A SCIENTIFIC FRAMEWORK FOR SETTING FLOW AND ALLOCATION LIMITS - TAKAKA

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A BIT ABOUT ME

- PhD in River Ecology, University of Otago 1998
- Freshwater Ecologist, Cawthron Institute for last 17 years
- Coastal and Freshwater Group Manager (Freshwater)

- Provide advice to councils and other stakeholders throughout NZ
- Involved in research relating to water management

- Cobb Power Scheme re-consenting
- Motupipi water quality
- TDC surface water quality reports
- Takaka flow management framework

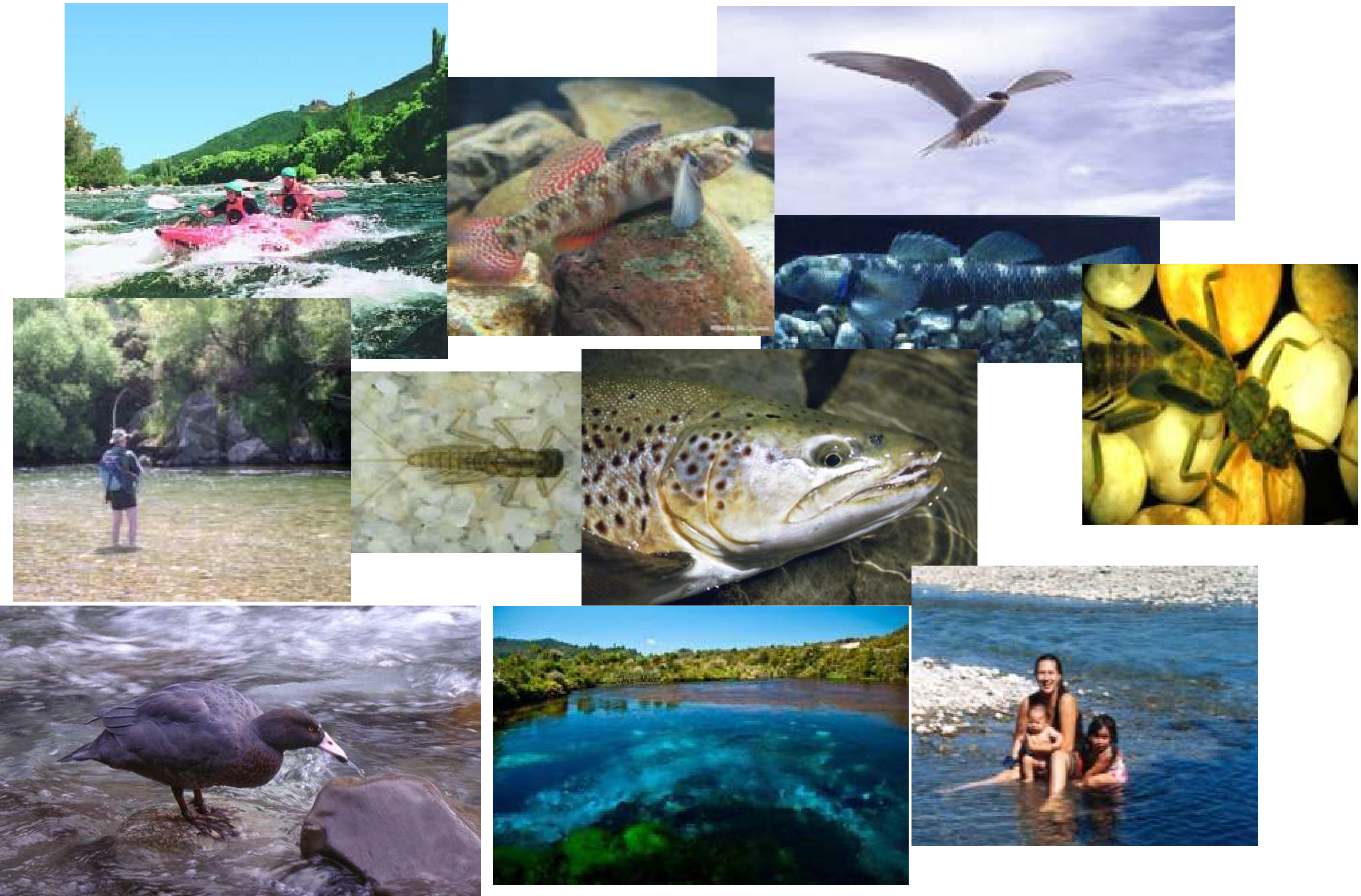
CAWTHRON INSTITUTE

DETERMINING ENVIRONMENTAL FLOW NEEDS – WHERE DO WE START?

1. Identify instream values
2. Define instream management objectives
3. Focus on critical values
    - those that have highest value and highest flow needs
    - in larger rivers these are typically salmonids and birds
4. Focus on critical flow related environmental requirements
    - physical habitat (space)
    - passage
    - food
    - water quality (temperature, oxygen, etc.)

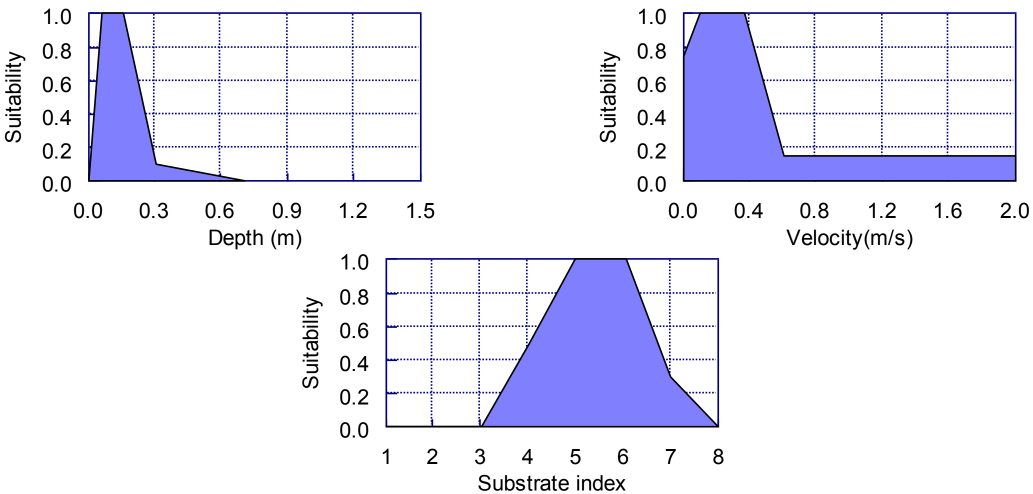
MFE 1998 - Flow Guidelines for Instream Values

