PHYSIOGRAPHICALLY CONTROLLED ALLOMETRY OF SPECIFIC SEDIMENT YIELD IN THE CANADIAN CORDILLERA: A LAKE SEDIMENT-BASED APPROACH

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ABSTRACT. It is generally supposed that specific sediment yield declines as the drainage basin area increases, as part of the mobilized sediment becomes trapped in the downstream cascade of storage zones. In British Columbia, using fluvial suspended sediment load data, Church and Slaymaker (Nature 1989, Vol 337, pp. 452–454) have observed a pattern of increasing specific sediment yield at all spatial scales up to 3×10^4 km^2. This trend has been attributed to the dominance of secondary remobilization of Quaternary sediments over primary denudation of the land surface. Using a larger data set of lake sediment-based estimates of long-term sediment yield, sub-regional patterns of specific yield have been investigated for the Canadian Cordillera. Between spatial scales of 0.9 and 190 km^2 sediment yield trends are differentiated by physiography, as indicated by the variable allometry observed in the specific sediment yield–drainage basin area relations. Highest sediment yields were observed in the Coast Mountains where specific sediment yields conform to the regional pattern described by Church and Slaymaker. However, in flat-lying plateau and major valley areas specific sediment yield decreases with increasing drainage area, thus conforming to the conventional model of sediment delivery. In several other subregions of intermediate relief there were no significant relations between specific yield and drainage area. These results suggest that no single model of sediment yield is adequate to describe sediment transfer processes in the Canadian Cordillera at the sub-regional scale.

Introduction

Sediment yield is the total outflow of sediment from a drainage basin measured at a cross-section of reference in a specified period of time. Most studies of sediment yield, including those covered in this paper, are restricted to using measures of suspended clastic solids to reflect contemporary fluvial sediment transfers. Despite this limitation, the sediment yield data presented are deemed suitable for the analysis of spatial sediment yield patterns, since suspended sediment likely represents the majority of clastic sediment transported through the stream networks of the Canadian Cordillera (Church *et al.* 1989). Sediment yield estimates are common in geomorphic literature because they are an index of catchment erosion and sediment delivery, and are a function of geological history, geomorphological setting, and climatic regime of the drainage basin. Sediment transfer processes are often systematically distributed in the landscape and impose a characteristic scale effect on areal sediment yield (Church *et al.* 1999). These scale relations are most commonly expressed by a power law, with specific sediment yield (sediment yield per unit area drained) expressed as a function of drainage area to a characteristic power: $Y = k_s A_d^b$, where Y is the specific sediment yield, k_s is the unit-area yield, A_d is the contributing drainage area, and b is the scale exponent. Absolute sediment yield is, therefore, proportional to A_d^{b+1}.

It has been demonstrated in many landscapes that specific sediment yield declines with increasing basin size (Schumm 1977; Milliman and Meade 1983; Chorley *et al.* 1984). This conventional model of specific sediment yield is illustrated in Fig. 1. The scale-related distortion in the specific sediment yield–drainage area ratio is an example of negative allometry, since yield decreases out of proportion to drainage area ($b < 0$). Such scale-related distortions of system parameters can provide information about how geomorphological processes operate in the landscape at different geographical scales (Church and Mark 1980). In the case of the conventional sediment yield model, the negative allometry has been attributed to the increased propensity for sediment storage in larger drainage basins. As drainage area increases a greater proportion of the mobilized sediment load becomes trapped in the downstream cascade of storage

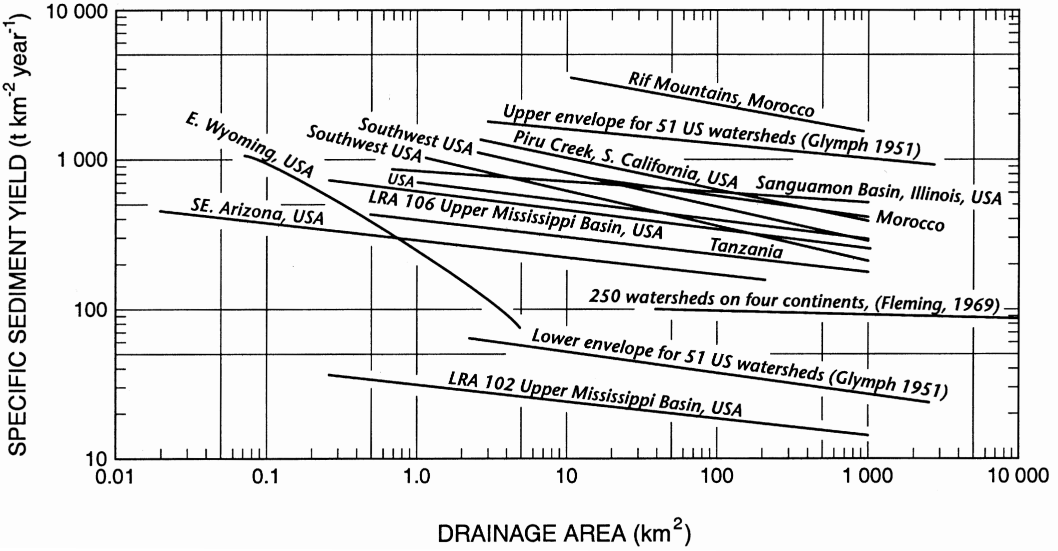

Fig. 1. The conventional model of specific sediment yield (based on Church *et al.* 1989)

zones on footslopes, floodplains, and in low-energy water bodies such as lakes and wetlands. Walling and Webb (1996) have reviewed notable exceptions and challenges to the conventional model where specific local circumstances can lead to different spatial patterns of downstream specific sediment yield.

