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Tools for Critical Inquiry

The Critical Thinking Consortium

Teaching about Geographical Thinking

Authors: Kamilla Bahbahani
Niem Tu Huynh

Editors: Roland Case
Bob Sharpe

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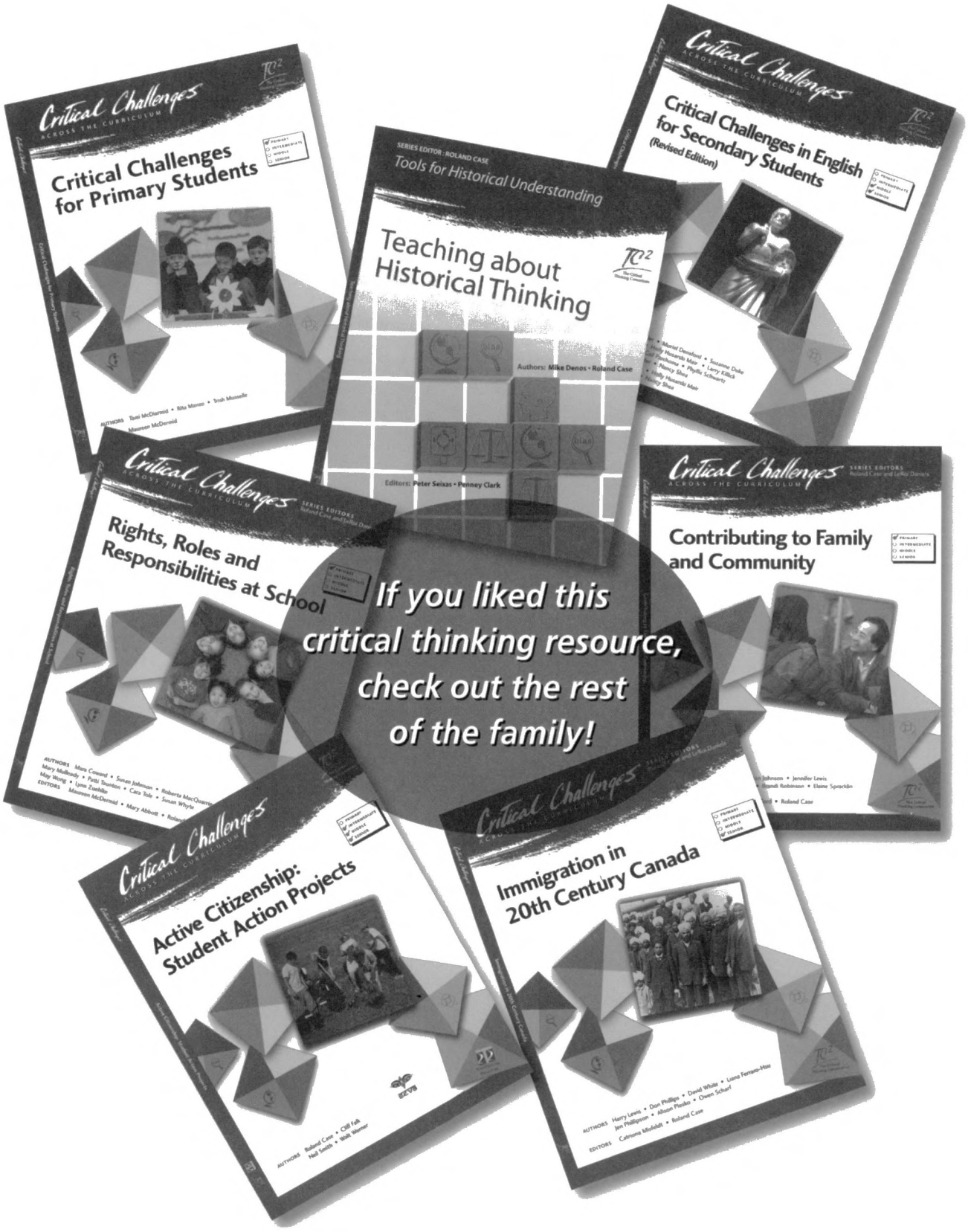

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A professional resource to help teach six interrelated concepts central to students' ability to think critically about geography

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Foreword

Teachers wanting to engage students in geographical thinking through critical inquiry will find this book a very welcome resource. It provides a solid framework of concepts, examples, and questions that clearly develop what critical inquiry means in geographical problem-solving.