INSTREAM WATER ALLOCATION GOALS



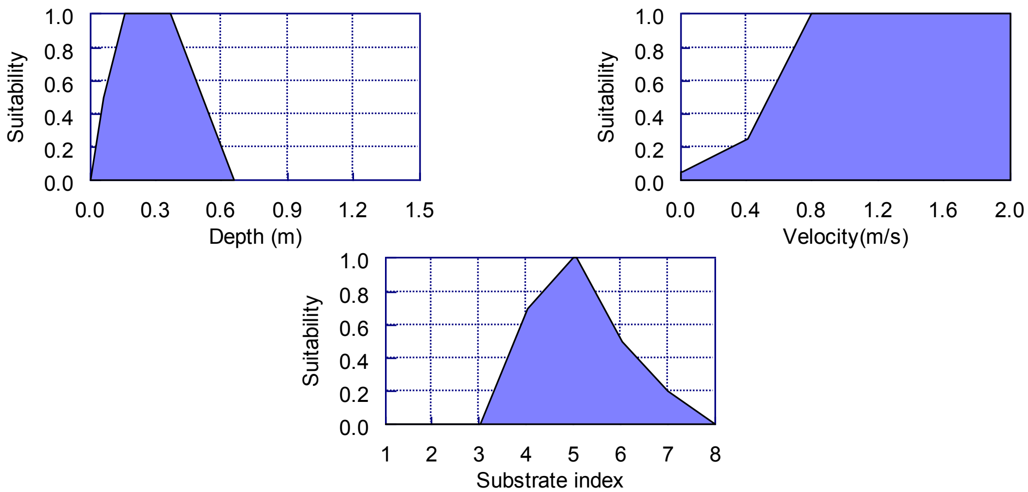
FLOW REQUIREMENTS OF DIFFERENT SPECIES

Upland bully



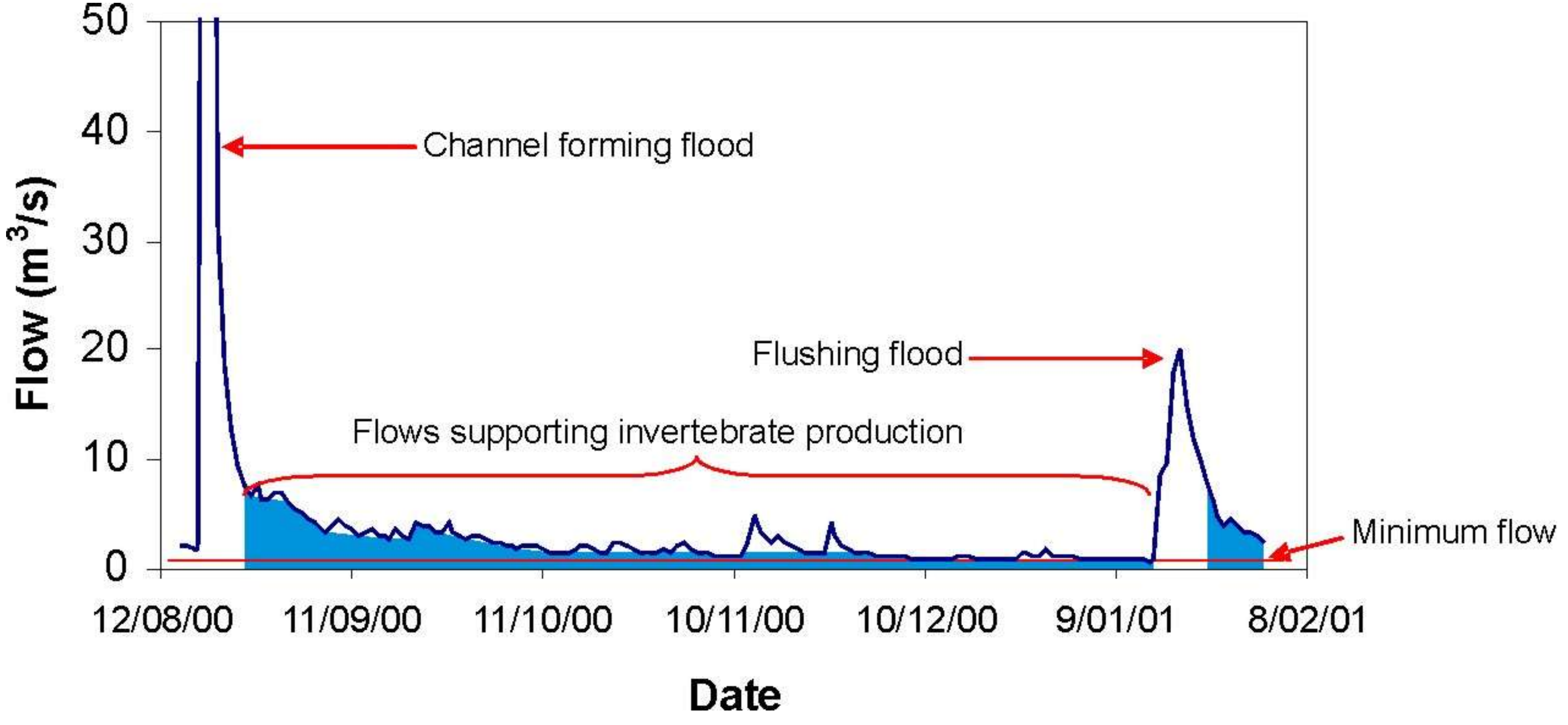
Slow water species

Torrentfish



Fast water species

WHAT FLOW FEATURES NEED ATTENTION?

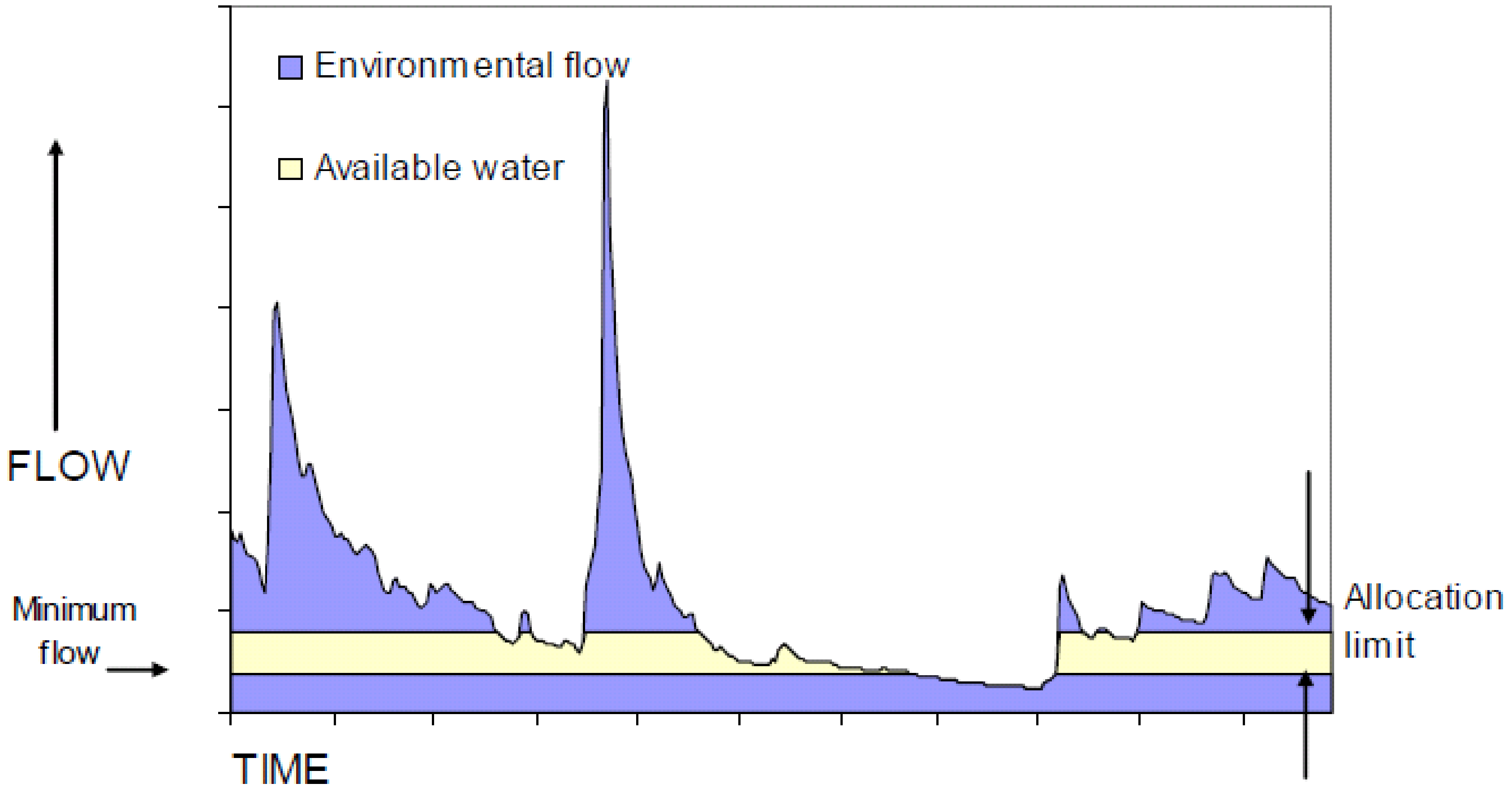


KEY COMPONENTS OF FLOW MANAGEMENT

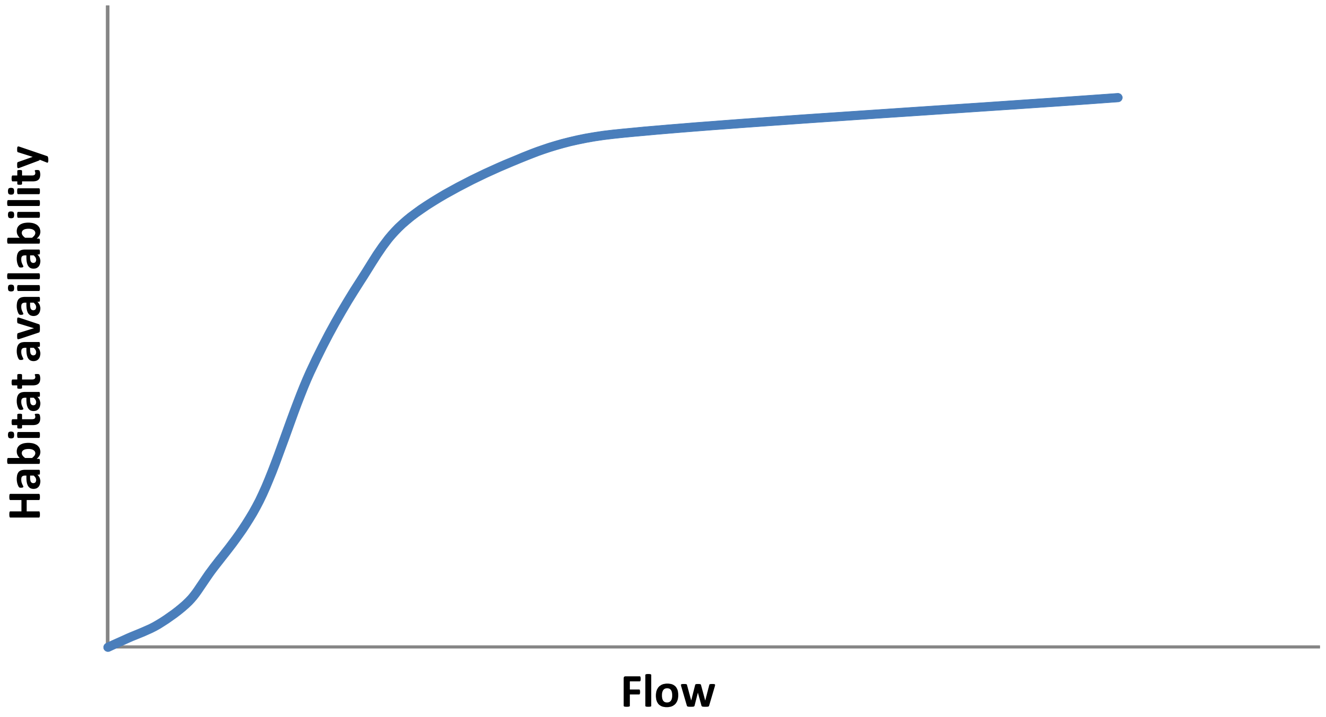
- Minimum flow is the flow at which abstraction must be restricted or cease
  - Protects instream values

