Memo

From	**Mike Hickford and Doug Booker**
To	Ben Pasco (Aqua Intel Aotearoa)
CC	Susie Osbaldiston (NRC), Paul Murphy (GDC)
Reviewer	Kristy Hogsden
Approver	Phil Jellyman
Date	29 June 2023
Subject	Non-technical summary of high-flow harvesting reports for engagement councillors, regional planners, water stakeholders and local iwi.
Reference	Hickford, M.J.H., Booker, D.J. (2023) Non-technical summary of high-flow harvesting potential effects on in-stream values and proposed guidance for devising water allocation rules. NIWA memo to AIA-NRC-GDC-GNS.

High-flow harvesting

Competing demands for water pose a challenge for environmental managers. Using water for irrigation, industry, and domestic purposes generates important human health and economic benefits, but water abstraction also alters the magnitude and timing of river flows with potentially harmful environmental consequences.

A solution to water abstraction limitations?

High-flow harvesting involves taking water from the natural environment during times of high flows in rivers (or high groundwater levels in unconfined shallow aquifers), storing the water temporarily, and using it later. In contrast, run-of-river abstraction takes water from the natural environment, transports it to the location of use, and uses it immediately. High-flow harvesting takes water at a higher rate at higher flows for shorter periods in comparison to run-of-river abstraction. Therefore, high-flow harvesting has been proposed as a viable option for providing access to water for out-of-stream uses (e.g., irrigation) whilst reducing the risk of producing detrimental effects on in-stream values (e.g., fish) during summer low flow periods when rivers are most vulnerable to flow alteration.

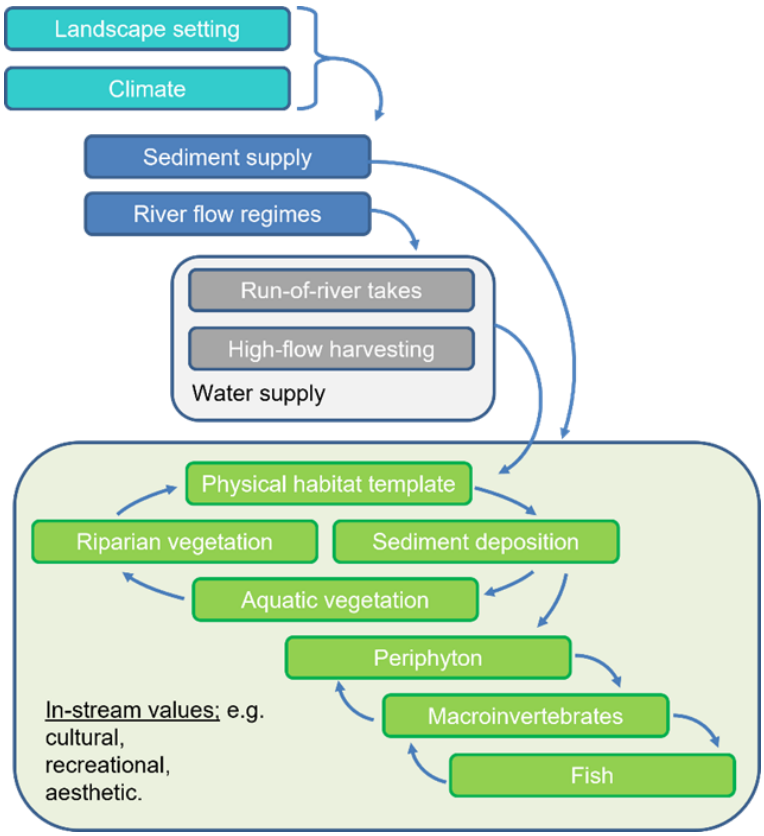
Water taken under high-flow harvesting does not have to be used immediately, therefore it may be possible to provide the same overall level of water supply as run-of-river abstraction but with less impact on in-stream values because water is only taken during higher flows. Under the right circumstances, high-flow harvesting could be consistent with the Te Mana o te Wai hierarchy of obligations within the National Policy Statement for Freshwater Management (2020) that prioritises first the health and well-being of water bodies and freshwater ecosystems, second the health needs of people, and third the ability to provide for their social, economic, and cultural well-being.

Potential impact on river ecosystem components

High-flow harvesting, and water abstraction in general, affect cultural landscapes in varying ways. Not only does abstraction of water directly impact the natural resources supporting Māori culture (e.g., mahinga kai), but it can also indirectly impact on cultural landscapes and many other aspects of Māori health and wellbeing depending on local practices and traditions of tangata whenua.