Teaching About Geographical Thinking is organized around six interrelated concepts central to geographical problem-solving. These are: geographical importance, evidence and interpretation, patterns and trends, interactions and associations, sense of place, and geographical value judgments. Each concept is discussed and illustrated with examples, questions, and criteria to guide the interrogation and assessment of geographic problems. Most of the examples draw upon current and pressing geographic problems in Canada. The examples are followed by concise discussions of the portal concept's key dimensions and suggestions for practical teaching applications across the curriculum. The teaching activities are designed to challenge students to explain, assess, rank, critique, interpret, conclude, rate, debate, test, and predict. An extended example at the end of the book illustrates how the portal concepts work together to provide an integrated geographical perspective.

The origins and preparation of the book are notable. The Critical Thinking Consortium at the University of British Columbia published *Teaching About Historical Thinking* in 2007 and soon afterwards people began asking them to do the same thing for geography. This led to a partnership between The Critical Thinking Consortium and the Canadian Council for Geographic Education (CCGE), which serves as the education program of The Royal Canadian Geographical Society, from whom it receives its funding. These partners assembled a diverse team of co-editors, co-authors, and reviewers from schools, faculties of education, teacher professional associations, universities, and other educational organizations across Canada. This group began with the six portal concepts from the *Historical Thinking* book and revised and adapted them to apply to the particular challenges of geographical problems. The authors also made good use of feature articles from *Canadian Geographic,* resources from the Canadian Atlas Online, and lesson plans on the CCGE website.

From this unique and successful partnership comes a rich resource to help engage and support students in thinking deeply and critically about geographic subject matter.

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Introduction to geographical thinking

Opportunities for geographical thinking

A ship loaded with fertilizer from northwestern Russia arrived in Churchill on Wednesday, the first time the northern Manitoba port has received goods from Russia.

—CBC News, October 17, 2007[1]

This seemingly simple news event reported online and featured on the CBC national news raises a host of questions that lie at the heart of the study of geography. If we can help students learn to think about and make sense of these kinds of issues, we have gone a long way in getting them to think geographically and in making geography a meaningful and useful part of their lives.

Perhaps the first and most obvious question is, why is this event newsworthy? It is likely that in October 2007 several other ships would have arrived in a new port for the first time. Yet the news coverage was of the docking of a single Russian ship in a small northern port accessible only four months of the year. CBC news anchor Peter Mansbridge referred to the event as a milestone. But what makes this event so important? Is it significant that it was a Russian ship? Would the story have made the news if the ship had been from England or China? Is it significant that the port of Churchill is in northern Manitoba? Does the significance lie in the fact that the ship was carrying fertilizer?

As it turns out, a key feature of this event's importance is the fact that this was the first time a trade ship was able to navigate the Arctic Ocean from Russia to Canada. Until then, goods were typically shipped to Churchill via the Atlantic Ocean from Europe, taking 15 days—almost twice the duration of the exclusively Arctic route. It would appear then that the event is important for its economic benefit. The group of Prairie farmers that arranged for the potash shipment claimed to have saved $400,000 in transportation costs compared with the typical route through Montreal and Thunder Bay.

But the real excitement in this news is not that the port will be able to receive Russian ships for four months a year, but rather the anticipated longer shipping seasons and expanded navigational routes resulting from global warming. Enthusiasts talk of the opening of an "Arctic bridge." The arrival of the Russian ship was possibly the first stage in establishing new, lucrative shipping routes, a year-round accessible Northwest Passage, new cruise ship destinations, and countless spin-off industries associated with servicing northern ports. But even more importantly, the arrival of a Russian ship represents a shift in the geopolitical significance of Canada's Arctic waters.

[1] *Churchill port welcomes first-ever Russian shipment.* Wednesday, October 17, 2007 | 4:42 PM CT, CBC News: http://www.cbc.ca/canada/manitoba/story/2007/10/17/churchill-port.html?ref=rss. See also the video clip of a CBC-TV report on *The National* by Marisa Dragani.

But is this optimism well-founded? Before concluding that this is indeed a milestone event, we need to consider the evidence for these conclusions. Do we know that global warming will have the near-term effects that are predicted? What if it will take 50 years for the navigational season to open significantly? And even if the season is extended, will the anticipated economic bonanza be forthcoming? Churchill has been trying to expand its business for decades. Perhaps there are other factors, not connected to navigational access, that stand in the way of an economic boom.

Further questions remain even if we accept that the anticipated economic benefits will be forthcoming. How will the increased traffic and development affect the existing ecosystem? Can we expect destruction of wildlife habitats and toxic pollution? Will hostile species and bacteria be introduced to the region? Should we not also be concerned about the life and lifestyle of those who live there? Opening up the North will likely alter the "sense of place" and the meaning of this unique region for its inhabitants. Are we able to anticipate what features of this environmentally sensitive region will change and which will persist?