- Allocation limit is the rate (or volume) that water can be extracted
  - Protects instream values by controlling length of low flow period
  - Maintains reliability of supply to abstractors

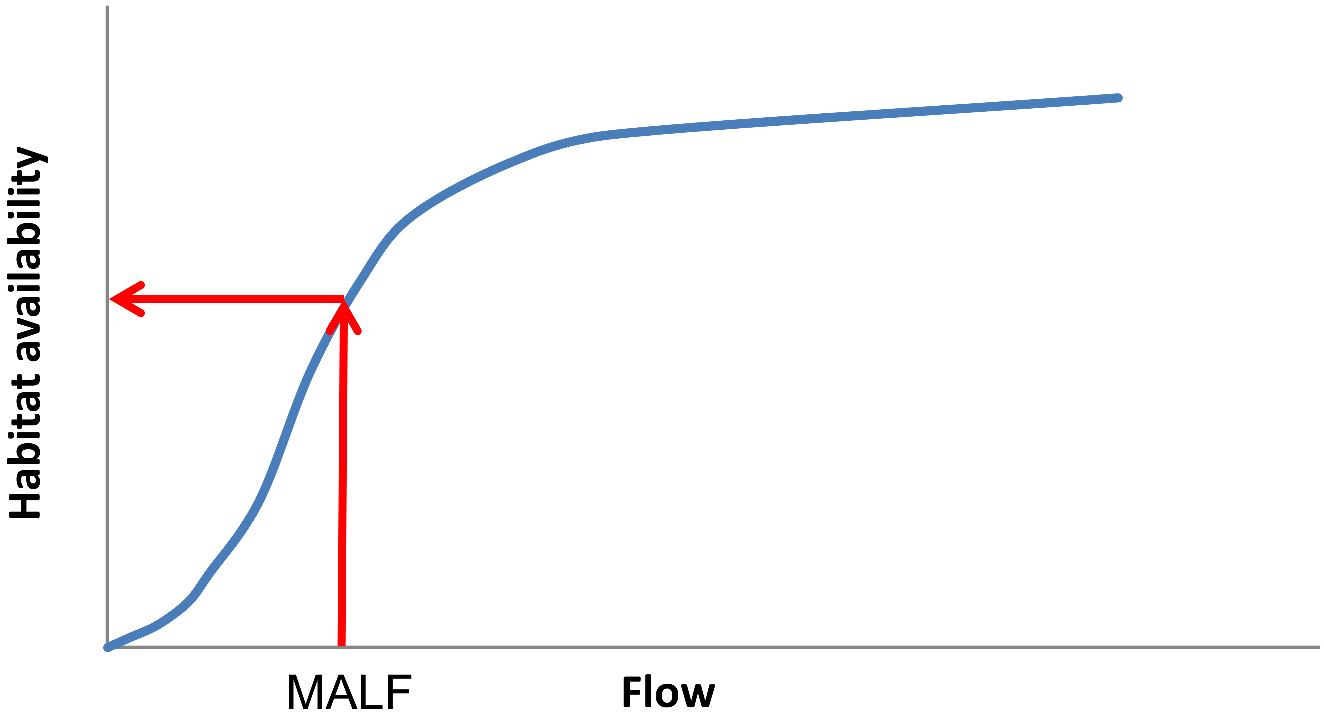
ENVIRONMENTAL FLOW REGIME



HABITAT RESPONSE TO FLOW



HABITAT RESPONSE TO FLOW



TECHNICAL ASSESSMENT METHODS

- Historic flow approaches

Assume status quo is best
Assume linear response to flow
Easily applied
Non-specific

- Generalised habitat modelling

- Hydraulic habitat modelling
- Water quality modelling
- Ecohydraulics modelling
- ++ many more

Assumes habitat (or WQ) is limiting
Non-linear flow response
Linked with specific values
Data hungry
Expensive
Controversial

TECHNICAL ASSESSMENT METHODS – VALUE AND DEMAND

Degree of hydrological alteration	Significance of instream values		
	Low	Medium	High
Low	Historical flow method Expert panel	Historical flow method Expert panel	Generalised habitat models 1D hydraulic habitat model Connectivity/fish passage Flow duration analysis
Medium	Historical flow method Expert panel Generalised habitat models	Generalised habitat models 1D hydraulic habitat model Connectivity/fish passage	1D hydraulic habitat model 2D hydraulic habitat model Dissolved oxygen model Temperature models Suspended sediment Fish bioenergetics model Groundwater model Seston flux Connectivity/fish passage Flow variability analysis
High	Generalised habitat models 1D hydraulic habitat model Connectivity/fish passage Periphyton biomass model	Entrainment model 1D hydraulic habitat model 2D hydraulic habitat model Bank stability Dissolved oxygen model Temperature models Suspended sediment Fish bioenergetics model Inundation modelling Groundwater model Seston flux Connectivity/fish passage Periphyton biomass model	Entrainment model 1D hydraulic habitat model 2D hydraulic habitat model Bank stability Dissolved oxygen model Temperature models Suspended sediment Fish bioenergetics model Inundation modelling Groundwater model Seston flux Connectivity/fish passage Periphyton biomass model Flow variability analysis

PROTECTION LEVELS

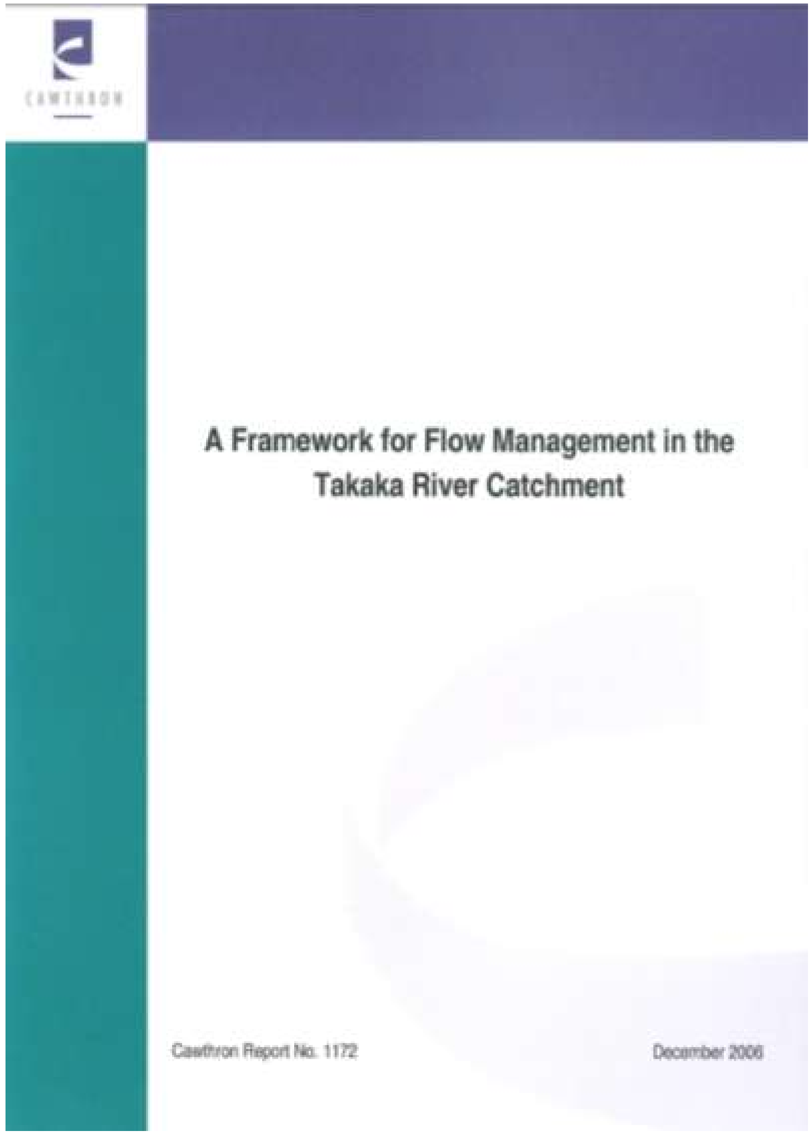
- Risk management
- High value then accept minimal risk
  - minimum flow provides 90-100% habitat retention at naturalised MALF
  - allocation limit 10-20% of MALF
- Lower value then accept more risk
  - minimum flow provides 60-80% habitat retention at naturalised MALF
  - allocation limit 30-50% of MALF

