Reducing flows in the Nechako River (British Columbia, Canada): potential response of the macrophyte community

T.D. French and P.A. Chambers

Abstract: Approximately 50% of the Nechako River's flow was permanently diverted into another watershed in the early 1950s. Up to 50% of the remaining flow may be diverted in the future. To give insight as to how future and past flow reductions will/have affect(ed) macrophyte abundance, we first developed equations relating average summer channel speed to cross-sectional biomass and bottom cover from data collected at 26 sites. The average summer channel speed at each site was then estimated assuming flows (at Fort Fraser) of 408 $m^3 \cdot s^{-1}$ (natural), 165 $m^3 \cdot s^{-1}$ (1952–1990 average), and two future scenarios: 120 and 60 $m^3 \cdot s^{-1}$. We then used these estimates in our equations to compute abundance under the various flow regimes. Our models suggest that flow has little influence on macrophyte abundance in two fast-flowing reaches, which together account for 50% of the river's length. In contrast, the diversion was predicted to have increased biomass and cover by, on average, 66 $g \cdot m^{-2}$ and 15%, respectively, in a slow-flowing reach accounting for 20% of the river's length. Biomass and cover in this reach could increase by an additional 65 $g \cdot m^{-2}$ (or 240 $g \cdot m^{-2}$) and 9% (or 29%) if flows are reduced to 120 $m^3 \cdot s^{-1}$ (or 60 $m^3 \cdot s^{-1}$).

Résumé : Près de 50 % de l'écoulement de la rivière Nechako a été détourné de façon permanente vers un autre bassin versant au début des années 50. Il se peut que jusqu'à la moitié de l'écoulement d'aujourd'hui soit aussi détourné dans un proche avenir. Pour comprendre quel effet les réductions d'écoulement ont eu sur l'abondance des macrophytes, et pour prévoir ainsi l'effet des réductions supplémentaires, nous avons élaboré des équations qui établissent un rapport entre la vitesse moyenne estivale de l'écoulement dans le lit et la biomasse et la couverture de fond en travers du cours d'eau, données recueillies à 26 sites. Nous avons pu estimer la vitesse moyenne estivale dans le lit à chaque site pour des écoulements, à Fort Fraser, de 408 $m^3 \cdot s^{-1}$ (naturel), de 165 $m^3 \cdot s^{-1}$ (moyenne pour la période 1952–1990) et de 120 et 60 $m^3 \cdot s^{-1}$ (scénarios futurs). Nous avons ensuite utilisé ces estimations dans nos équations pour calculer l'abondance pour les divers régimes d'écoulement. D'après nos modèles, l'écoulement n'aurait que peu d'influence sur l'abondance des macrophytes dans deux biefs où l'écoulement est rapide et qui, ensemble, comptent pour 50 % de la longueur de la rivière. Au contraire, on pense que le détournement a fait augmenter la biomasse et le couvert respectivement de 66 $g \cdot m^{-2}$ et de 15 %, en moyenne, dans un bief à écoulement lent qui compte pour 20 % de la longueur totale de la rivière. À cet endroit, la biomasse et le couvert pourraient augmenter en plus de 65 $g \cdot m^{-2}$ (ou 240 $g \cdot m^{-2}$) et de 9 % (ou 29 %) si l'écoulement baissait à 120 $m^3 \cdot s^{-1}$ (ou 60 $m^3 \cdot s^{-1}$).
[Traduit par la Rédaction]

Introduction

Dams have been built to control or harness energy from river flows for over 5000 years (Smith 1971). Today, most of the world's major rivers are regulated to some degree (Petts 1984). Compared with their unregulated counterparts, regulated rivers often differ markedly with respect to annual and seasonal flows (Dickson 1975; Hall et al. 1977; Dessaix et al. 1995), flow variability (King and Tyler 1982; Nilsson and Dynesius 1994), and spate periodicity and intensity (Dolan et al. 1974; Holmes and Whitton 1977; Maheshwari et al. 1995). Changes in flow regime are almost always associated with changes in flow-dependent factors such as current speed (Peltier and Welch 1969; Kraft 1972; Cushman 1985), water temperature and duration of ice cover (Ward 1974; Short and Ward 1980; Rørslett 1988; Helešic and Sedlák 1995), substrate stability (Graf 1980), water clarity and suspended load (Armitage 1976; Helešic and Sedlák 1995), and water chemistry (Ward 1982).