Assuming we can answer all of these questions, we are left with a final overarching concern: Is this a positive development? Should we welcome and hasten these changes? Or are they to be dreaded and resisted? Not all milestone events are positive. They may make economic sense, but are they environmentally sound? Perhaps, if we factored into our economic calculation the true environmental and human costs of opening the North, it would no longer look like a great idea. Then again it may be desirable for some—Prairie farmers and northern shipping interests—and detrimental for others—Inuit residents and southern shipping interests. How do we decide whose interests should carry the day?

Helping students grapple with these kinds of issues is central to teaching them to be intelligent consumers and users of geographic information—in a phrase, it teaches students to think geographically.

The importance of geographical thinking

As the Churchill example shows, a seemingly simple event raises a host of complex geographical questions. We could attempt to answer these questions for our students, but we would be doing students and the study of geography a disservice. Geography education cannot simply be—nor should primarily be—a matter of supplying answers to complex questions about natural and human environments. We must support students in learning to think through these geographic questions for themselves. We must teach them to think geographically.

Geographical thinking ought to be a central feature of geography instruction for at least four reasons:

- ***Engagement.*** Geography becomes more interesting and meaningful for students when they are regularly invited to think for themselves and not simply to find answers that others have produced. It is inherently more engaging to be invited to analyze situations, assess options, solve problems, and reach conclusions.

- ***Understanding.*** Countless educators, from Alfred North Whitehead on, have attested to the limited value of transmitting facts to students. Students are unlikely to remember and are even less likely to understand unless they work with and digest the information they are presented.

- ***Literacy beyond the classroom.*** Unless students are taught to think through geographic questions for themselves, they will be unable to understand and assess the claims they encounter in daily life, when there is no teacher to provide the answers. From a geographic perspective, functional literacy requires that students can make sense of the geography-related conclusions they are presented with, assess and interpret the supporting evidence, appreciate the contributing factors and implications, and judge the merits of various courses of action.

- ***Efficacy.*** If students are to contribute as local, national, and global citizens, they must have a sense of how the space they are a part of shapes and is shaped by other parts of the world.

The challenge is not simply to find ways of making geography more relevant to students. It is, more importantly, a matter of making the study of geography more intellectually active. To do this, students must understand that geography is an integrated body of knowledge and methods that must be constructed, interpreted, and assessed, and a storehouse of opportunities for problem-solving in their own lives and the world around them.

Portals to geographical thinking

A major step in embedding geographical thinking resides in making the curriculum problematic so that the study of geography is more a matter of challenges to think through than it is information to be remembered. Based on the work of Peter Seixas in history,[2] we have identified six concepts that serve as portals to turn the factual content of geography into the subject of analysis. These six concepts are not "content"—although they have to be taught to students—as much as they are sources of questions or considerations that invite and support students in thinking critically about what they are learning. As such, they serve a dual purpose:

- teachers can use these concepts as the basis for raising critical questions about geographic subject matter;

- students can learn to use these concepts as tools to help them think in more sophisticated ways about their natural and human environments.

The six portals are described briefly here; the chapters following elaborate on the dimensions of each concept that students should understand and on the opportunities they present to teachers to invite geographical thinking.

[2] See, for example, P. Seixas and C. Peck, Teaching historical thinking, in *Challenges and prospects for Canadian social studies*, ed. A. Sears and I. Wright (Pacific Educational Press, Vancouver, 2004, 109-117) and M. Denos and R. Case, *Teaching about historical thinking* (The Critical Thinking Consortium, Vancouver, 2006).

Geographical importance. The central question about matters of geographical importance is: *What aspects or features of particular geographic phenomena and locations make them worthy of attention or recognition?*

At the heart of any geographic analysis or representation lies the question of importance. It is a core question in geographer Charles Gritzner's very definition of geography: "What is Where, Why There, and Why Care?"[3] Determining geographic importance requires identifying and assessing the significance or value of a particular location or phenomenon. As we saw in the opening example, this involves asking about the reasons for thinking that the Russian ship's arrival in Churchill might be important and also in deciding whether these reasons are compelling—was it actually a geographically newsworthy event? Conclusions about importance are commonplace and inevitable in geography. For example, we frequently want to determine the most important industries or products in a region or identify the most notable features to highlight in a tourist brochure or on a regional map.

All decisions about what to emphasize or downplay involve questions of importance. These choices are implicit in what cartographers and other geographers include and exclude in their representations. For example, the decision of a textbook author to discuss the Arctic but not the Antarctic region is a matter of relative importance. And notice that conclusions about relative importance will likely vary with the perspective and purpose. An Australian textbook is more likely than a North American textbook to emphasize the Antarctic. Similarly, assessments about the importance of a region may depend on whether the focus is political, cultural, environmental, or economic. Geographic importance can be assessed very broadly (for example, what is the generally recognized biological importance of the North) or more narrowly in terms of particular groups or individuals (for example, what is important in the eyes of Churchill's mayor or the local Inuit).