APPROACHES IN OTHER REGIONS

- Historical flow methods to guide broad-scale flow management decisions
- Detailed instream habitat analysis for rivers with very high values and/or large flow alteration
- Protection levels based on risk assessment
- Allocation limits set based on security of supply

Critical value	**% habitat retention**
Large adult trout – perennial fishery	90
Diadromous galaxiid	90
Non-diadromous galaxiid	80
Trout spawning/juvenile rearing	70
Redfin/common bully	60

CLASSIFICATION OF TAKAKA WATERBODIES 2006

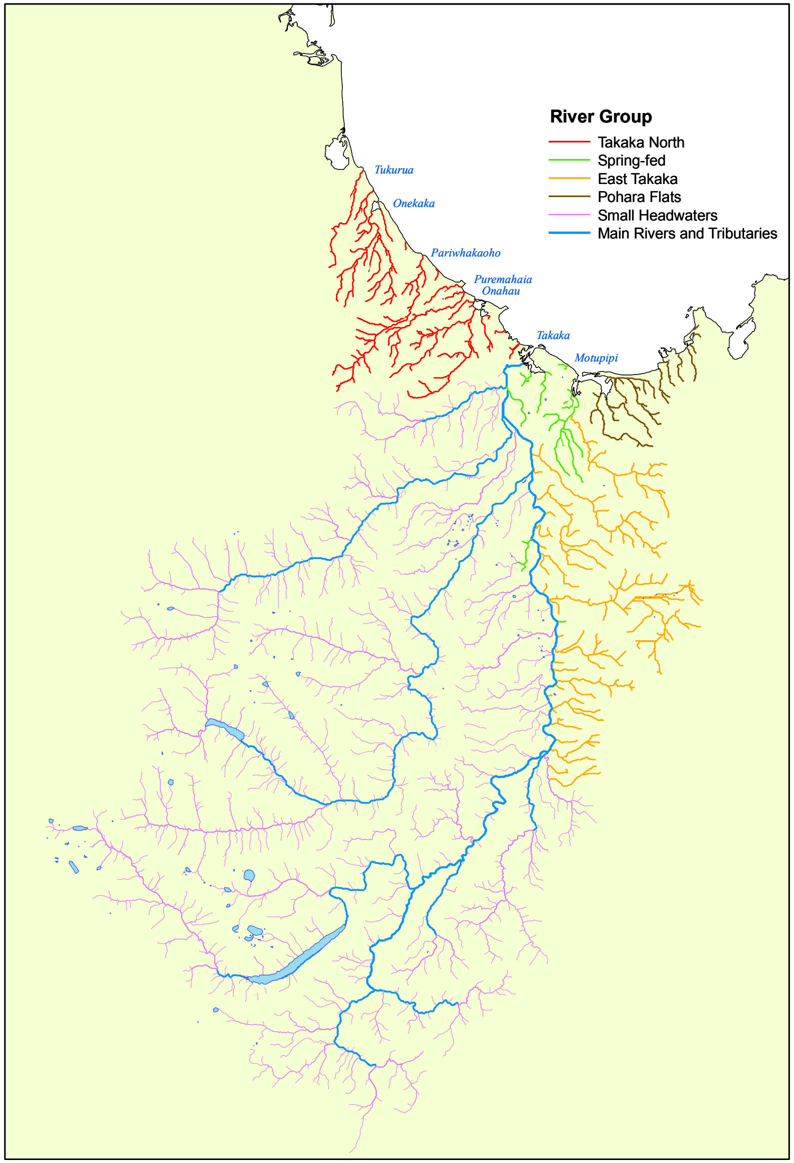

CAWTHRON

A Framework for Flow Management in the Takaka River Catchment

Cawthron Report No. 1172

December 2006

CLASSIFICATION OF TAKAKA WATERBODIES 2006



CLASSIFICATION OF TAKAKA WATERBODIES 2006

River group

	Takaka North Rivers *Tukurua, Onekaka, Pariwhakaoho, Puremahaia, Onahau*	Springfed Rivers *Motupipi,Te Kakau, Wai Tapu, East Takaka Springs, Spring Brook, Spittals*	East Takaka Streams *Gorge, Ironstone, Rameka, Scott, Dry*	Pohara Flats *Kite Te Tahu, Gibson, Ellis, Winter*	Small Headwater Streams *Tributaries of Anatoki, Waingaro, Takaka and Cobb*	Major Rivers and their Tribs *Waikoropupu, Takaka, Anatoki, Waingaro, Cobb*
Typical Instream Values	Eel Migratory galaxiids (including shortjaw and giant kokopu) Redfin/Common bully Lamprey Torrentfish Koura Trout (Onekaka only) Absence of trout Whitebaiting/Eeling Native biodiversity Landscape values	Eel Migratory galaxiids Redfin/Common/ Giant bully Koura Bird habitat Customary values Watercress Whitebaiting/Eeling Native biodiversity Landscape values	Eel (lower reaches) Koaro (upper reaches) Trout spawning/rearing (lower reaches) Native biodiversity Landscape values	Eel Migratory galaxiids (including giant kokopu) Redfin bully Torrentfish Koura Whitebaiting/Eeling Native biodiversity	Eel Koaro Upland bully (upper Takaka) Redfin bully (lower Anatoki tribs) Koura Trout spawning/rearing Native biodiversity Landscape values	Eel Migratory galaxiids (including giant kokopu) Common/Redfin bully (lower reaches) Upland bully Lamprey Torrentfish Koura Large adult trout Trout spawning/rearing Bird habitat and corridor Customary values Whitebaiting/Angling/Eeling Kayaking/Rafting/Swimming Landscape values
Instream Management Objective	Maintain available natural habitat to sustain the diverse native fish community	Protect groundwater recharge, spring flows and water quality	Protect groundwater recharge, maintain natural frequency and duration of drying	Maintain available natural habitat to sustain the diverse native fish community	Maintain available natural habitat for trout spawning/rearing	Maintain available natural habitat to sustain a productive trout fishery
Critical Value	Torrentfish	Native biodiversity	Landscape values	Migratory galaxiids	Trout spawning/rearing	Large adult trout
Critical Factors	Torrentfish habitat	Minimum dissolved oxygen concentration	Duration and frequency of drying	Migratory galaxiids habitat	Trout spawning/rearing habitat	Large adult trout habitat
Protection level	High (90% retention of habitat at natural MALF)	Medium (Maintain minimum dissolved oxygen above critical levels)	Low (<20% change in duration and frequency of drying)	Medium (70% retention of habitat at natural MALF)	Medium (70% retention of habitat at natural MALF)	High (90% retention of habitat at natural MALF)
Likely Demand	Medium	High	Low	Medium	Low	High
Technical method	Detailed instream habitat analysis and models, or set minimum flow at MALF	Water quality modelling and Surface/Groundwater model	Hydrological analysis	Generalised habitat models	Generalised habitat models	Detailed instream habitat analysis and models

Aligns with FLAG objectives

CLASSIFICATION OF TAKAKA WATERBODIES - UPDATED

- Values
- Current and likely water demand
- Measurement points

- Coastal rivers (Takaka North plus Wainui)
- Waingaro
- Anatoki
- Upper Takaka
- Motupipi
- Te Waikoropupu
- Pohara Flats/Clifton

TAKAKA WATER MANAGEMENT ZONES

OTHER CONSIDERATIONS

- Minimum flow equals cease take
- Security of supply
- Restriction trigger and number of steps
- Flow statistics – 7Day or 1Day