In British Columbia, Church and Slaymaker (1989) have observed a pattern of increasing specific sediment yield at all spatial scales up to 3×10^4 km^2. This is an example of positive allometry since yield increases out of proportion to drainage area ($b>0$). This trend clearly controverts the conventional model of specific sediment yield. The trend was delineated from fluvial suspended sediment load data obtained by the Water Survey of Canada within the period of 1966–1985, shown in Fig. 2. Church *et al.* (1989) give a detailed discussion of the fluvial-based data set. The positive allometry has been attributed to the dominance of secondary remobilization of Quaternary sediments from stream banks and valley bottom areas over primary denudation of the land surface. This result suggests that sediment yield of larger drainage basins remains conditioned by the extraordinary glacial events of the Quaternary Peri-

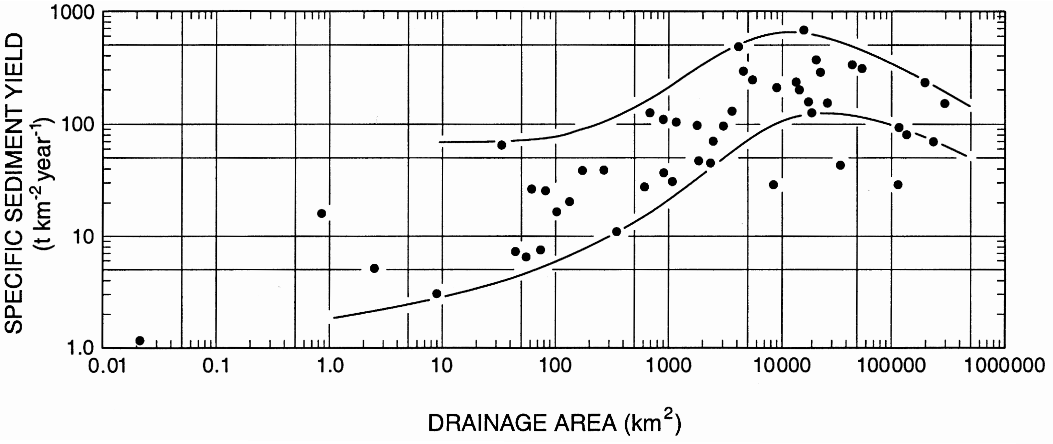

Fig. 2. The Church–Slaymaker model of specific sediment yield in British Columbia (based on Church and Slaymaker 1989)

od, when large quantities of unconsolidated sediments were delivered to the major valleys of British Columbia (Church and Ryder 1972). The divergence of the trend to over an order of magnitude in small basins is attributed to variability in relative relief and local geology, factors that become more averaged in larger basins. Negative allometry is detected beyond the maximum observed sediment yield at 3×10^4 km^2 where the large rivers generally flow in relatively wide valleys with well-developed floodplains which protect non-alluvial banks from river attack, and which therefore reduce the intensity of sediment remobilization (Slaymaker 1987). Sub-regional analysis of specific sediment yield trends has been limited because of the areal heterogeneity and limited size of the fluvial-based yield data set.

The lake sediment-based approach

The lake catchment is a specific terrestrial drainage basin unit. Lakes act as a primary sink in the cascading sediment system of the drainage basin. The quantity of sediment accumulating in the lake basin will reflect the integration of all interacting processes of erosion and sediment transfer in the contributing drainage basin area, as well as internal lake processes. A continuous record of historical sediment accumulation rates and palaeoenvironmental conditions is often logged in lacustrine sediments. The sampling and analysis of lacustrine sediments can be effective in determining the sediment yield of the catchment. The lake sediment-based framework for reconstructing historical sediment yields has been reviewed by Dearing *et al.* (1982), Petts and Foster (1985) and Foster *et al.* (1988, 1990). The lake sediment approach can obviate some of the common limitations of drainage basin studies of sediment yield based on suspended sediment transport data. Since lake sediments are a record of historical catchment conditions, an appropriate time scale of analysis can be selected which will permit the determination of background conditions and long-term trends. This approach is especially useful in remote and mountainous regions where sediment transfer is highly episodic and long-term stream monitoring records are not generally available. In the Canadian Cordillera, lake sediment analysis has been shown to provide important historical information on changing sediment yields and sediment delivery processes (e.g. Souch 1990; Owens and Slaymaker 1992; Desloges and Gilbert 1994, 1998; Evans 1997; Arnaud and Church 1999; Spicer 1999; Schiefer 1999). Lake sediment research has become more common in recent years, as sediment sampling and analysis procedures have become more standardized, and as the lake sediment-based framework has become more generally accepted for the reconstruction of past sedimentary environments. A variety of sediment sampling and analysis techniques have been applied successfully in the Canadian Cordillera to estimate historical sediment yields of lake catchments. These data provide an independent means for verifying fluvial-based trends in sediment yield. Furthermore, with the recent addition of some larger sets of lake sediment-based yield estimates from a variety of different geographic areas, most significantly those by Spicer (21 catchments) and Schiefer (70 catchments), a sub-regional analysis of sediment yield patterns is now possible.