It is possible to make conceptual links between high-flow harvesting and in-stream values. However, quantifying the impact of high-flow harvesting on in-stream values is difficult because it depends on several interacting factors such as the size of the river, the characteristics of the flow regime, the size of the water storage, the level of water demand, and the nature of in-stream values.

The hydrological impacts from high-flow harvesting are determined by interactions between river flow, storage size and position, water demands, water allocation rules, and consent conditions controlling water takes. However, the general effects of high-flow harvesting on in-stream values can be viewed as an interlinked cascade.



Diagrammatic representation of how high-flow harvesting relates to various components of river ecosystems. Diagram: Doug Booker (NIWA).

High-flow harvesting may affect the shape and condition of a river's bed: high flows play a critical role in the balance between sediment supply and transport capacity (i.e., how much sand/silt gets moved downstream and whether/where it gets deposited). Riverine environments are prone to fine sediment deposition onto riverbeds when flows recede while still carrying sediment suspended in the water.

Silty-sand draping the cobbly substrate of the Rangitata River. Photo: Jo Hoyle (NIWA).

High-flow harvesting may alter a river's bankside vegetation and bank/island shape: any reductions in the magnitude or frequency of high-flow events are likely to be associated with changes in the types of shrubs and trees that grow alongside river margins, accompanied by an alteration to the shape of the river's banks and channel.

Weedy vegetation invading the margins of the Waitaki River. Photo: Jo Hoyle (NIWA).

High-flow harvesting may affect algal and macroinvertebrate communities: fewer high flows/floods can result in more algae in rivers and if there are a long periods of time between floods, then undesirable species of algae can become more prevalent, particularly during summer months. Changes in river algae can have knock-on effects for riverbed conditions and grazing macroinvertebrates which are food for fish. High-flow harvesting may directly influence macroinvertebrates by reducing their rate or reproduction or their opportunities for recolonisation of different types of river habitat.

A dense mat of filamentous green algae and diatoms forms in the Okuku River during low flows. Photo: Anika Kuczynski (NIWA).

High-flow harvesting may impact the life-cycles of fish: the life-cycles of many native fish depend on natural variability in flows and associated in-channel and flood plain habitats. High-flow harvesting may modify critical habitats (e.g., for fish spawning), alter food webs by removing essential food sources, or disrupt key migration pathways of native fish (e.g., by impacting river mouth openings).

Upland bully (*Gobiomorphus breviceps*) eggs deposited on the underside of a cobble in an area free of silt. Photo: Phil Jellyman (NIWA).

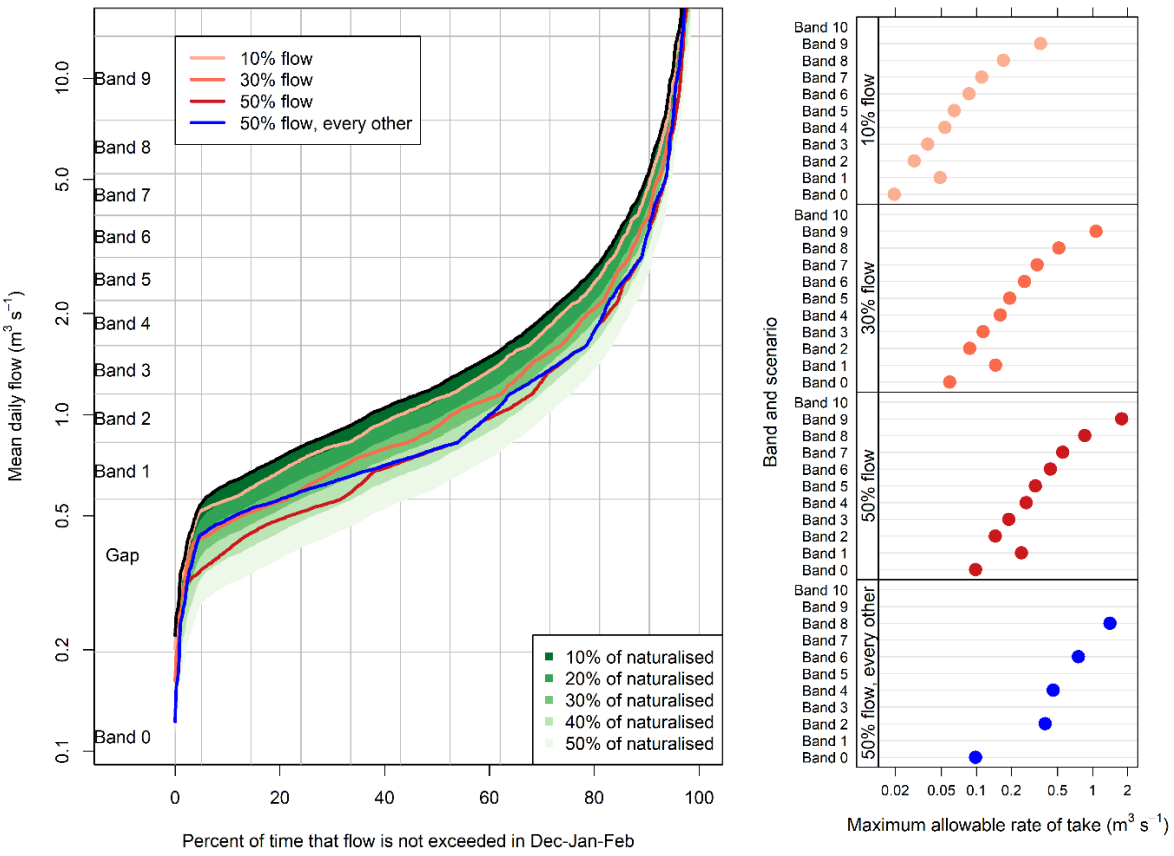
High-flow harvesting may have impacts throughout a river's catchment: the cumulative effects of high-flow harvesting may be seen most strongly in estuarine ecosystems of some catchments (ki uta ki tai), with disruptions to river shape, habitat, ecology and water quality.