Evidence and interpretation. These concepts raise the question: *How adequately does the geographic evidence justify the interpretations offered, and what interpretations might plausibly be made from the evidence provided?*

Students often approach data from a naïve perspective, assuming that the data is accurate, relevant, and free of biases or distortion. To provide a more critical perspective on data—the source of all subsequent interpretations—we must invite students to examine the accuracy, precision, and reliability of various data sources. These include primary sources, which provide the raw data for geographical knowledge; secondary sources, which are geographic reports not drawn directly from the object of study; and tertiary sources, which provide overviews of information based almost exclusively on secondary sources. Students must learn to scrutinize the information found in these various sources and to think carefully about the interpretations made from the available evidence. In the discussion of the importance of the opening of the polar region, we saw several opportunities to scrutinize the evidence, including assessing the warrants for believing that a sea route would open up substantially in the near future and that the anticipated economic benefits were consistent with an objective review of all the facts.

[3] C. F. Gritzner. 2002. What is where, why there, and why care? *Journal of Geography* 101(1): 38-40.

Patterns and trends. These concepts raise the question: *What can we conclude about the variation and distribution of geographic phenomena over time and space?*

The concepts of patterns and trends are significant notions in geography. They are what geographers look for as they examine constancy and change in spatial arrangements over time as well as across regions and places. They include efforts to develop models, such as central place theory, to explain and predict patterns. Geographers seek to understand the forces that maintain or shift patterns across space and time and, in the face of changing conditions, predict future trends.

The purpose of raising questions about geographical patterns and trends is not essentially to describe the models and present the generalizations but to invite students to develop their own theories or to use existing models to draw new insights and fresh conclusions about the world. For example, students might study recent warming trends to help them predict the levels of glacial melting or permafrost dissipation in northern Canada over the next decade. Alternatively, they might look for patterns by comparing and contrasting climatic conditions in the Arctic and Antarctic polar regions.

Interactions and associations. These concepts raise the question: *How do human and environmental factors and events influence each other?*

The physical and human environment are powerful forces. They do not exist in isolation. Each shapes and influences the other over time and space. Sometimes these forces interact in mutually transforming ways. Global warming and globalization are some of most widely discussed examples of interacting forces. Recognizing the reciprocal nature of these interactions is essential to understanding the complexities of their functioning. Viewed through the lens of systems, geography becomes dynamic. Particular locations are often in flux, influenced by forces from within and without, changing or reinforcing their identities in response to these forces. Interactions also occur among locations through the movement or exchange of people, goods, services, ideas, and information. Not all influences are interacting; some are associated: they combine together to produce a particular result, such as when the depletion of sea ice and the resulting growth of the tourist industry threaten the continued existence of polar bears.

Examination of interactions and associations must go beyond listing the ways in which a group or place has been influenced by various climatic, economic, and geographic factors. Rather, we want to encourage students to identity and assess for themselves the influences that have shaped the world and to extrapolate from knowledge of interacting forces how the world might have been otherwise and how these factors might operate in the future.

Sense of place. The key question in understanding the geography of a place is: *What are the human and physical features and identities that characterize a place?*

Place refers to the mix of physical and human features that characterize and give meaning to a particular location. Developing a holistic understanding of the qualities of place is geographic perspective-taking. It requires understanding the human (economic, social, historical, cultural) and physical (landforms, climate, soil, wildlife, vegetation)

features that characterize a place. Without a sensitive understanding of the realities of place, students may unintentionally develop mistaken or "foreign" impressions of the experiences and characteristics of other places. For example, someone unfamiliar with the tundra may be prone, quite mistakenly, to view the region as "barren" and "lifeless." These individuals are, in effect, imposing a stereotypical or geocentric perspective rather than perceiving and appreciating the region's distinctive features.

Taking on the perspective of a place requires more than acquiring relevant geographic facts—it requires developing a tangible sense of what it means to "inhabit" the space. It requires an openness to the particular features of a place—a suspending of preconceived or stereotypical ideas about how a place should be. Such a suspension allows students to understand the nature of life and the reasons for the decisions made by people. It is the absence of this kind of appreciation of the Canadian North that prevents many people from making fair and informed assessments of what is at risk with the advent of climate change and massive economic development.