While several studies have shown that physical and chemical changes to rivers affected by regulation schemes can affect fish (Kraft 1972; Newcombe 1981; Bain et al. 1988; Baran et al. 1995; Kubecka and Vostradovský 1995) and invertebrate communities (Briggs 1948; Spence and Hynes 1971; Ward 1976; Baxter 1977; Dumnicka et al. 1988; Dessaix et al. 1995; Helešic and Sedlák 1995), few studies have quantified the effects of flow regulation on aquatic macrophyte communities. Given that macrophyte abundance is strongly influenced by current speed in lotic systems (Bilby 1977; Chambers et al. 1991) and that current speed is a function of flow (Gordon et al. 1992), modifications to flow should be expected to affect macrophyte abundance.

In this study, we developed simple empirical models that relate macrophyte abundance (average cross-sectional biomass and bottom cover) in the Nechako River (British Columbia, Canada) to average summer (June 15 – August 15) channel speed. We then used these models to give insight as

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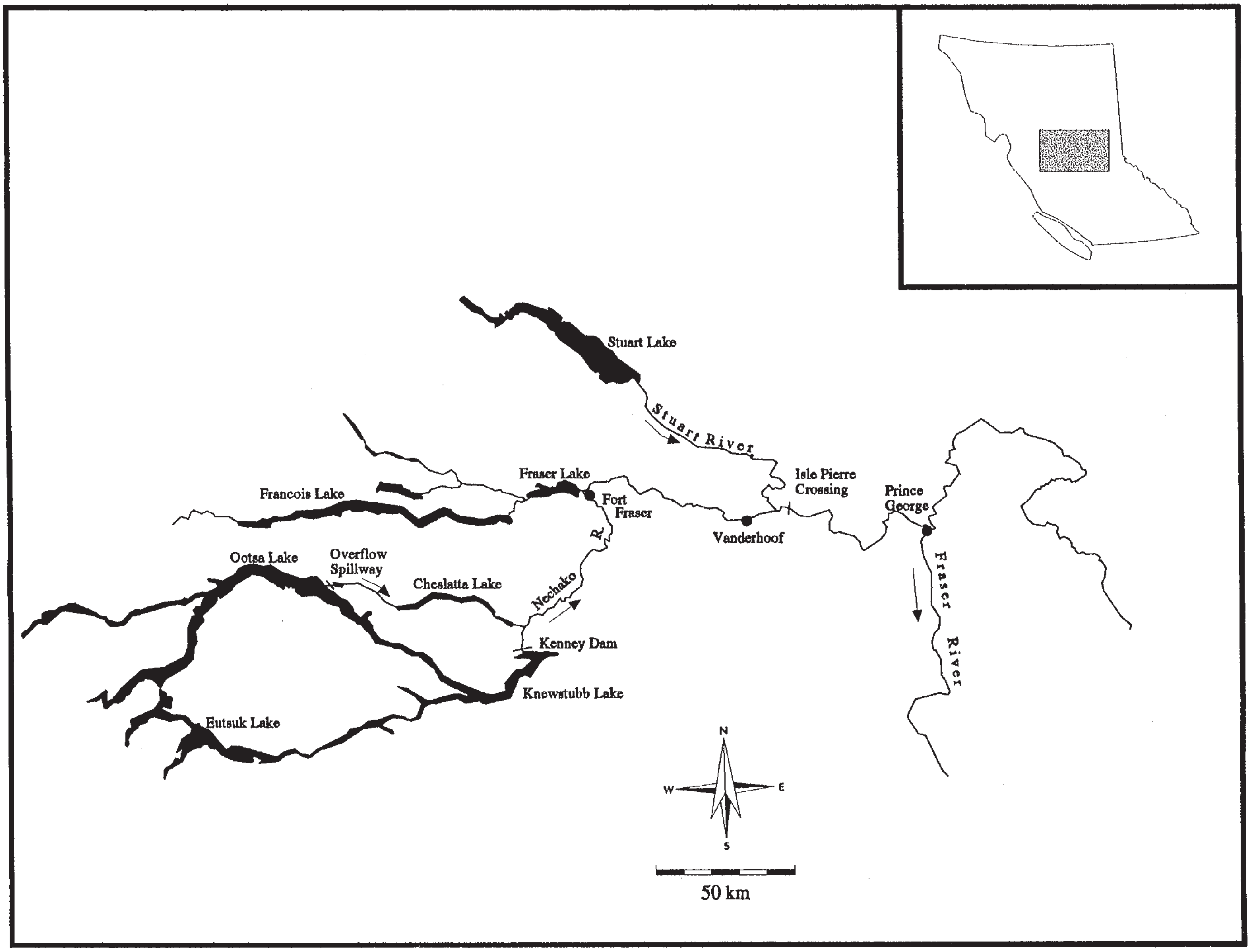
T.D. French.[1] Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9, Canada.
P.A. Chambers. National Hydrology Research Institute, 11 Innovation Boulevard, Saskatoon, SK S7N 3H5, Canada.