Source data

The data used in this study have been obtained from lake catchments in the Canadian Cordillera, the locations of which are shown in Fig. 3. The estimates of sediment yield in all cases were derived from laboratory analysis of sediment core samples from the lakes. Studies that only provide volumetric results without measures of sediment density have not been included since sediment yields, measured in mass per unit time, cannot be calculated. A variety of sampling strategies, operating assumptions, and methods of chronological control have been utilized depending on the scale and scope of the investigation.

This study relies primarily on the records of sediment yield obtained for 70 lake catchments in the Skeena Region of northwestern British Columbia by Schiefer (1999). The study used ^{210}Pb dated sediment cores to research natural patterns and land use impacts on lacustrine sedimentation over the last 150 years for lake catchments ranging from 0.9 to 190 km^2. The concentrations of excess ^{210}Pb were interpreted using the constant rate of supply dating model (Robbins 1978; Appleby *et al.* 1979). Details of the procedures used are presented by Evans and Rigler (1980) with modifications described by Cornett *et al.* (1984) and Rowan *et al.* (1995). This data set provides the main input for investigating specific sediment yield patterns at the sub-regional scale. The catchments have been stratified into physiographic sub-regions based on observations made in the field and on the work by

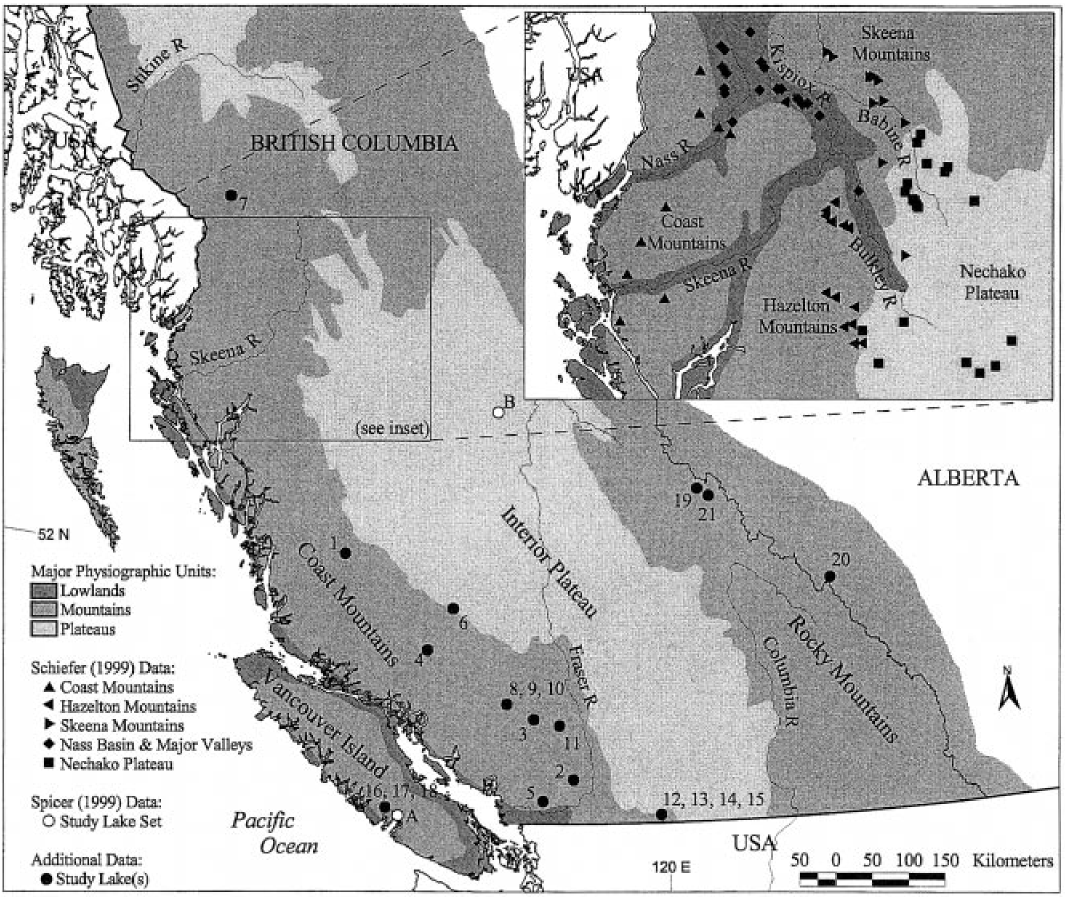

Fig. 3. Locations of lake sediment-based studies that include sediment yield calculations for the catchment. Inset map shows the locations of the Skeena Region lakes studied by Schiefer (1999). Open symbols show the locations of the two Spicer (1999) lake sets: (A) Vancouver Island (10 lakes); (B) Interior Plateau (11 lakes). Numbers refer to study lakes: (1) Ape, (2) Harrison, (3) Lillooet, (4) Nostetuko, (5) Stave, (6) Chilko, (7) Bowser, (8) Gallie, (9) Middle, (10) Ash, (11) Klept, (12) Glacier, (13) Pyramid, (14) Woods, (15) Quiniscoe, (16) Maggie, (17) Kite, (18) Clayoquot, (19) Berg, (20) Chephren, and (21) Moose Lake.

Mathews (1986). The Coast Mountains contain the most spectacular mountainous terrain in the study area. Other significant mountain areas include the Hazelton and Skeena Mountains. The eastern portion of this study area comprises the more flat-lying terrain of the Nechako Plateau. Sampling density varied between the physiographic sub-regions, and the distribution of sampled lakes is heterogeneous. This was a consequence of accessibility limitations and, to a lesser extent, the geographic occurrences of lakes in the study area. Sediment yield estimates made by Schiefer (1999) were based on sediment accumulation rates measured from the deepest point of the lake. The use of a single core strategy prohibited an assessment of within-lake spatial variability of sedimentation patterns. However, based on the common assumptions of areal continuity and synchroneity of lacustrine sediments, the calculated sediment yields should be a consistent index of the actual yield to the lake. Lakes were selected that had a well defined, singular, steep-sided central basin in order to