Geographical value judgments. The central question invoked by geographical value judgments is: *How desirable are the practices and outcomes associated with particular geographic actions and events?*

Value judgments in geography arise in the context of drawing conclusions about desired actions and effects. Other portal concepts invite students to inquire into the ways in which things are or how they might be and the reasons for this. The role of value judgments is to engage students in considering what *should* happen, whether what has happened is *desirable,* and what a *positive* possible future would look like. Value judgments can be uninformed and irrational, such as when someone reacts rashly to a situation. They can, however, involve careful, fair-minded consideration of the advantages and disadvantages of the options before reaching a conclusion. Clearly it is the latter kind of value judgments that we want to help students learn to make when assessing the desirability of various geography-related events and situations. The mayor of Churchill and many others may believe that massive expansion of the city's port is highly desirable. We want students to competently assess this conclusion and form their own reasoned opinions based on a consideration of all the evidence.

Geographic value judgments can be offered through various disciplinary lenses—including economic, environmental, cultural, political, historical, and ethical—and from various group and regional perspectives. As was suggested earlier, the expansion of sea traffic in the Arctic may be economically desirable, but environmentally undesirable; it may be a good idea for Prairie farmers, northern shipping interests, and Russian producers of fertilizer, but a poor one for Inuit residents and southern shipping interests.

Overlapping entry points

These six portal concepts offer entry points into the geographic curriculum that overlap in many situations. As was illustrated with the news announcement discussed at the start of the chapter, seemingly simple events can raise questions that touch upon all of the concepts. Often it may be a somewhat arbitrary decision as to which portal is at issue. For example,

an examination of the anticipated melting of polar ice might invoke any of three portal concepts: evidence and interpretation, patterns and trends, or interactions and association. The decision as to which concept is most relevant depends on the aspects of the issue into which we most want to inquire. If our focus is the quality of the evidence—the reliability of the climate change data, whether there is sufficient information to warrant drawing conclusions, whether there are alternative credible predictions—we would want students to apply what they had learned about evidence and interpretation. Alternatively, if the data were relatively unproblematic or if we did not want to emphasize the data's shortcomings, we might focus students' attention on the nature of the myriad changes that accompany polar melting, in which case patterns and trends would be the salient concepts. Or if our objective is to understand the many factors that contribute to the melting of the ice, we would focus on interactions and associations.

In sum, geographical thinking, as driven by the portal concepts, provides a means for turning the factual content of geography into the subject of analysis for students. As we will see in subsequent chapters, these portals provide students with analytic tools to enable them to think through the geography-related issues they will confront in school and, just as importantly, in their lives outside the classroom.

Challenges for teachers of geography

Teaching geographical thinking, rather than simply teaching geography, requires adjusting traditional instructional practices. The following are key factors for successful implementation of geographical thinking in one's teaching.

- ***Making geography problematic.*** Geography has often been taught as an informational subject, rather than one that is inquiry-based. The challenge is to learn to teach geography within a context of exploring genuine inquiries where the conclusions are open for critical debate and not already prepackaged for students.

- ***Assembling of multiple resources.*** Teaching geographical thinking requires that students have access to a variety of primary, secondary, and tertiary sources that reflect a multiplicity of perspectives.

- ***Using geography to inform everyday issues and actions.*** Geography can be used to inform students' understanding of an enormous array of contemporary issues. Students need opportunities to translate what they learn in geography class into decisions that affect their lives and actions.

- ***Offering multiple geographic perspectives.*** No place or phenomenon means the same thing to all people. Acknowledging multiple points of view enables students to see the complexity of issues and prevents rigid, geocentric judgments.

- ***Shifting the focus in assessment.*** Traditional instruction has focused on getting the right answers. In a discipline as rich in information as geography, this has been translated into testing knowledge. Assessing for geographical thinking means evaluating students on their ability to provide evidence-based responses to open-ended inquiries.

- ***Teaching the tools.*** To effectively understand geography, students need a firm grasp of the concepts that guide geographical thinking. They need to apply these regularly to curricular materials and progressively refine their uses of the tools.

Teaching students to think geographically requires energy and openness on the part of both teachers and students. Our objective is to provide teachers with some of the resources to meet these challenges by showing in concrete ways how to use the six concepts as portals to embed and support geographical thinking within their classrooms.

Organization of the book

In the next chapter, we look at alternative conceptions of thinking in geography and situate our approach with these other frameworks.

The second part of this book addresses each of the six portal concepts in detail. Each of these chapters begins with an everyday example illustrating the geographic considerations raised by one of the concepts and explains why these are important. Key dimensions or aspects of each concept are described and specific suggestions are offered for introducing these dimensions to students. These chapters conclude with teaching activities that illustrate how each concept can be used broadly across the curriculum to turn the study of geography into a critical inquiry.

The final section of the book contains extended lesson plans that model how teachers might teach and assess each portal concept and blackline masters of data charts and activity sheets for student use in working with various aspects of the concepts.

2

Alternative conceptions of thinking in geography

Various organizations have developed frameworks and approaches to thinking in geography. It will be useful to situate our approach within the broader scope of these alternative conceptions. We believe these frameworks can be classified under two headings:

- geographic standards or themes; and
- geographic inquiry.