[1] Author to whom all correspondence should be addressed. e-mail: tdfrench@netbistro.com

Fig. 1. Map of the Nechako River, British Columbia.



to how macrophyte abundance has changed in the Nechako River since 1952, at which time a substantial portion of the river's flow was permanently diverted into a different watershed. Because increasing demands for electricity have raised the possibility that more water will be diverted from the Nechako River in the future, we also used our models to predict how further reductions in flow may affect macrophyte abundance.

Materials and methods

Study site

The Nechako River (Fig. 1), being 290 km in length and having an average annual flow of 9×10^9 m^3, is one of the largest tributaries of the Fraser River which drains 25% of British Columbia. The Nechako drainage lies entirely within a subboreal pine–spruce biogeoclimatic zone and has an area of about 3 131 250 ha of which 85% is forested and 8% is farmed (Dorcey and Griggs 1991). Soils in the Nechako drainage are of sedimentary and volcanic origin (Dorcey and Griggs 1991).

The sewage treatment plants of Vanderhoof (population ~4000) and Fort Fraser (population ~500) are the only significant point-source nutrient contributors to the Nechako River. French and Chambers (1995) estimated that these communities contribute, respectively, approximately 1600 and 200 kg of total phosphorus and 4000 and 600 kg of dissolved inorganic nitrogen to the river annually. Fertilizers are applied in the Nechako drainage at a rate of about 4000 t·year^{-1} (Dorcey and Griggs 1991).

Prior to the construction of the Kenney Dam in the early 1950s, the Nechako River arose from Knewstubb Lake and flowed northward for 8 km via the Nechako Canyon to where it joined the Cheslatta River (Fig. 1). Following the construction of the Kenney Dam, however, flows to the Nechako Canyon were blocked, with the water being backed into a 906-km^2 reservoir located upstream of the canyon. Water required for power generation is removed from the west end of the reservoir and diverted through a tunnel to the coast and over a 792-m fall to the Pacific Ocean. Water not needed for power generation is released into the Cheslatta River via an overflow spillway; thus the outflow of Cheslatta Lake is now, effectively, the beginning of the Nechako River.

The present Nechako River flows northeast from the Cheslatta River inflow for 83 km to the village of Fort Fraser and then northwest for 4.5 km to where it converges with the Nautley River which drains Fraser and Francois lakes. The Nechako then flows southeast for 196 km to where it joins with the Fraser River at Prince George (population ~71 000). Between its confluence with the Nautley River and

Prince George, the Nechako River flows through the town of Vanderhoof and is joined by its largest tributary, the Stuart River.

Macrophyte collection and abundance

In September 1991, a filmed (video) helicopter survey of the Nechako River was undertaken to approximate the boundaries of the river's macrophyte community. From this survey, macrophytes were found to be most abundant between Vanderhoof and the Stuart River inflow where they often covered more than 30% of the river bottom (Fig. 2). By comparison, bottom cover was always less than 10% between Vanderhoof and the Nautley River inflow and downstream of the Stuart River inflow (Fig. 2). To sample sites having conditions both favorable and unfavorable to macrophyte growth, sampling sites were chosen such that some were located in reaches having high (i.e., between Vanderhoof and the Stuart River inflow) and low (i.e., between Vanderhoof and the Nautley River inflow and downstream of the Stuart River inflow) macrophyte cover. The exact position of each site was chosen arbitrarily (with the only condition being that each site be accessible with a small boat) from 1 : 50 000 maps prior to visiting the site for the first time. Eight sites were located between the Stuart River inflow and the Fraser River, seven between Vanderhoof and the Stuart River inflow, and nine between the Nautley River inflow and Vanderhoof. Two additional sites were located slightly upstream of Fort Fraser, to make a total of 26 sites.

During the latter half of August 1992, submerged macrophytes (excluding below-ground structures) were harvested using SCUBA from within three 0.1-m^2 quadrats placed haphazardly at 5-m intervals across the channel at each site. Collections proceeded from each bank to 10 m beyond the maximum depth of colonization. The macrophyte samples were frozen in plastic bags until they were processed. After they were thawed, the macrophyte samples were rinsed with tap water to remove invertebrates and debris, dried at 80°C to constant weight, and weighed to the nearest 0.01 g. Biomass at each sampling interval was calculated by averaging the mass of the three replicate samples and expressed as grams dry weight per square metre.