minimize the effects of within-lake spatial variability in the data set. Since cores were sampled from the deepest point of the lake, the index of sediment yield will likely overestimate the actual yield because of sediment focusing effects in the lake basin. The index will approach actual sediment yield in lakes with less sediment focusing characteristics (i.e. steeps sides and a flat bottom). Direct lake-to-lake comparisons of specific sediment yield are made only between lake catchments exhibiting similar physiographic characteristics. This should make any bias in the yield index relatively consistent in the sub-regional analysis.

The other data set used in this study to investigate specific sediment yield patterns at the sub-regional scale was compiled in a study by Spicer (1999). Sediment yield records were established using ^{210}Pb dating for lakes in two contrasting areas of British Columbia, the central interior near Prince George (11 lakes) and the west coast of Vancouver Island (10 lakes). The purpose of the study was to evaluate differences in sediment yield response to various types of catchment disturbance over the last 100 years. Catchments selected for the study were all between 1 and 70 km^2. The Spicer study used sampling and analysis techniques very similar to those used by Schiefer (1999) in northwestern British Columbia. Direct comparisons of specific sediment yield patterns can be made between these two studies since the range of spatial scales used and the time period of the investigations were also similar. Sediment yield estimates for catchments subject to land use disturbances were based on predisturbance background sedimentation conditions for both of these lake sets.

Through a review of the geomorphic literature, 21 additional lake sediment-based estimates of sediment yield in the Canadian Cordillera have been compiled. The details of these studies are included in Table 1. These yield estimates were not stratified for sub-regional analysis because of discrepancies in the study methods used in the investigations and the lack of consistent temporal control. Results tabulated by Desloges and Gilbert (1994) indicate that sediment delivery to their study lakes is dominated by the average regime and that there is a long-term persistence in sediment accumulation rates. Therefore, the observed spatial variability between lakes in the data is believed to be greater than temporal variability in any one catchment during the postglacial period. This data set, which spans over five orders of magnitude in spatial scale, is useful for studying the general regional pattern of specific sediment yield, providing an independent comparison to the trend observed by Church and Slaymaker (1989). The regional data set contains a disproportionate number of glaciolacustrine and coastal lakes because of the focus of lake sediment-based research in these environments. There are no lakes from any of the flat-lying plateau sub-regions of the Canadian Cordillera in the regional set. All of these additional lake sediment studies used some type of multi-core sampling approach for determining sediment yield. The Schiefer and Spicer data sets were not incorporated into the regional analysis since a single-core sampling approach was used.