Geographic standards or themes

The most famous framework for thinking about geography is the "five themes" developed in 1984 by a joint committee of geography educators and geographers. Their "framework for studying the world" was organized around the following concepts:[1]

- location;
- place;
- human/environmental interactions;
- movement; and
- regions.

These themes served as organizing strands within which the content of geography could be taught. This model was superseded to a large extent in 1994 when the National Council for Geographic Education developed the National Geography Standards (NGS).[2] Their 18 sets of standards are organized around six elements that subsume the five themes of the earlier developed framework. As described by the Canadian Council for Geographic Education:

> *Voluntary national standards for the study of geography were agreed upon in 1994 in the United States by a consensus of educators, parents and other interested citizens. These standards outline what students should know and be able to do in geography, and are organized into six "essential elements": (1) the world in spatial terms (location); (2)*

[1] Joint Committee on Geographic Education of the National Council for Geographic Education and Association of American Geographers. *Guidelines for geographic education: Elementary and secondary schools.* (The Association of American Geographers, Washington, DC, 1984.)

[2] Geography Education Standards Project. *Geography for life: The national geography standards.* (National Geographic Society Committee on Research and Exploration, Washington, DC, 1994.) Online: http://ncge.net/publications/tutorial/standards/

places and regions; (3) physical systems; (4) human systems; (5) environment and society; and (6) the uses of geography.[3]

A parallel framework of Canadian Geography Standards was developed several years later for Canadian teachers.

Although there is considerable overlap in the terminology used in our approach to geographical thinking and these earlier frameworks, our purposes differ from theirs and, therefore, the common language is potentially misleading. The articulation of standards and themes was intended to provide an organizing structure for the vast subject matter of geography. As the authors explain, they "are benchmarks against which the content of geography courses can be measured," ensuring appropriate coverage of the many important topics and skills in geography. However, these standards do not provide much direction for supporting critical inquiries into geography. That is, they do not consistently invite students to interrogate the concepts; evaluate the validity of claims; assess the relative merits of different accounts of similar phenomena; or extrapolate from the given information to critically consider its implications in new situations. In short, *their focus is more on the key knowledge outcomes of geography than on knowledge building and geographical thinking.*

How does this differ from our approach to geographical thinking? We use the term portal concepts to highlight the difference between studying *about* the world and making the study of the world problematic or open to debate. Our concepts are not "topics" to cover but "challenges" to resolve. The study of geography is a genuine inquiry only when it is not essentially a matter of finding out what others know (students must, of course, do this) but more a matter of reaching conclusions, making decisions, and solving problems using the available tools and information. In a genuine inquiry students are expected to make their own assessments and ground them in careful analysis of diverse data sources, and not simply to locate the conclusions offered by others. Students will learn to think geographically only if they are regularly invited to make reasoned judgments about the most justifiable conclusions or interpretations emerging from the material presented to them. This is the purpose of our framework for geographical thinking.

The following table—From factual coverage to critical inquiry—illustrates the difference between information questions that expect students to *find* an answer and critical inquiry questions that invite students to *reason through* the material. In the left-hand column are the six essential elements of geography identified in the Canadian Geography Standards. The second column lists learning outcomes with the specified grade levels for each essential element. The third column describes a learning activity suggested in the Canadian National Standards for Geography (Royal Canadian Geographical Society 2001) to teach each of the identified outcomes. The last column suggests how teachers might use one or more of the portal concepts to "tweak" the suggested activity into a task or question requiring students to make a reasoned assessment using the information or concepts identified in the learning outcomes.

[3] S. Semple. *Canadian national standards for geography: A standards-based guide to K-12 geography.* (The Royal Canadian Geographical Society, Vanier, ON, 2001.) Retrieved July 22, 2008 from: http://www.ccge.org/ccge/english/prodevelopment/programs_geoStandards.asp