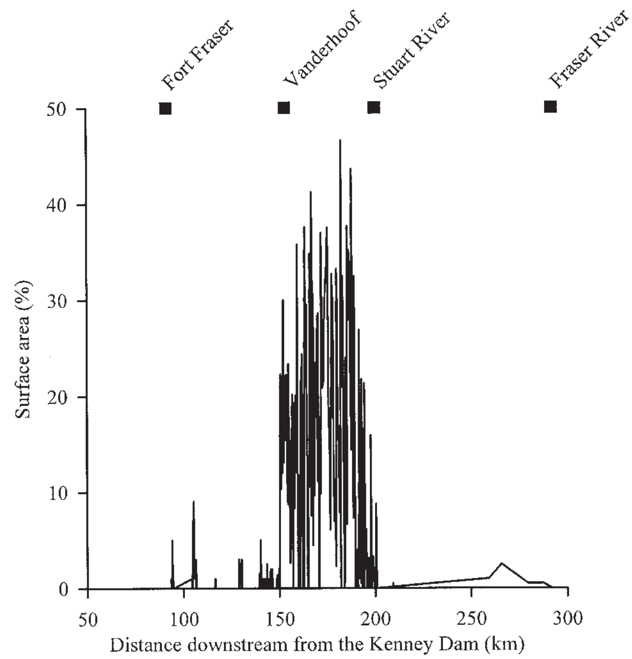
The average biomass across the channel (hereinafter referred to as "cross-sectional biomass") at each site was determined by planimetry from graphs of biomass versus distance across the channel. Bottom cover was estimated by summing the distance that the macrophyte community extended from each bank and dividing this sum by the river's average summer width (see Hydraulic calculations section) and multiplying by 100 (to convert to a percent).

Hydraulic calculations

Daily flow (cubic metres per second) data were obtained from Environment Canada (Water Resources Branch, Vancouver, B.C.) for the Nechako River at Fort Fraser, Vanderhoof, and Isle Pierre. Daily flow data were also obtained for the Nechako River's two largest tributaries, the Nautley and Stuart rivers. All stations had flow data for the period since the completion of the Kenney Dam (post-KDC, 1952–1990). Data prior to the completion of the Kenney Dam (pre-KDC) were available only for the Vanderhoof (1915 and 1948–1951) and Stuart River (1929–1952) stations. Pre-KDC flow was estimated for the Nechako River at Fort Fraser as the difference between the flow at Vanderhoof pre-KDC and the flow of the Nautley River post-KDC, and for the Nechako River at Isle Pierre as the sum of the flow at Vanderhoof pre-KDC and the flow of the Stuart River pre-KDC.

Measurements of river width, flow, and cross-sectional area were obtained from Environment Canada (Water Resources Branch, Vancouver, B.C.) for the three water survey sites on the Nechako River for each date the survey station was calibrated. Mean channel speed was calculated for each calibration date by dividing flow by cross-sectional area. Mean channel speed (metres per second) and river width (metres) were then related to flow (cubic metres per second) for each station with power functions following procedures outlined in Norusis (1993):

Fig. 2. Surface area of the Nechako River covered by aquatic macrophytes as determined by an aerial survey conducted in September 1991.



Fort Fraser:

(1) Width = $50.5 \times \text{flow}^{0.18}$ ($r^2 = 0.77$, $n = 122$)
Channel speed = $0.082 \times \text{flow}^{0.37}$ ($r^2 = 0.86$, $n = 131$)

Vanderhoof:

(2) Width = $35.4 \times \text{flow}^{0.24}$ ($r^2 = 0.88$, $n = 362$)
Channel speed = $0.14 \times \text{flow}^{0.21}$ ($r^2 = 0.90$, $n = 362$)

Isle Pierre:

(3) Width = $25.9 \times \text{flow}^{0.21}$ ($r^2 = 0.85$, $n = 205$)
Channel speed = $0.058 \times \text{flow}^{0.53}$ ($r^2 = 0.97$, $n = 213$).

The flow data at Fort Fraser, Vanderhoof, and Isle Pierre were assumed to adequately represent the flow of the Nechako River between our two most-upstream sites (located slightly upstream of Fort Fraser) and the Nautley River inflow (the Upper Nechako reach), the Nechako River between the Nautley River and Stuart River inflows (the Middle Nechako reach), and the Nechako River between the Stuart River inflow and Prince George (the Lower Nechako reach), respectively. This assumption is reasonable, as only minor tributaries enter the Nechako River between the upstream/downstream boundary of each reach as defined.

To calculate mean channel speed and river width for each site at any flow, we first calibrated the width and mean channel speed versus flow curves (eqs. 1–3) to each site by shifting the *y*-intercept of each curve vertically so that the curve passed through a known coordinate (i.e., a point of known width or mean channel speed and flow) for each of the 26 sites. Equations 1–3 were used to calibrate sites located in the Upper, Middle and Lower Nechako River, respectively. The known coordinates for each site were determined from the summer 1992 field measurements of river width and cross-sectional area and Environment Canada (Water Resources Branch, Vancouver, B.C.) measurements of flow. The cross-sectional area of the channel at each site was calculated from depth measurements taken at 1-m (where changes in depth were deemed large) or 5-m (where changes in depth were deemed small) intervals across the channel. Mean summer (June 15 – August 15) channel speed and mean summer river width were then determined for each site for four flow regimes (pre-KDC,

Table 1. Channel morphometry (maximum depth and wetted width as measured during the 1992 survey) and estimated average summer (June 15 – August 15) channel speed at various flow scenarios for sites in the Nechako River.