Specific sediment yield scale relations

Sediment yield per unit area, or specific sediment yield, is used as an index of primary sub-aerial denudation of the lake catchments. In the Schiefer (1999) lake set, specific yield ranges from 0.57 t km^{-2} yr^{-1} in the interior to 52.42 t km^{-2} yr^{-1} in the Coast Mountains. The Coast Mountain catchments had generally higher specific yields than all of the other interior sub-regions. The greater yields in these mountains reflect the more active landscape and climate of the coastal region. The average specific yield for all of the catchments was 10.22 t km^{-2} yr^{-1}, with a standard deviation of 9.86 t km^{-2} yr^{-1}. Over the range of spatial scales investigated (0.9 to 190 km^2), these data fit almost entirely within the envelope limits defined by Church and Slaymaker (1989) for observed specific sediment yield in British Columbia (Fig. 2). Only a few lakes with significant lake and wetland areas upstream plotted below the lower envelope.

The data used to plot the specific sediment yield trend for British Columbia in Fig. 2 are sparse for drainage areas from 1 to 100 km^2 (eight data points). A closer look at scale relations between this range can be made using the Skeena data compiled by Schiefer (1999). Although no trend is apparent when looking at the data set as a whole, some interesting patterns emerge when the data are stratified by physiography, as shown in Fig. 4, plots A, B, and C. Plot A shows the spatial trend of specific yield for the Coast Mountain catchments. These are high-energy systems that contain steep slopes, averaging 22.3 degrees over the land surface area, and receive large amounts of precipitation, locally exceeding 3500 mm annually. Upland slopes are thinly mantled with large areas of exposed bedrock. Storage potential is low since there is relatively little flat terrain in the contributing catchment areas. Specific yield increases with increasing drainage area, roughly proportional to (drainage area)$^{0.4}$, for lake catchments in this region. This trend is similar to the Church–Slaymaker model of sediment yield where remobilization of Quaternary sediment dominates sediment transfer in the basin, thus resulting in the observed positive allometry. The substantial Pleistocene deposits on lower valley slopes (fans and aprons) and val-

Table 1. Additional lake sediment-based specific yield data for the Canadian Cordillera

Location	Source	Lake*	Basin area (km^2)	Lake area (km^2) †	Focus of study	Specific yield (t/km^{2}yr)	Dating control	Time period
Coast Mountains	Desloges and Gilbert (1994)	(1) Ape	43	2.5	Extreme hydrological and geomorphological events from glaciolacustrine sediments (outburst floods)	265	^{137}Cs, varves	Averaged over last 140 years
		(2) Harrison	7870	269	Extreme hydrological and geomorphological events from glaciolacustrine sediments (slope failures)	35	^{14}C, varves	
		(3) Lillooet	3850	21	Extreme hydrological and geomorphological events from glaciolacustrine sediments (autumn floods)	205	^{137}Cs, varves	
		(4) Nostetuko	12	0.5	Extreme hydrological and geomorphological events from glaciolacustrine sediments (glacier melt floods)	220	^{137}Cs, varves	
		(5) Stave	727	27	Extreme hydrological and geomorphological events from glaciolacustrine sediments (autumn floods)	450	Known marker	
	Desloges and Gilbert (1998)	(6) Chilko	1960	182	Processes and rates of sediment delivery to a large, glacier-fed lake to the east of the Coast Mountains axis	80	^{210}Pb, acoustic profile	Post- glacial period (last 10000 years)
	Gilbert, Desloges, and Clague (1997)	(7) Bowser	1290	32	Description of the sedimentary environment of a northern Coast Mountain proglacial lake.	360	^{137}Cs, varves	Contemporary (last 200 years)
	Owens and Slaymaker (1992)	(8) Gallie	0.023	901 m^2	Establish late Holocene rates of catchment erosion and sediment yield and assess the proportion of lake sediment which is not derived from erosion of the catchments under investigation	0.005	Known marker	Last 2350 years
		(9) Middle	0.202	600 m^2		0.030		
		(10) Ash	0.022	618 m^2		0.220		
	Souch (1990)	(11) Klept	62	0.083	Reconstruction of glacial activity over the Holocene through the use of lake sediments	0.35	Known marker	Last 2400 years
Cascade Mountains	Evans (1997)	(12) Glacier	1.12	0.088	Assess the sensitivity of the alpine–subalpine sediment system to external climatic forcing functions	9.2	^{14}C	Last 3390 years
		(13) Pyramid	2.03	0.045		2.4		
		(14) Woods	2.21	0.031		5.6		
		(15) Quiniscoe	1.72	0.091		13.7		
Vancouver Island	Arnaud and Church (1999)	(16) Maggie	57	2.2	Improve understanding of the relation between disturbances associated with forestry activity and downstream sediment accumulation in lakes	73.4	^{137}Cs, ^{210}Pb	Since 1943
		(17) Kite	25	0.2		1.8		Since 1830
		(18) Clayoquot	67	0.5		3.0		Since 1878
Rocky Mountains	Desloges and Gilbert (1994)	(19) Berg	56	2.1	Extreme hydrological and geomorphological events from glaciolacustrine sediments (glacial melt floods)	310	^{137}Cs, varves	Averaged over last 140 years
		(20) Chephren	11	1.4	Extreme hydrological and geomorphological events from glaciolacustrine sediments (avalanche, slope failures)	65	^{14}C	
		(21) Moose	1640	12	Extreme hydrological and geomorphological events from glaciolacustrine sediments (avalanche, spring floods)	30	^{14}C, varves	

*Numbers refer to geographic locations in Fig. 3. † Unit is m^2 where indicated.