***A high-flow event realigns the mouth of the Hurunui River's hāpua*.** Photo: Richard Measures (NIWA).

A new set of water allocation rules?

Rules in regional plans set water-take limits to control how much water can be taken from the natural environment and under what circumstances. These rules clarify water allocation and level of protection for in-stream values. Often these rules apply cease-to-take thresholds and maximum allowable rates of take. However, in many regions these rules do not extend to higher flows.

New high-flow harvesting rules could use a similar format to existing low flow rules. High-flow harvesting rules could use a sequence of bands that are defined by cease-to-take thresholds and maximum rates of take. The lower flow bands correspond to rules for run-of-river takes, whilst higher flow bands correspond to high-flow harvesting takes. Positioning of multiple bands relative to the flow regime at a monitored flow control site could allow higher total allowable rates of take at relatively high flow by relating hydrological alteration to river flow in a predictable way.



***The potential impacts of different water allocation rules for a small Northland river*. Deviation of summer mean daily flow from a naturalised state (left panel) is controlled by varying allowable rates of take within flow bands (right panels)** Diagram: Doug Booker (NIWA).

The position and number of bands could be adjusted to meet local needs by declining applications for consents to take water or assigning consents (or parts of consents) to different bands depending on:

- the level of current allocation for each band,
- the estimated degree of hydrological alteration,
- the estimated effects on in-stream values,
- proposed environmental flow regimes, and
- other considerations (e.g., efficient irrigation).

The National Policy Statement for Freshwater Management (2020), and particularly the principles of Te Mana o te Wai, requires that an environmentally-conservative approach is adopted. A more environmentally-conservative set of rules would be represented by setting high cease-to-take flows, low allowable rates of take, and/or choosing not to assign any consented takes to some bands.

Further information

Hickford, M.J.H, Booker, D.J., et al., (2023) High-flow harvesting Part 1: The potential effects of high-flow harvesting on in-stream values in New Zealand. Report prepared for AIA/NRC/GDC/GNS/MBIE-Envirolink. 88pp

Booker, D.J., Rajanayaka, C. (2023) High-flow harvesting Part 2: guidance for devising water allocation rules with examples from Northland and Gisborne. Report prepared for AIA/NRC/GDC/GNS. 120pp.

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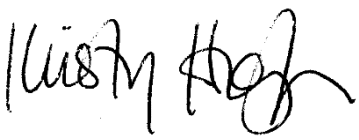
Quality Assurance Statement		
	Reviewed by:	Kristy Hogsden
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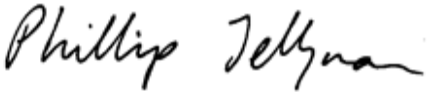	Approved for release by:	Phillip Jellyman