Site location (km upstream of Fraser River confluence)	Estimated average summer (June 15 – August 15) channel speed ($m \cdot s^{-1}$)				Channel morphometry (July–August 1992)	
	Pre-KDC (408 $m^3 \cdot s^{-1}$ at Fort Fraser)	Post-KDC (165 $m^3 \cdot s^{-1}$ at Fort Fraser)	Regime I (120 $m^3 \cdot s^{-1}$ at Fort Fraser)	Regime II (60 $m^3 \cdot s^{-1}$ at Fort Fraser)	Maximum depth (m)	Wetted width (m)
Lower Nechako reach (between the Stuart River inflow and the Fraser River confluence)						
7.5	1.79	1.52	1.38	1.26	7.6	117
8.2	1.85	1.59	1.44	1.33	4.4	130
24.5	1.82	1.56	1.41	1.30	3.3	149
26.1	1.78	1.52	1.37	1.26	6.1	86
26.4	2.03	1.79	1.63	1.52	4.3	152
27.0	1.81	1.55	1.38	1.29	4.6	130
28.0	2.01	1.75	1.60	1.49	3.8	135
30.0	2.01	1.77	1.60	1.48	5.7	123
Middle Nechako reach (between Vanderhoof and the Stuart River inflow)						
62.1	1.52	1.33	1.12	1.00	7.8	118
97.8	0.98	0.77	0.72	0.62	2.7	101
100.3	0.66	0.44	0.38	0.29	3.8	145
132.2	0.84	0.63	0.58	0.48	1.2	131
132.8	0.76	0.55	0.50	0.40	3.6	130
136.5	0.75	0.54	0.48	0.38	2.5	69
136.8	0.73	0.52	0.47	0.38	1.7	63
Middle Nechako reach (between the Nautley River inflow and Vanderhoof)						
138.2	0.96	0.75	0.70	0.61	1.7	113
138.9	1.01	0.81	0.76	0.66	2.1	120
140.4	1.30	1.08	1.03	0.93	1.7	104
140.9	1.23	1.02	0.97	0.87	2.0	152
148.8	1.09	0.89	0.84	0.74	3.1	144
164.9	1.04	0.83	0.78	0.68	3.6	85
165.6	1.16	0.95	0.89	0.79	1.9	184
165.9	1.26	1.05	1.00	0.90	2.3	79
166.0	1.34	1.13	1.07	0.97	1.3	92
Upper Nechako Reach (upstream of the Nautley River inflow)						
200.7	0.71	0.48	0.44	0.32	2.0	105
202.5	0.71	0.52	0.45	0.33	2.0	87

post-KDC, Regime I, and Regime II; Table 1) by determining the mean daily flow at each site between June 15 and August 15 for each of the four flow regimes and interpolating mean channel speed and channel width from the mean channel speed and width versus flow curves (eqs. 1–3), respectively, for each site.

Predicting macrophyte abundance

Following procedures outlined in Norusis (1993), power functions were used to relate cross-sectional biomass and bottom cover to mean summer channel speed. To predict cross-sectional biomass and bottom cover at each site pre-KDC and under various reduced-flow regimes (Table 1), the mean summer channel speed (interpolated from site-specific variants of eqs. 1–3; see Hydraulic calculations section) estimated for each site under each flow regime was put into the regression models and macrophyte abundance computed. Summer channel speeds fell outside the bounds of the regression models (i.e., $<0.5\ m \cdot s^{-1}$) for six sites under the Regime II scenario and one site under the Regime I scenario. To avoid overpredicting bottom cover and cross-sectional biomass for these sites, predicted bottom cover and cross-sectional biomass were capped at 100% and 500 $g \cdot m^{-2}$ (the average biomass across the nearshore zone for the site with the greatest macrophyte abundance), respectively.

Results

Hydrology

Analyses of long-term flow records showed that the Kenney Dam has substantially decreased summer flows in the Nechako River (Fig. 3). Prior to the construction of the Kenney Dam, summer flows averaged about 408, 468, and 699 $m^3 \cdot s^{-1}$ at Fort Fraser, Vanderhoof, and Isle Pierre, respectively. Since the completion of the Kenney Dam, summer flows at these sites have been reduced, on average, to about 165, 224, and 525 $m^3 \cdot s^{-1}$, respectively.