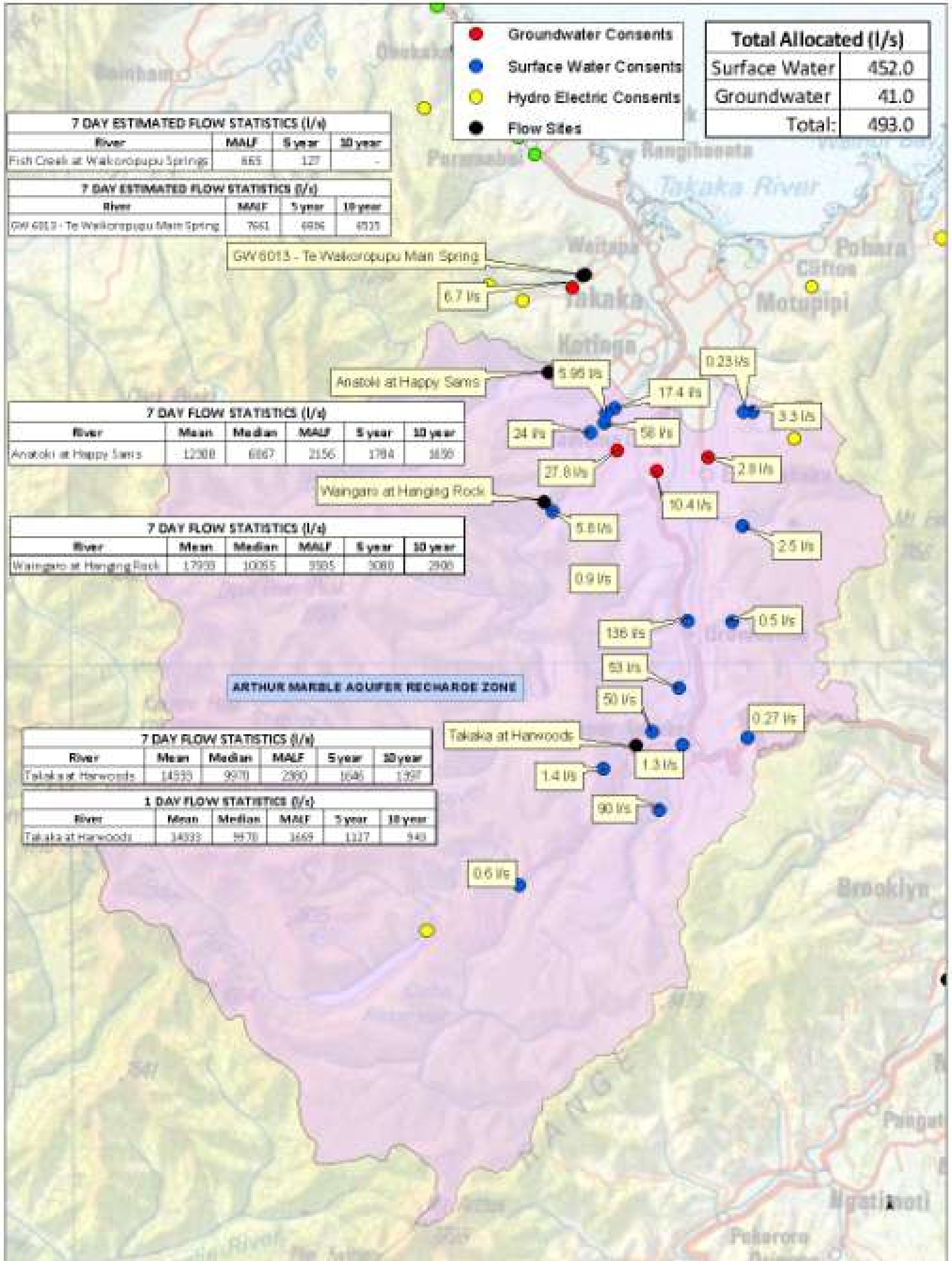
RECOMMENDED FRAMEWORK

- Historical flow approach across all classes
- Minimum flow equals % of naturalised 7Day MALF
    - High value sites 90-100%
    - Lower value sites 70-80%
- Allocation limit equals % of 7Day MALF
    - High value sites 10-20%
    - Lower value sites 30-50%
- Minimum flow equals cease take
- 50% allocation rationing trigger only in Anatoki and Waingaro
  applied when flow equals minimum flow plus allocation limit

DISCUSSION/QUESTIONS

UPPER TAKAKA/ ARTHUR MARBLE AQUIFER

Arthur Marble Aquifer Recharge Zone
Consents & Flow Statistics



Total Allocated (l/s)	
Surface Water	452.0
Groundwater	41.0
Total:	493.0

7 DAY ESTIMATED FLOW STATISTICS (l/s)

River	MALF	5 year	10 year
Fish Creek at Waikoropupu Springs	665	127	-

7 DAY ESTIMATED FLOW STATISTICS (l/s)

River	MALF	5 year	10 year
GW 6013 - Te Waikoropupu Main Spring	7661	6906	6515

7 DAY FLOW STATISTICS (l/s)

River	Mean	Median	MALF	5 year	10 year
Anatoki at Happy Sams	12308	6867	2156	1784	1659

7 DAY FLOW STATISTICS (l/s)

River	Mean	Median	MALF	5 year	10 year
Waingaro at Hanging Rock	17933	10055	9385	3080	2906

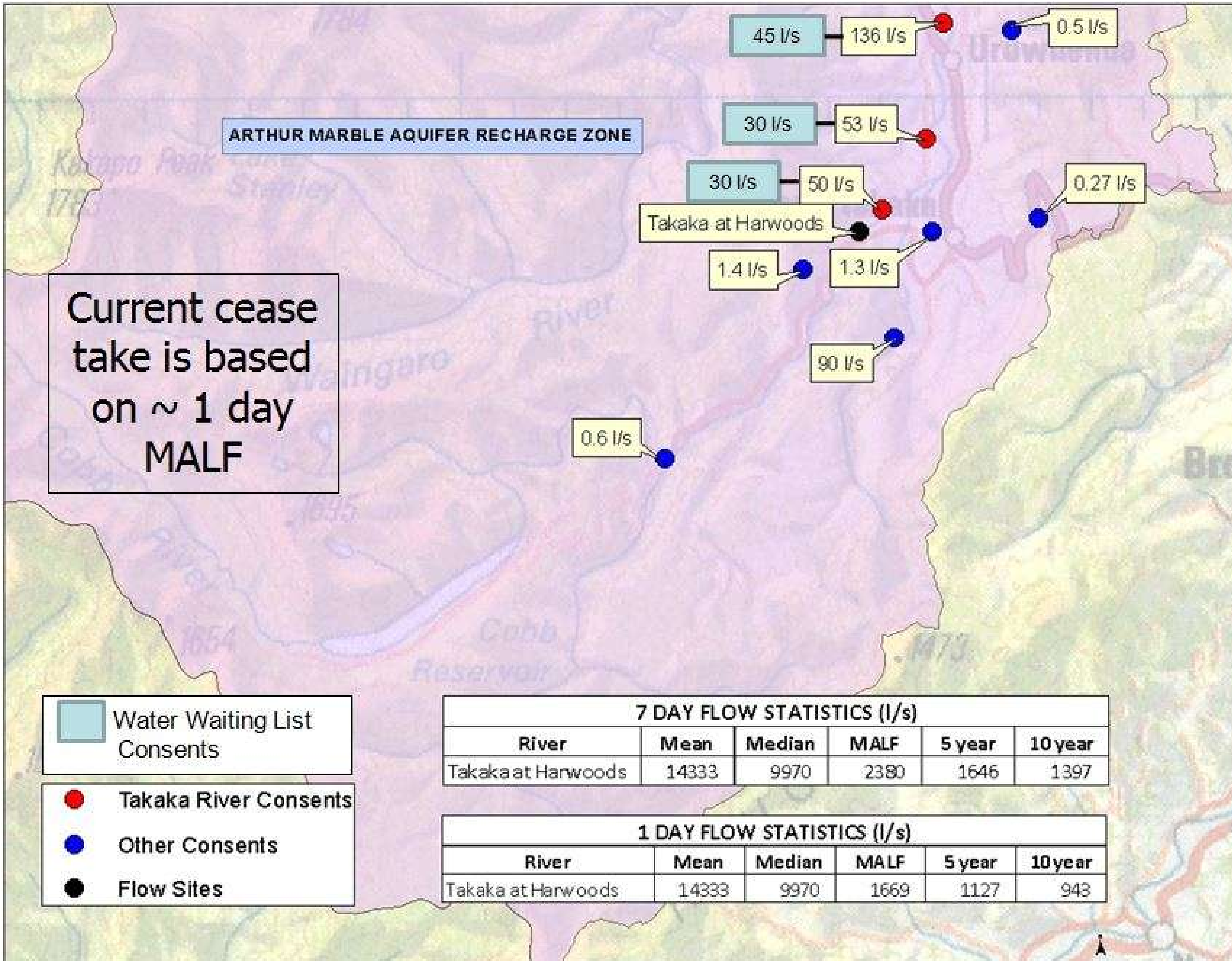
7 DAY FLOW STATISTICS (l/s)

River	Mean	Median	MALF	5 year	10 year
Takaka at Harwoods	14933	9970	2980	1646	1397

1 DAY FLOW STATISTICS (l/s)

River	Mean	Median	MALF	5 year	10 year
Takaka at Harwoods	14933	9970	1669	1117	940