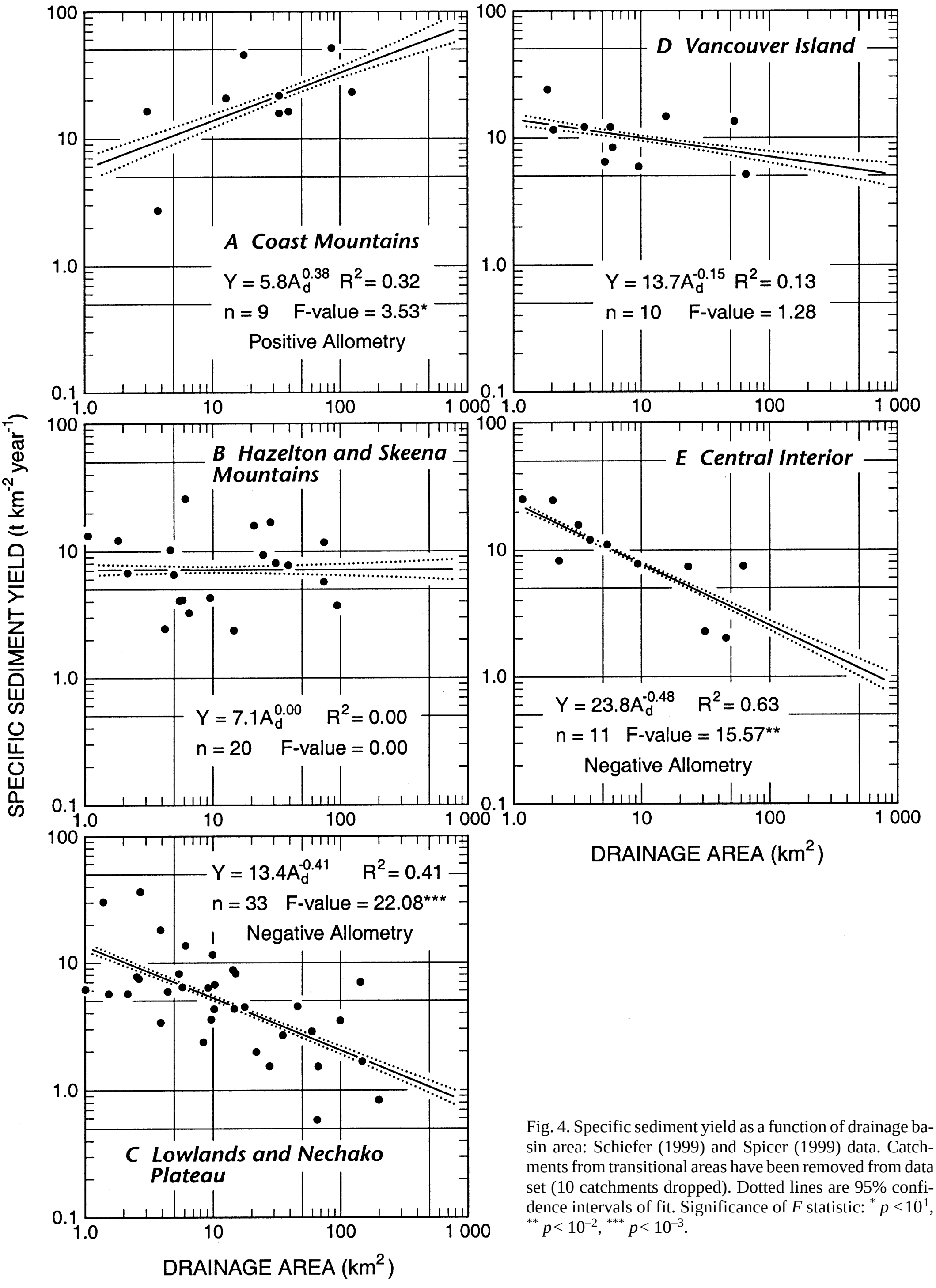

Fig. 4. Specific sediment yield as a function of drainage basin area: Schiefer (1999) and Spicer (1999) data. Catchments from transitional areas have been removed from data set (10 catchments dropped). Dotted lines are 95% confidence intervals of fit. Significance of *F* statistic: * $p < 10^{1}$, ** $p < 10^{-2}$, *** $p < 10^{-3}$.