Associated with these flow reductions have been reductions in channel speed (Table 1). According to our estimates, average summer channel speeds at sites in the Lower Nechako were reduced by 12–15% ($\bar{x} = 4\%$) by the Kenney Dam. Similarly, average summer channel speeds decreased by 12–33% ($\bar{x}$ = 25%) at sites between Vanderhoof and the Stuart River inflow, by 16–22% ($\bar{x}$ = 18%) at sites between the Nautley River inflow and Vanderhoof, and by 27–32% ($\bar{x}$ = 30%) at sites upstream of the Nautley River inflow. Our analyses indicate that channel speeds will be further reduced at all sites in the event that flows at Fort Fraser are reduced to Regime I levels and even further if they are reduced to Regime II levels (Table 1).

Abundance predictions

Biomass in the Nechako River ranged from 0 to 1262 $g \cdot m^{-2}$. Bottom cover and average cross-sectional biomass ranged from 0 to 46% and from 0 to 168 $g \cdot m^{-2}$, respectively. Both bottom cover (percent) and cross-sectional biomass (grams per square metre) were negatively correlated with mean summer channel speed (metres per second) such that (Figs. 4*a* and 4*b*)

(4) Bottom cover = $5.86 \times \text{speed}^{-2.62}$ ($r^2 = 0.80$, $n = 26$, $F = 8.8$, $P < 0.01$)

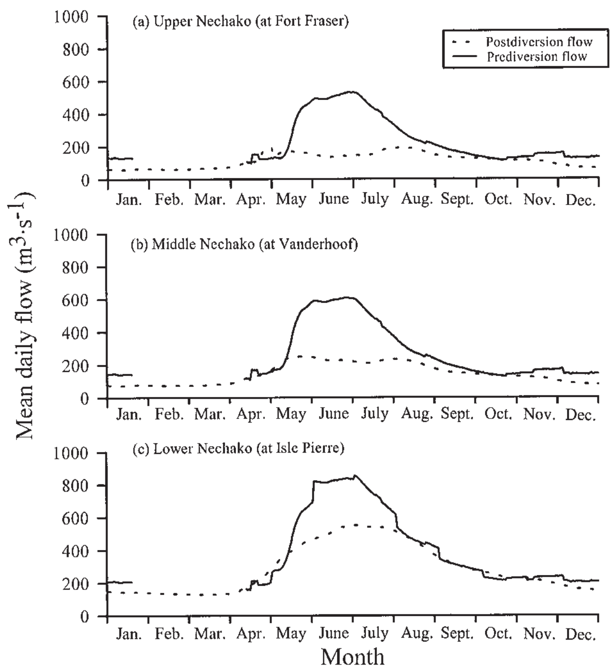
(5) Cross-sectional biomass = $0.15 \times \text{speed}^{-9.83}$ ($r^2 = 0.82$, $n = 26$, $F = 73.0$, $P < 0.01$)

Predictions based on eqs. 4 and 5 indicate that the Kenney Dam has had little effect on macrophyte abundance in the Lower Nechako or Middle Nechako between the Nautley River inflow and Vanderhoof (Figs. 5*a* and 5*b*). Thus, cross-sectional biomass and bottom cover in the Lower Nechako were predicted to have increased, on average, by only 1.4×10^{-3} $g \cdot m^{-2}$ and 0.6%, respectively, since the 1952 diversion. Similarly, cross-sectional biomass and bottom cover in the Middle Nechako between the Nautley River inflow and Vanderhoof were predicted to have increased, on average, by only 0.5 $g \cdot m^{-2}$ and 3.0%, respectively, since the diversion. Reducing the summer flow at Fort Fraser to Regime I or Regime II levels would not likely have a substantial effect on macrophyte abundance in the Lower Nechako or Middle Nechako between the Nautley River inflow and Vanderhoof (Figs. 5*c* and 5*d*). In contrast, macrophyte abundance in the Middle Nechako between Vanderhoof and the Stuart River inflow and Upper Nechako appears to be strongly influenced by summer flow levels (Fig. 5). Thus, cross-sectional biomass and bottom cover in the Middle Nechako between Vanderhoof and the Stuart River inflow were predicted to have increased, on average, by 66 $g \cdot m^{-2}$ and 15%, respectively, since the 1952 diversion. If the summer flow at Fort Fraser were to be reduced to Regime I levels, cross-sectional biomass and bottom cover in this reach could increase, on average, by an additional 65 $g \cdot m^{-2}$ and 9%, respectively (Figs. 5*b* and 5*c*). This increase would be expected to be 240 $g \cdot m^{-2}$ and 29%, respectively, if flows at Fort Fraser were reduced to Regime II levels (Figs. 5*b* and 5*d*). Macrophyte abundance at the two sites in the Upper Nechako likely responds to summer flow levels in way similar to that in the Middle Nechako between Vanderhoof and the Stuart River inflow (Fig. 5).

