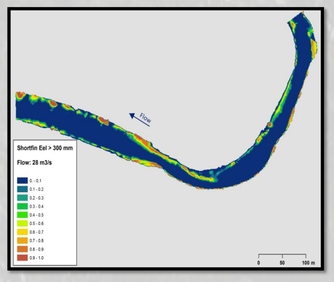


Late Recovery of Equipment
- The water level recorder was not removed until autumn by which point flows had increased markedly.
- This put the equipment at risk and made recovery difficult
- This equipment could have been removed much earlier reducing the risk to both personnel and the equipment

Extended Time to Complete Bathymetry and Substrate Surveys
- The dry bank bathymetry survey took too long to complete. The total duration for data collection was 2 to 3 months
- During this time the nature of both the bathymetry and substrate could have been drastically altered by a flood event
- For this reason the survey should have been completed within a month at most

Preliminary Model Results





Habitat Suitability

These model outputs indicate habitat suitability for different species. On the left is suitability for Shortfin Eel >300mm and on the right suitability for Adult Trout at flows of 5m^3/s (top figures) and 28m^3/s (bottom figures). Already the model indicates that Shortfin Eel are adversely affected by increasing flow velocity compared to Adult Trout.