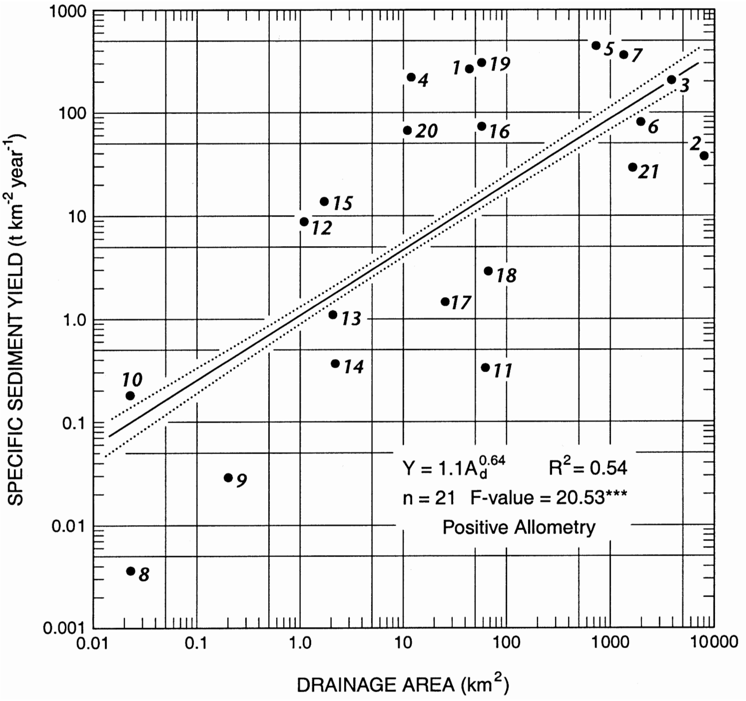

Fig. 5. Specific sediment yield as a function of drainage area : regional data. Numbers refer to geographic locations on Fig. 3. Dotted lines are 95% confidence intervals of fit. Significance of *F* statistic: *** $p < 10^{-3}$.

ley bottom areas are likely the dominant sediment sources for receiving lakes in the Coast Mountains. Plot C in Fig. 4 shows the spatial trend of specific yield for the Nechako Plateau, Nass Basin, and Major Valley catchments. These are lower energy systems with gentle relief, slopes averaging less than 10 degrees, and a drier continental climate, with precipitation as low as 400 mm annually. Upland slopes are mantled by thick glacial deposits. Sediment storage zones, such as lakes, wetlands, and broad valley flat areas, are common upstream from receiving lakes. Specific yield decreases with increasing drainage area, roughly proportional to (drainage area)$^{-0.4}$, for lake catchments in these sub-regions. This trend conforms to the conventional model of sediment yield where sediment mobilized from upland areas goes back into storage on footslopes, floodplains, and water bodies downstream, thus resulting in the observed negative allometry. Plot B in Fig. 4 shows the spatial trend of specific yield for catchments in the Skeena and Hazelton Mountain physiographic sub-regions. The landscape characteristics of these areas are intermediate to the regions described above. No scale-related distortion in yield was detected in these catchments. This pattern of specific sediment yield does not clearly fit either of the two models mentioned previously. In all regions the range of specific yield spans an order of magnitude at all spatial scales, likely the consequence of differences in relative relief and local geology.

The sub-regional analysis of specific sediment yield trends can be extended to two additional physiographic sub-regions of the Canadian Cordillera, the central Interior Plateau and the west coast of Vancouver Island, using the lake sediment data by Spicer (1999). These data are also plotted in Fig. 4, plots D and E. The range of observed specific yield closely matches the Skeena Region lake catchment estimates. Plot D shows the pattern of specific yield for the Vancouver Island lake catchments. The physiography of this sub-region is quite different from all of the Skeena regions in terms of geology and Quaternary history. The degree of relief, however, is similar to the Skeena and Hazelton Mountains. The lack of significant allometry in specific yield is also similar to the pattern observed in those sub-regions, fitting neither of the sediment yield models described previously. Weak negative allometry was detected in the Vancouver Island catchments indicating that storage processes may slightly dominate, although this trend is not statistically significant. Plot E in Fig. 4 shows the specific yield trend for the Interior Plateau. This sub-region is very similar physiographically to the Nechako Plateau (the Nechako Plateau in fact makes up the western portion of the Interior Plateau in central British Columbia). The pattern of specific yield in this area is also similar to that observed in the Nechako Plateau, with specific yield being roughly proportional to (drainage area)$^{-0.5}$. The negative allometry again demonstrates the likely dominance of downstream storage in sediment transfer in flat-lying plateau sub-regions of the Canadian Cordillera.

All of the additional lake catchment sediment yield data have been used to investigate further the regional specific yield pattern for the Canadian Cordillera, shown in Fig. 5. Strong positive allometry is observed in the data with specific yield increasing approximately five orders of magnitude over six orders of magnitude in increasing spatial scale. Specific sediment yield is roughly proportional to (drainage area)$^{0.6}$. This pattern closely matches the trend observed in the fluvial-based records for British Columbia by Church and Slaymaker (1989), where remobilization of Quaternary sediments downstream dominates sediment transfer processes. Although the variability is very high, up to three orders of magnitude, the positive allometry observed is highly significant.