Discussion

In this study, we developed simple models that relate macrophyte abundance (bottom cover and cross-sectional biomass) in the Nechako River to average summer (June 15 – August 15) channel speed. Predictions based on these models (Fig. 4; eqs. 4 and 5) suggest that the original diversion in 1952 had little effect on macrophyte abundance in the Lower Nechako or Middle Nechako between the Nautley River inflow and Vanderhoof (Figs. 5*a* and 5*b*). Future flow reductions to Regime I or Regime II levels (Table 1) are also expected to have minimal effects on macrophyte abundance in these reaches (Figs. 5*c* and 5*d*). In contrast, macrophyte abundance in the Middle Nechako between Vanderhoof and the Stuart River inflow and Upper Nechako has, according to our models, increased substantially since the original diversion of the river (Figs. 5*a* and 5*b*). Macrophyte abundance in these reaches will likely increase (by substantial amounts) once again if flows are reduced to either Regime I or Regime II levels (Figs. 5*b* and 5*c*). Our predictions that macrophyte abundance has increased in reaches of the Middle and Upper Nechako River since the 1952 diversion and that macrophyte abundance will increase in these reaches once again if flows are further reduced are consistent with observations made on other regulated rivers. In a synopsis of Norway's regulated rivers, Rørslett et al. (1989) described how regulating the flows of the Otra, Suldalslågen, and Børleva rivers resulted in significant increases in aquatic macrophyte abundance. Similarly, flow modifications to rivers in the United States (e.g., the Mill, Tuolmne, and Tennessee rivers; Hilsenhoff 1971; Fraser 1972; Krenkel et al. 1979), Britain (e.g., the Tees, Colne, and Rheidol rivers; Butcher 1933; Armitage 1976; Holmes and Whitton 1977; Haslam 1987), France (e.g., the Rhône, Dordogne, and Truyere rivers; Déscampes et al. 1979; Dessaix et al. 1995), Sweden (e.g., the Umeälven River; Nilsson 1978), Australia (e.g., the Murray River; Maheshwari et al. 1995), Rhodesia (e.g., the Zambezi River; Attwell 1970; Jackson and Davies 1976), Ghana (e.g., the Volta River; Petts 1984), India (e.g., the Sutlej River; Petts 1984), Czech Republic (e.g., the Jihlava River; Helešic and Sedlák 1995), and Alberta, Canada (e.g., the Bow River; Culp et al. 1992), are thought to have been responsible for increases in macrophyte abundance.

Fig. 3. Hydrologic cycle of the (*a*) Upper, (*b*) Middle, and (*c*) Lower Nechako River, British Columbia, before and after the 1952 diversion.



As explained above, changes in macrophyte abundance

Fig. 4. Relationship between mean summer (June 15 – August 15) channel speed and macrophyte abundance for the Nechako River, British Columbia: (*a*) bottom cover; (*b*) cross-sectional biomass.

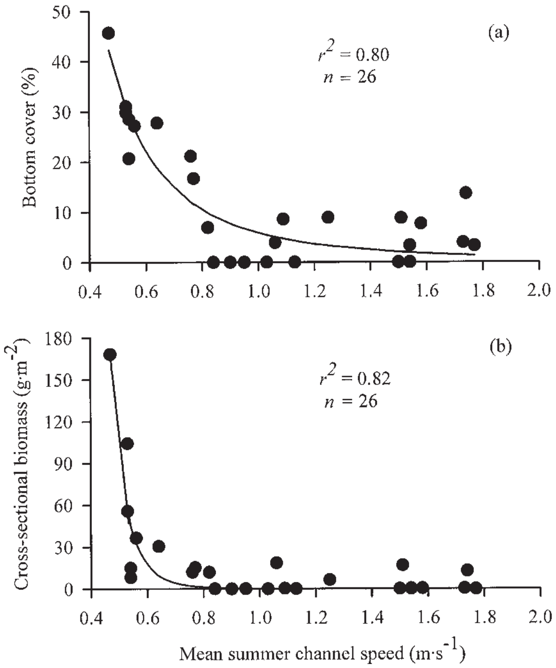
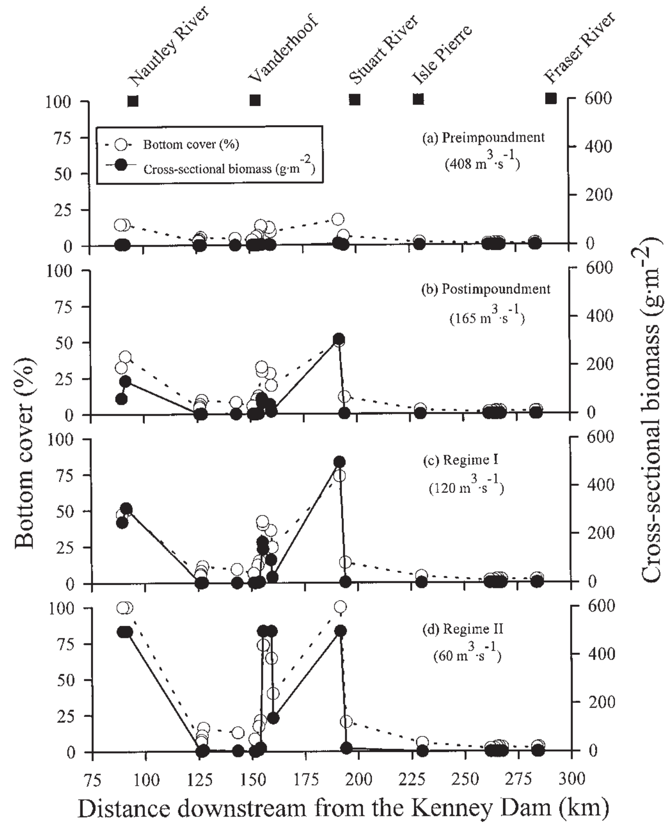