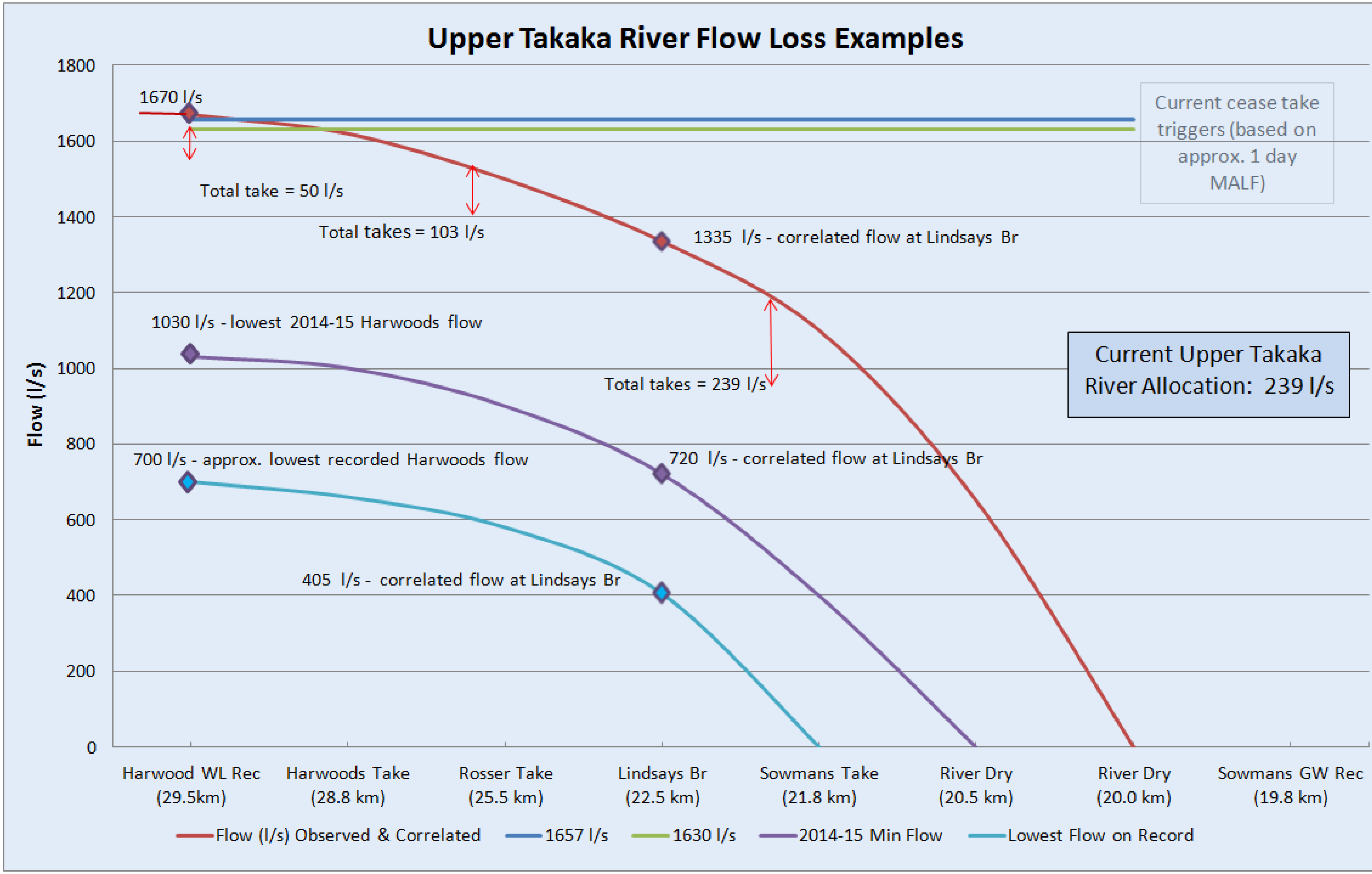
Current Water Take Consents



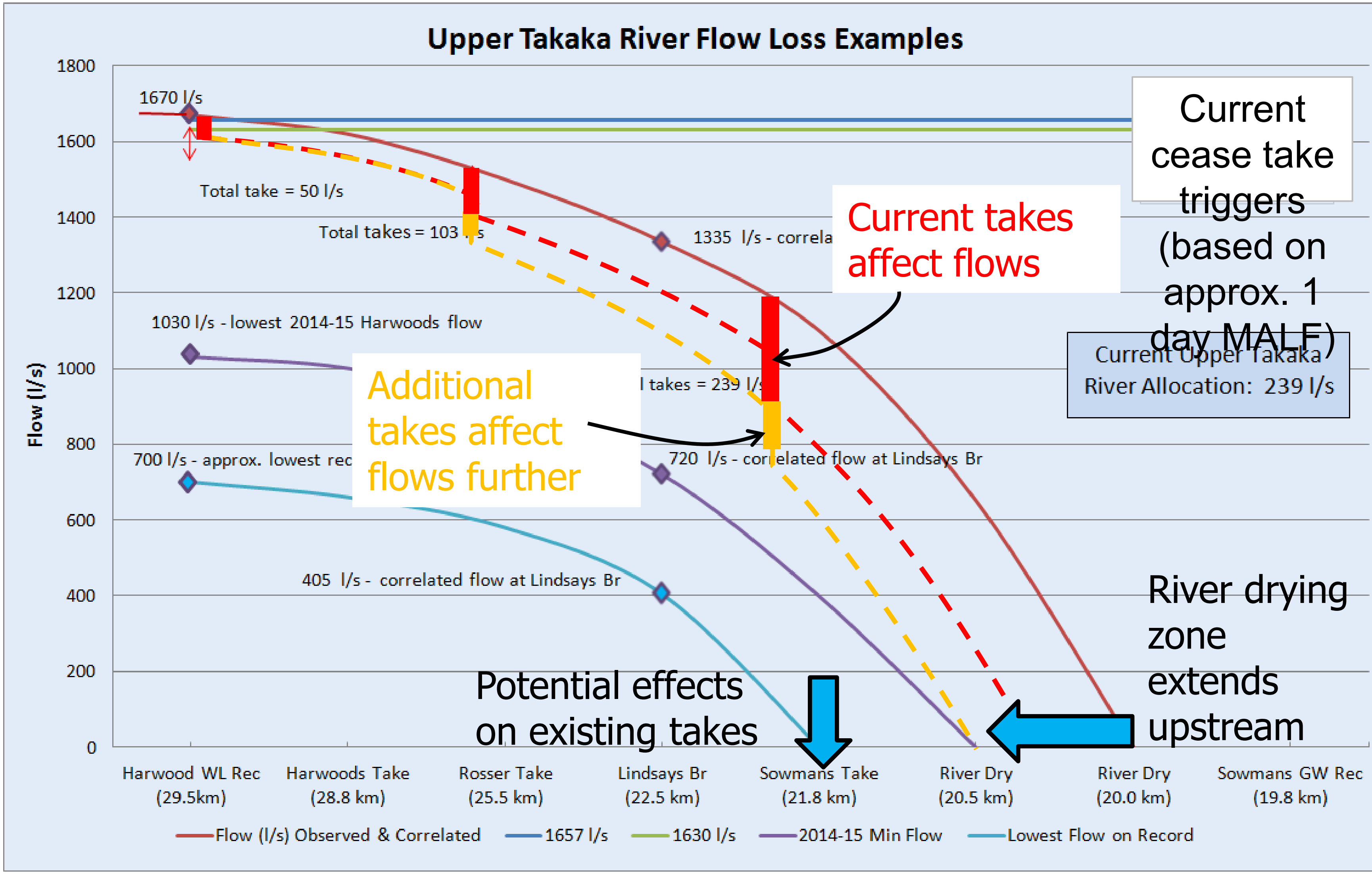
7 DAY FLOW STATISTICS (l/s)					
River	Mean	Median	MALF	5 year	10 year
Takaka at Harwoods	14333	9970	2380	1646	1397