From factual coverage to critical inquiry

CGS essential elements	Broad learning outcomes	Sample activities (Royal Canadian Geographical Society 2001)	Critical inquiries (suggestions for problematizing the sample activities)
The world in spatial terms—Location	Apply concepts and models of spatial organization to make decisions. (Specified outcome for grades 9-12)	Explain the recent shift in retail shopping from original CBDs [Central Business Districts] or suburban shopping centres to retail parks such as Bayer's Lake Park as part of the multiple nuclei model of development.	Based on the lessons learned from recent shifts in retail shopping, recommend the best location for a new fast-food outlet in your city. (*Geographical value judgment*) Rank order the three most significant changes brought on by retail suburbanization for the Central Business District. (*Patterns and trends*)
Places and regions	Evaluate how humans interact with physical environments to form places. (Specified outcome for grades 9-12)	Explain why places have specific physical and human characteristics in different parts of the world (e.g., the effects of climate, tectonic processes, settlement and migration patterns, site and situation components).	What aspects of Canada's northern location and physical geography figure most in shaping the Canadian identity? (*Geographical importance*) Which of the UNESCO heritage designations in Canada represents the most notable example of the interaction of humans on the environment? (*Geographical importance/ Interactions and associations*)
Physical systems	Describe how physical processes affect different regions of Canada and the world. (Specified outcome for grades 9-12)	Explain how extreme physical events affect human settlements in different regions (e.g., the destructive effects of hurricanes in the Caribbean Basin and the eastern United States, the ice storms in Eastern Canada, and earthquakes in Turkey, Japan, and Nicaragua).	Based on the data provided about the destructive effects of an extreme physical event in several places (e.g., hurricanes in the Caribbean Basin and the eastern United States, or earthquakes in Turkey, Japan, and Nicaragua) develop an in-depth profile of each place after the destructive event has occurred. (*Sense of place*) Debate the claim that, relative to other countries, Canada stands to benefit from the effects of global climate change. (*Patterns and trends*)

continued on next page

From factual coverage to critical inquiry (continued)

CGS essential elements	Broad learning outcomes	Sample activities (Royal Canadian Geographical Society 2001)	Critical inquiries (suggestions for problematizing the sample activities)
Human systems	Describe the structure of different populations through the use of key demographic concepts. (Specified outcome for grades 6-8)	Compare Canada and an economically less developed country using natural increase, crude birth rate, crude death rate, and infant mortality.	Based on a comparison of natural increase, crude birth rate, crude death rate, and infant mortality rate in Canada and a selected less developed country, identify the biggest differences for the provision of education, health care, housing, and water in the two countries. (*Evidence and interpretation*)
Environment and society	Describe how humans prepare for natural hazards. (Specified outcome for grades 6-8)	Explain the ways humans prepare for natural hazards (e.g., earthquakes, floods, tornadoes, snowstorms).	What are the biggest differences between Canada's preparedness for three common natural hazards with those of selected countries around the world prone to similar hazards? (*Patterns and trends*)
Uses of geography	Analyze the ways in which physical and human features have influenced the evolution of significant historic events and movements. (Specified outcome for grades 9-12)	Examine the historical and geographical forces responsible for the industrial revolution in England in the late 18th and early 19th centuries (e.g., the availability of resources, capital, labour, markets, technology).	Humans or Nature? Create an annotated pie chart rating the relative influence of geographical and historical forces on the advent of the industrial revolution in England in the late 18th and early 19th centuries. (*Interactions and associations*)

Geographic inquiry

We have referred to our framework as an inquiry approach, yet there are other models for geographic inquiry. For example, in an article titled "Geographic Inquiry: Thinking Geographically," the Environmental Systems Research Institute[4] presents a five-step approach to inquiry:

- ask geographic questions;
- acquire geographic resources;

[4] ESRI Schools and Libraries Program. *Geographic inquiry: Thinking geographically.* (ESRI Inc, Redlands, CA, 2003.) Accessed August 10, 2008 at www.esri.com/k-12

- explore geographic data;
- analyze geographic information; and
- act upon geographic knowledge.

This approach is designed specifically for problem-solving with the aid of geographic information systems. Although the emphasis is on information processing, the approach has many similarities to other "inquiry" models. For example, the authors of the "five themes" framework discussed earlier proposed the following geographical skills for processing information:[5]

- asking geographic questions;
- acquiring geographic information;
- presenting geographic information;
- interpreting geographic information; and
- developing and testing geographic information.

These models of geographic inquiry outline a set of procedures to guide students from framing an initial question about a geographic problem through to acting on the analysis of the acquired information. While each of these inquiry steps might invite reasoned judgment, they often do not. We can contrast our approach to inquiry with the information processing approaches by looking at the kinds of questions recommended as exemplars in the ESRI article (2):

- Where do songbirds nest?
- What is the result of refugees moving from this land across the border to that place?
- Why is there a drought in this region while that region is flooded?

These questions appear largely to require students to find factual information on the topic. Since these answers already exist in textbooks, students are simply "re-searching" the answers—locating ideas and facts that others have uncovered. As such, we would regard these as research questions, not critical inquiry, properly understood. Notice the term "original research" (which may be an oxymoron) indicates that a study is intended to produce new knowledge and not simply reproduce what others know already. Understood in these terms, research (re-search) does not require geographical thinking, but simply skill in information retrieval. We believe that the study of geography is a genuine inquiry—a critical inquiry—when the task is to reach a conclusion using this information. *This feature defines a critical inquiry: it requires that students make a reasoned judgment about the most justifiable conclusion to reach.*

[5] A. Backler and J. Stoltman. *The nature of geographic literacy.* (ERIC Clearinghouse for Social Studies/Social Science Education, Bloomington IN. ERIC Digest No. 35, 1986) available at http://www.ericdigests.org/pre-925/nature.htm

In other words, the information processing approach to inquiry invites more than information retrieval. The following table illustrates how at each step of an inquiry the portal concepts help to problematize the study of two geographic topics—area studies and greenhouse gases.

