Appendix 8

Information on the range of days between high (flushing) flow events (accrual periods) for the Manawatu at Hopelands

The evidence of Dr Biggs clearly shows the key factors controlling periphyton growth are the frequency of high (flushing) flows, and nutrient concentrations. A qualification of the modeling of Dr Biggs is the use of the average days of periphyton accrual (number of days between high flow events). In reality, the time between high flow events varies greatly from year to year and site to site, with some periods between floods being substantially greater than the mean. In some cases, there may not be a flood event for more than 150 days (Figure 1 and Table 1). In events with long accrual times such as this, the river will experience periphyton growth which exceeds the standards for the entirety of the accrual period, apart from the first few weeks when biomass is building up after the preceding high flow event. The maximum periphyton biomass will depend on the availability of nutrients during these times and shifts in the dominant periphyton taxa may occur as a result of variations in nutrient limitation (ie. including widespread blooms of potentially toxic cyanobacteria). When maximum cover is reached, periphyton sloughs off the substrate due to cell die-off at the attachment surface and drifts downstream, often rotting on exposed gravel beaches as flows continue to recede.

Flushing flows need to be substantial and frequent following such an accrual period to clear the residual algal material from the river. If flows are not of a high enough intensity nor sufficiently regular there will be rapid recolonisation of periphyton for some time after freshes, at the Hopelands and downstream sites, due to high levels of residual algal material. Small, regular flood events are more likely to maintain low biomasses if they are preceded by a high intensity event which cleans the system out.

Obviously, such situations have highly detrimental effects on aesthetic and recreational values. These conditions also have an overriding influence on the health of aquatic ecosystems, with large diurnal fluctuations in pH and dissolved oxygen resulting in extremely low dissolved oxygen at night, which can be lethal to fish and macroinvertebrates. Elevated pH (ie. pH > 9) also causes lethal and avoidance effects in fish and invertebrates. Over the accrual period macroinvertebrate communities decline in health with MCI/QMCI scores dropping as flows continue to recede. The combined effects of low dissolved oxygen, high water temperatures and smothered substrate mean large predatory invertebrates cannot be sustained and after several weeks the community consists of only worms and midges. This in turn has negative effects up the food chain on any native fish or trout that are able to physically survive this environment.