1 DAY FLOW STATISTICS (l/s)					
River	Mean	Median	MALF	5 year	10 year
Takaka at Harwoods	14333	9970	1669	1127	943

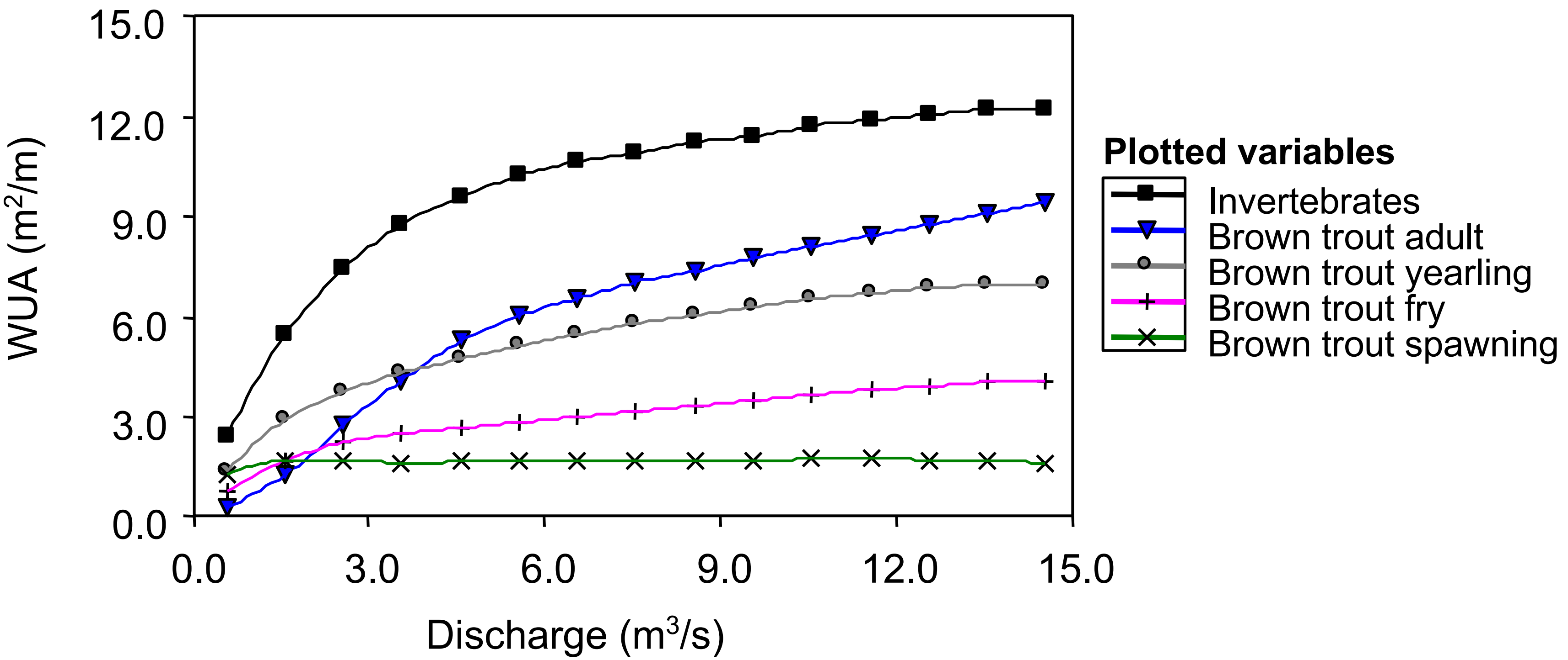
LOSSES TO GROUNDWATER



LOSSES TO GROUNDWATER



HABITAT VERSUS FLOW MODEL – HARWOODS REACH



UPPER TAKAKA

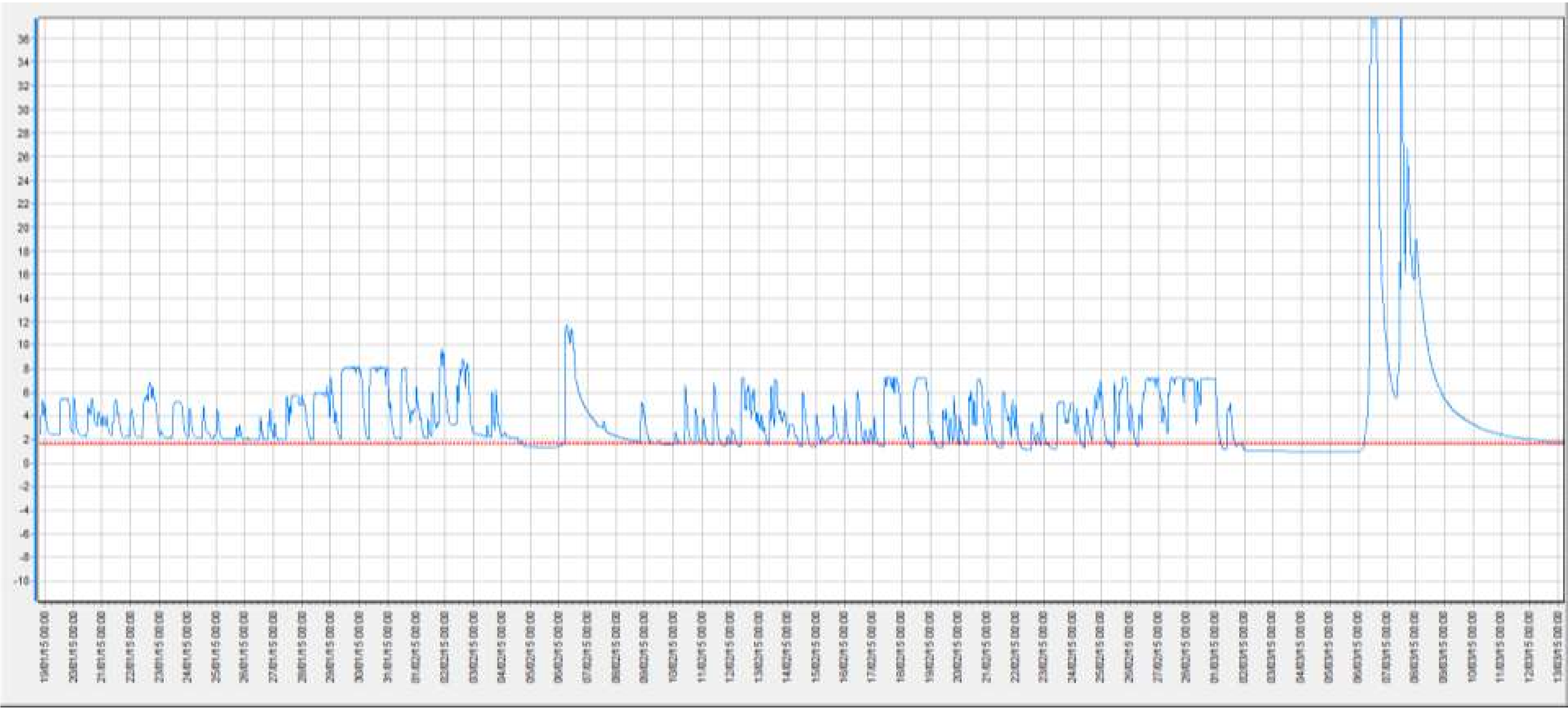
- Upper Takaka class
- Moderate ecological values
- Significant loss to Marble Aquifer (up to 100%)
- Significant contribution to Te Waikoropupu (45%)
- Relatively high mean flow (14 m^3/s)
- 239 l/s of current takes
- Further demand
- Current minimum flow (cease take) = 1657 l/s (70% 7 Day MALF)

- Minimum flow = 70-80% of 7 Day MALF
- Allocation limit = 20-30% of 7 Day MALF
- Minimum flow = cease take
- No rationing trigger

- Minimum flows and abstraction based on flows at Takaka at Harwoods

FLUCTUATING FLOWS – COBB POWER SCHEME

- Frequent fluctuations of 6-7 m^3/s related to power scheme generation



UPPER TAKAKA– SECURITY OF SUPPLY

Flow statistic	Flow (l/s)	Average number of days below this flow per year
7Day MALF	2380	
70% 7Day MALF	1666	8
70% 7Day MALF + 10% allocation	1904	12
70% 7Day MALF + 20% allocation	2142	16

UPPER TAKAKA – SECURITY OF SUPPLY

Flow statistic	Flow (l/s)	Average number of days below this flow per year
7Day MALF	2380	
70% 7Day MALF	1666	8
70% 7Day MALF + 10% allocation	1904	12
70% 7Day MALF + 20% allocation	2142	16

UPPER TAKAKA - OPTIONS

- Minimum flow = 1666 l/s (70% of 7Day MALF at Harwoods)
- Allocation limit = 476 l/s (20% of 7Day MALF at Harwoods)

- Cease take at 2142 l/s
- Expect cease take for 16 days per year

- But…..increased allocation may affect Marble Aquifer
- ……..large frequent fluctuations from Cobb Power Station