Discussion

The purpose of this study was to look at spatial sediment yield trends in the Canadian Cordillera using lake sediment data and to use the observed patterns to make inferences about the dominating processes of sediment transfer in drainage basins at different spatial scales. The data used in this investigation included 112 lake sediment-based estimates of sediment yield. The majority of the data set (91 catchments) was used to investigate specific yield patterns at the sub-regional scale for various different physiographic areas. The remainder of the data were used for a regional analysis.

Variable allometry was observed within different physiographic sub-regions of the Canadian Cordillera. The range of spatial scales investigated in the sub-regional analysis was limited to small catchments, from about 1 to 200 km^2. Although this range is limited to only a couple of orders of spatial scale, previous work has indicated that scale distortions of specific yield operate similarly over all scales up to the largest drainage basins, over 10 000 km^2 (Church *et al.* 1999). Although none of the relations observed would be suitable for predictive purposes due to the high degree of natural variability, they do show some interesting scale-related trends. The positive allometry in the specific yield–drainage area relation for the Coast Mountains fits the Church and Slaymaker (1989) model of sediment yield where remobilization of Quaternary sediments dominates sediment transfer. Observations of the contemporary landscape support this hypothesis. High elevation areas consist primarily of large granitic intrusions of the Coast Plutonic Complex (Clague 1984), and are highly resistant to erosion. Little sediment is derived from these upland areas. Landforms associated with Quaternary sediments become more common down-slope and down-valley, including fans, aprons, and veneers with some deeper pockets of glacial till. Erosional evidence of the unconsolidated Quaternary sediments includes mass wasting of unstable deposits on steep valley slopes (often entering directly into stream courses), channel incision on alluvial fans, and increasing degradation of valley fill. The proportion of the total sediment load derived from these sources increases downstream, thus causing yield to increase out of proportion to area drained. An opposite pattern of specific yield was observed in the two plateau subregions of British Columbia. Negative allometry in the specific yield–drainage area relation suggests that the conventional model of increased downstream storage of mobilized sediment applies for these areas. Field observations also provide supporting evidence for this model of sediment transfer. The watersheds largely consist of hummocky, rolling, and undulating terrain underlain by thick and erodible Quaternary sediments. Large and relatively flat low-lying areas contain an abundance of poorly drained lakes and wetlands in shallow post-glacial depressions, making efficient sediment traps. Stream channels also have well defined floodplains, and hillslope coupling is minimal or non-existent. A greater proportion of sediment mobilized from upland areas becomes trapped in the cascade of storage zones downstream, thus causing yield to decrease out of proportion to area drained. In the two other physiographic sub-regions of intermediate relief studied, the Hazelton–Skeena Mountains and Vancouver Island, there was no significant relation between specific yield and drainage area. In these areas sediment yield increases downstream in simple proportion to the area drained.

The converse downstream effects of continued sediment recruitment in the Coast Mountains versus sediment loss to storage in flat-lying areas results in a reversal in the geographic occurrence of upper and lower specific yield limits. Over the range of spatial scales investigated, highest specific yields observed (>25 t km^{-2} yr^{-1}) occur in large Coast Mountain catchments (>100 km^2) and small Interior Plateau catchments (<5 km^2). Conversely, lowest specific yields (<2.5 t km^{-2} yr^{-1}) occur in small Coast Mountain catchments (<5 km^2) and large Interior Plateau catchments (>50 km^2). At the intermediate spatial scale of approximately 5 km^2, specific yield averages are nearly equivalent in all sub-regions at about 10 t km^{-2} yr^{-1}.

The remaining regional lake sediment-based data clearly fit the Church–Slaymaker model of sediment yield. Not only does the specific yield–drainage area relation show significant positive allometry, but the exponent of the regressed power function was the same as that estimated from the fluvial-based data for the same range of geographical scales, with specific yield roughly proportional to (drainage area)$^{0.6}$. These data include no Interior Plateau catchments. The fluvial-based data were predominantly composed of records from the Coast–Cascade, Cassiar–Columbia, and Rocky Mountain ranges, and therefore also under-represented the Interior Plateau region. There are no consistent regional data of sediment yields derived from either fluvial- or lacustrine-based sampling. Since few hydrometric stations are currently monitoring sediment transport, the best prospect for substantially improving this data set may lie with the lake sediment-based approach. Based on the results of the sub-regional analysis, the positive allometry observed in both regional analyses may have been weaker if more data had been included from flat-lying plateau areas. However, since the Canadian Cordillera is predominantly mountainous and most of the landscape is still responding to the extraordinary glacial events of the Quaternary Period, the pattern of increasing specific sediment yield with increasing drainage area will likely dominate regionally. Sub-regional analysis indicates that no single model of sediment yield is adequate to describe sediment transfer processes at the sub-regional scale and, although local variability is high, spatial patterns of specific yield conditioned by physiography are observed in lacustrine sediment records. Scale-related trends in sediment yield are a consequence of the spatial distribution of both sediment sources and sediment sinks in lake catchments of the Canadian Cordillera.

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