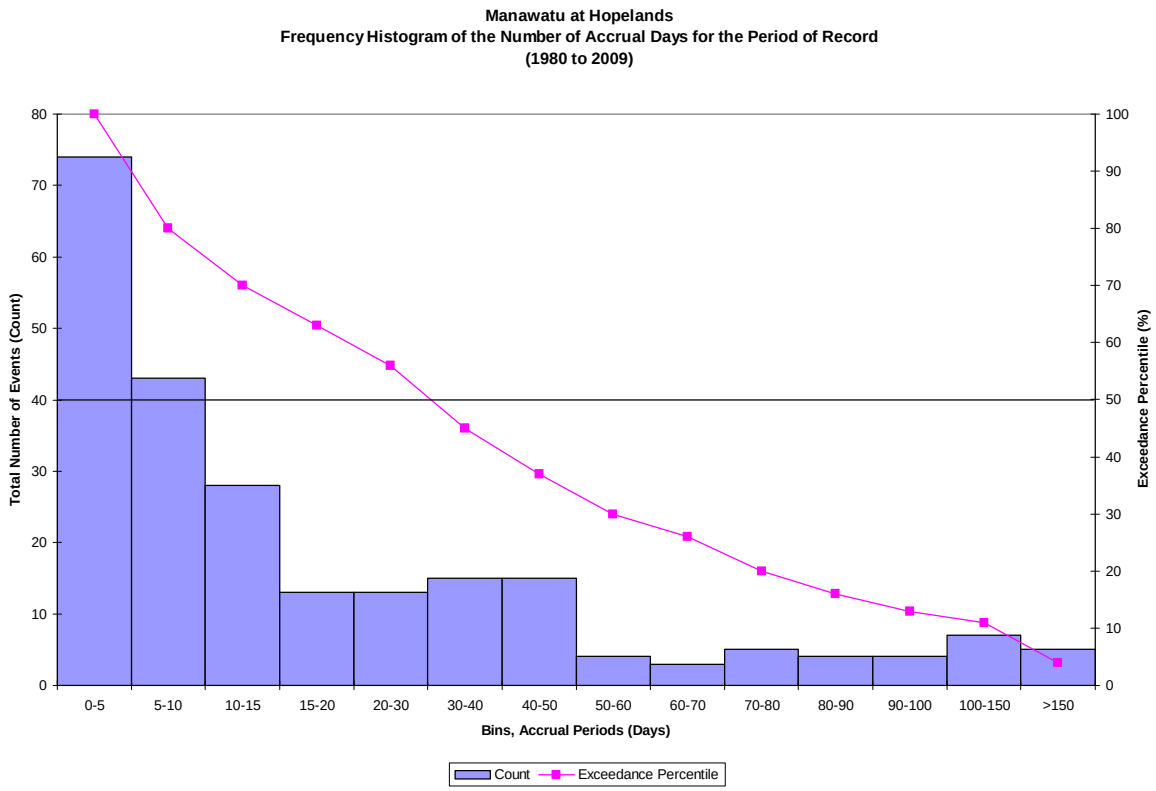

Figure 1: Variation in number of days between flushing flow events (accrual days) for the Manawatu at Hopelands flow site. The horizontal axis shows categories that group the number of days between 3 times median flow events and the vertical axis shows the number of times accrual period of this length have been recorded between 1980 and 2009.

Table 1: Distribution of mean days of accrual for the Manawatu at Hopelands between 1980 and 2009.

Accrual periods (days)	*No. of events of this accrual period*	*Event count comment*	*Flow exceedence percentile*	*Flow exceedence percentile comment*	*Comment on occurrences*
0-5	**74**	Number of events that fall in the range of 0-5 Days	**100**	100% of the time the accrual days are greater than 0	There are 74 occurrences of this
5-10	**43**	Number of events that fall in the range of 5-10 Days	**80**	80% of the time the accrual days are greater than 5	There are 43 occurrences of this
10-15	**28**	Number of events that fall in the range of 10-15 Days	**70**	70% of the time the accrual days are greater than 10	There are 28 occurrences of this
15-20	**13**	Number of events that fall in the range of 15-20 Days	**63**	63% of the time the accrual days are greater than 15	There are 13 occurrences of this
20-30	**13**	Number of events that fall in the range of 20-30 Days	**56**	56% of the time the accrual days are greater than 20	There are 13 occurrences of this
30-40	**15**	Number of events that fall in the range of 30-40 Days	**45**	45% of the time the accrual days are greater than 30	There are 15 occurrences of this
40-50	**15**	Number of events that fall in the range of 40-50 Days	**37**	37% of the time the accrual days are greater than 40	There are 15 occurrences of this
50-60	**4**	Number of events that fall in the range of 50-60 Days	**30**	30% of the time the accrual days are greater than 50	There are 4 occurrences of this
60-70	**3**	Number of events that fall in the range of 60-70 Days	**26**	26% of the time the accrual days are greater than 60	There are 3 occurrences of this
70-80	**5**	Number of events that fall in the range of 70-80 Days	**20**	20% of the time the accrual days are greater than 70	There are 5 occurrences of this
80-90	**4**	Number of events that fall in the range of 80-90 Days	**16**	16% of the time the accrual days are greater than 80	There are 4 occurrences of this
90-100	**4**	Number of events that fall in the range of 90-100 Days	**13**	13% of the time the accrual days are greater than 90	There are 4 occurrences of this
100-150	**7**	Number of events that fall in the range of 100-150 Days	**11**	11% of the time the accrual days are greater than 100	There are 7 occurrences of this
>150	**5**	Number of events that fall in the range of >150 Days	**4**	4% of the time the accrual days are greater than 150	There are 5 occurrences of this

Note: The frequency analysis does not include periods that the daily mean flow is above 3x Median (41.109 m3/s), these periods are not included in calculations of percentage accrual time because they are high flow events.