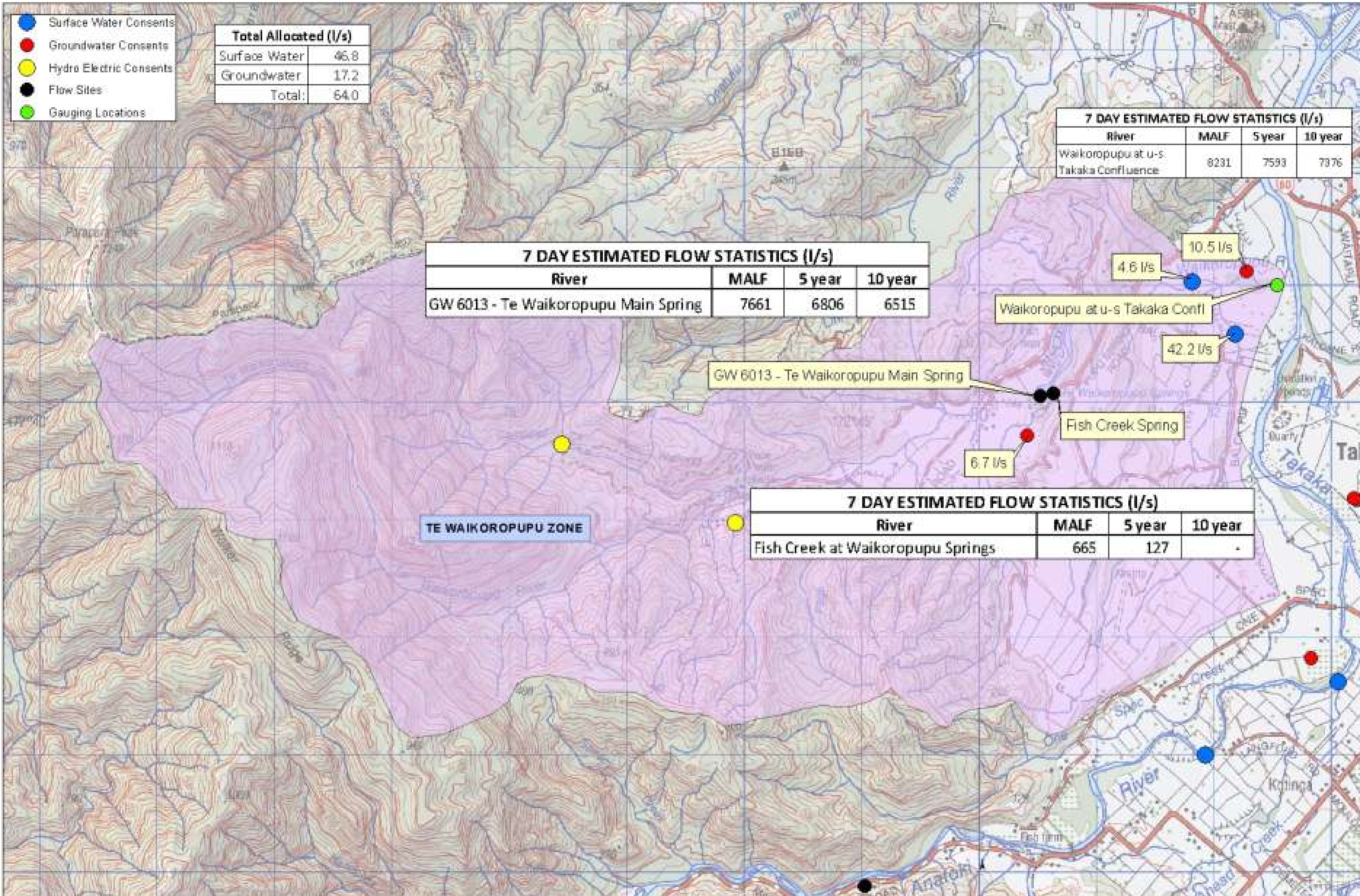
- Cap allocation at current levels or allow increase??
- Allocations need to consider overall Arthur Marble Aquifer allocation

- Current management only restricts takes once minimum flow is hit

DISCUSSION/QUESTIONS

TE WAIKOROPUPU

Te Waikoropupu Zone
Consents & Flow Statistics



Total Allocated (l/s)	
Surface Water	46.8
Groundwater	17.2
Total:	64.0

7 DAY ESTIMATED FLOW STATISTICS (l/s)

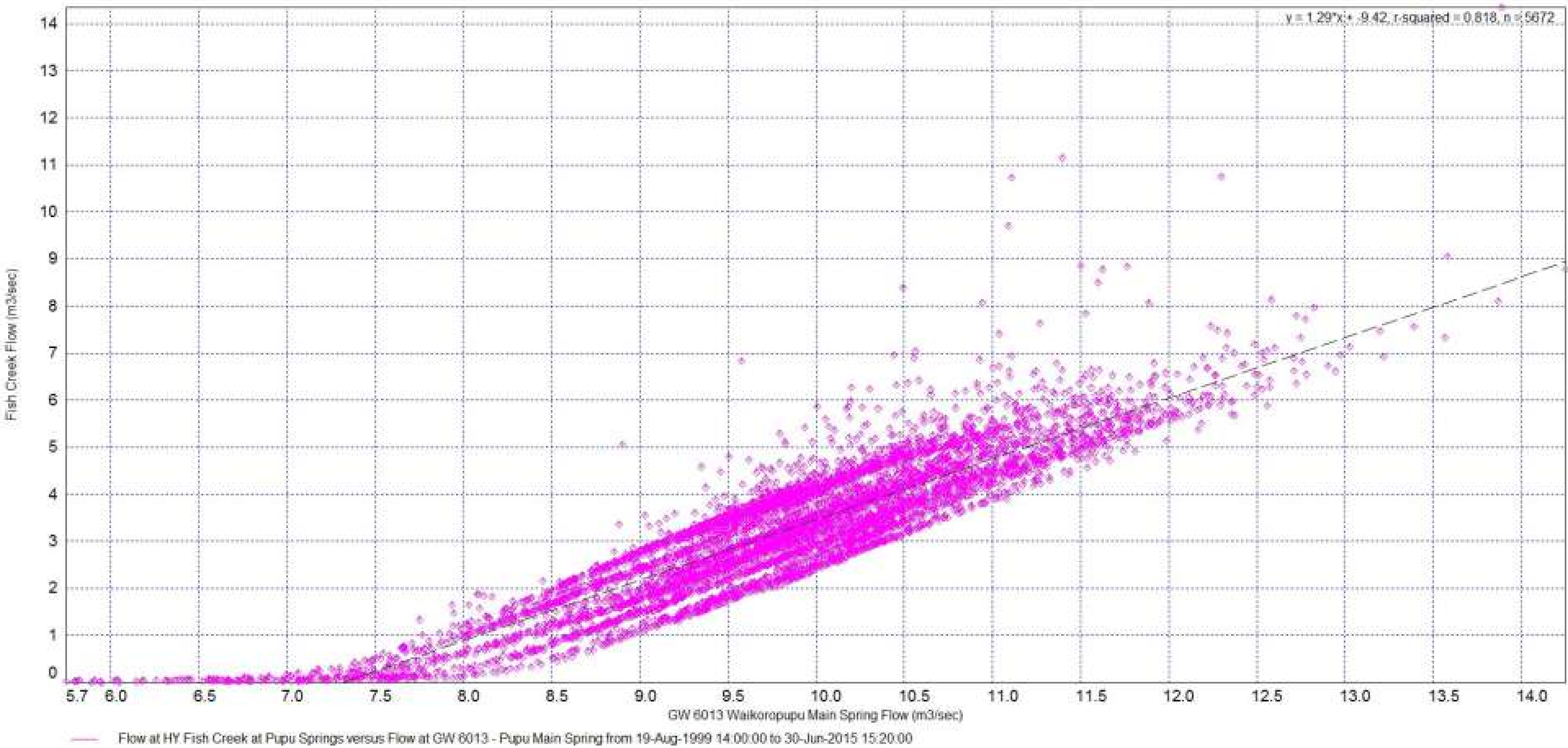
River	MALF	5 year	10 year
Waikoropupu at u-s Takaka Confluence	8231	7593	7376

7 DAY ESTIMATED FLOW STATISTICS (l/s)

River	MALF	5 year	10 year
GW 6013 - Te Waikoropupu Main Spring	7661	6806	6515

7 DAY ESTIMATED FLOW STATISTICS (l/s)

River	MALF	5 year	10 year
Fish Creek at Waikoropupu Springs	665	127	-


y = 1.29*x + -9.42, r-squared = 0.818, n = 5672
Fish Creek Flow (m3/sec)
GW 6013 Waikoropupu Main Spring Flow (m3/sec)
Flow at HY Fish Creek at Pupu Springs versus Flow at GW 6013 - Pupu Main Spring from 19-Aug-1999 14:00:00 to 30-Jun-2015 15:20:00

TE WAIKOROPUPU

- Te Waikoropupu class
- Moderate-High ecological values
- Very high cultural values
- Fed by Marble Aquifer
- 64 l/s of current consumptive takes

- Minimum flow = 90-100% of 7 Day MALF
- Allocation limit = 10-20% of 7 Day MALF
- Minimum flow = cease take

- Takes from surface catchment based on Bell Creek flows

TE WAIKOROPUPU - OPTIONS

Whole Springs area including recharge zone

- Minimum flow = 6895 l/s (90% of 7Day MALF at Main Spring)
- Allocation limit = 766 l/s (10% of 7Day MALF at Main Spring)
- Rationing step (50%) = 7661 l/s
- Cease take at 6895 l/s

- Expect cease take for XX days per year

- Total allocation is 64 l/s in surface catchment, but 500 l/s in AMA
- AMA allocation currently 500 l/s
- Future AMA allocation needs to consider new limits for all parts of AMA

Surface area focussed on Bell Creek

- Minimum flow 90% MALF
- Allocation limit 10% Bell Creek