Fig. 5. Macrophyte abundance (predicted) in the Nechako River at various discharge regimes: (*a*) preimpoundment (prior to 1952); (*b*) postimpoundment (typical 1952–1990); (*c*) Regime I (120 m^3·s^{-1} at Fort Fraser); (*d*) Regime II (60 m^3·s^{-1} at Fort Fraser).



resulting from past or future flow reductions are not expected to be of a constant magnitude along the length of the Nechako River. The primary reason for this is that the relationship between average summer channel speed (the independent variable used in both of our models) and macrophyte abundance is not a linear function (Fig. 4). Thus, while macrophyte abundance in the Nechako River decreased relatively rapidly with increasing average summer channel speed at channel speeds between about 0.4 and 0.8 m·s^{-1}, between-site variability in macrophyte abundance was relatively small at sites having channel speeds greater than 0.8 m·s^{-1}. While Chambers et al. (1991) found that macrophyte biomass in stands dominated by *Potamogeton vaginatus*, *Potamogeton pectinatus*, *Potamogeton crispus*, and *Zannichellia palustris* decreased linearly with increasing current speed in the Bow River (Alberta, Canada) over a current-speed range of 0–1 m·s^{-1}, our results are consistent with those of Bilby (1977) who found that the abundance of *Elodea canadensis* (also the dominant macrophyte species in the Nechako River; French and Chambers (1996)) decreased curvilinearly with increasing current speed in Fall Creek (New York, U.S.A.). Over the range of flows considered in this study, average summer channel speeds in the Lower Nechako and Middle Nechako between the Nautley River inflow and Vanderhoof would be maintained over 0.8 m·s^{-1} at most sites (Table 1). Thus, flow reductions of the magnitude considered in this study would be expected to have little effect on macrophyte abundance in these reaches. By comparison, average summer channel speeds at sites located in the Middle Nechako between Vanderhoof and the Stuart River inflow and Upper Nechako decrease, for the most part, through the channel speed range of 0.4 and 0.8 m·s^{-1} (i.e., the range of channel speeds that appear to have the greatest influence over macrophyte abundance) over the range of flows considered (Table 1). Thus, flow reductions of the magnitude considered in this study would be expected to have substantial effects on macrophyte abundance in these reaches.

The ecological consequences of past and future expansions of the Nechako River's macrophyte community have not been investigated. Given that aquatic macrophytes are primary producers and that their presence contributes to habitat structure, increases in macrophyte abundance in reaches having small littoral zones (e.g., the Lower Nechako and Middle Nechako between the Nautley River inflow and Vanderhoof) may stimulate higher level production by increasing food availability and (or) habitat complexity (sensu Culp et al. 1992). Conversely, increases in macrophyte abundance in reaches already having extensive macrophyte communities (e.g., the Middle Nechako between Vanderhoof and the Stuart River inflow; Fig. 2) may have detrimental effects on higher trophic levels. In the regulated Wye River (Wales, Great Britain), the decomposition of extensive macrophyte beds (36% coverage), combined with high water temperatures (28°C), resulted in severe deoxygenation (as low as 0.5 mg·L^{-1}) of the water column and a concurrent major die-off of salmonids in 1976 (Brooker et al. 1977). Given that macrophyte bottom cover in the Middle Nechako between Vanderhoof and the Stuart River inflow often exceeds 30% (Fig. 2), past and future increases in macrophyte abundance in this reach may pose a threat to fish populations under conditions conducive to decomposition-related oxygen deficits.

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