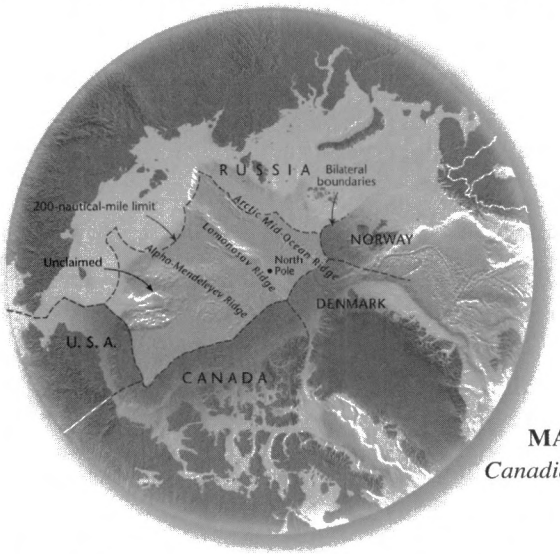
ESRI steps of geographic inquiry	Area studies	Greenhouse gases
Ask geographic questions Through observation and question refinement, create a question about a particular location or phenomenon that sets up exploration.	What are the most significant natural features in these two regions? *(Geographical importance)*	What three factors—human or environmental—have most significantly affected the emission of greenhouse gases? *(Interactions and associations)*
Acquire geographic resources By defining the geographic focus, time period and subject of your exploration, identify and locate the data needed to explore your question.	Which of the three suggested sources (government publication, environmental group report, industry assessment) provides the most reliable information about the assigned regions? *(Evidence and interpretation)*	The assigned materials offer two theories about the causes of greenhouse gas emissions. Which theory is more credible, given the information available to you? *(Evidence and interpretation)*
Explore geographic data Transform your data into tools for exploration: maps, tables, and charts. Explore different organizations and identify patterns.	What patterns of significance emerge as you overlay maps of various features in the region? *(Patterns and trends)*	Is the scale of this atmospheric data (including temperatures, gas levels, and water concentrations) at an appropriate temporal and spatial scale to assess the main causes of greenhouse gas emissions? *(Evidence and interpretation)*
Analyze geographic information Select the patterns and tools that best address your questions, then use queries to find the relationships among the layers of data to answer your questions.	What are the principal causes of the differences between the regions? *(Interactions and associations)*	Based on the available data about atmospheric gas concentrations and human industrial activity for the past 300 years, can we reliably conclude that human activities are a significant source of greenhouse gas emissions? *(Evidence and interpretation)*
Act upon geographic knowledge Using the answers you have gained about complex realities, act to benefit your community and the planet.	Given what you have learned about the main similarities and differences between the two regions, offer a recommendation to the local governments on how best to promote and preserve their unique features. *(Geographical value judgments)*	Given what you have learned about the main sources of greenhouse gas emissions, what actions would be the most effective and realistic for your class to take to reduce local greenhouse gas emissions? *(Geographical value judgments)*

As can be seen, each step in the ESRI model can be extended to invite geographical thinking, but it is the portal concepts that provide entries into this critical inquiry. Without a conscious attempt to create critical questions or tasks that focus students' learning, the use of frameworks organized around standards or stages of inquiry will likely remain information-focused. The defining purpose of the portal concepts is to create opportunities that engage and support students in thinking deeply about the subject matter of geography.

Geographical importance

3

Control over the Arctic Ocean is a matter of much contemporary debate. Under existing international law, countries can claim jurisdiction over areas extending up to 200 nautical miles from their coastline. The following map shows the recognized claims of the five countries involved in this region and a large unclaimed portion, beyond the 200-mile limit.[1]



MAP 1: the status quo
Canadian Geographic, Jan/Feb 2008, p 40

With growing interest in asserting control over this region, the five countries are looking for a basis on which to settle their competing jurisdictional claims. One approach called the median line proposal (shown in Map 2), is to apportion the area among the countries by drawing lines that are equidistant from the two nearest points of shoreline. A second approach called the sector method proposal (shown in Map 3), recommends drawing lines of longitude from the North Pole to the existing territorial boundaries of the respective countries.

MAP 2: median line proposal
Canadian Geographic, Jan/Feb 2008, p 41

MAP 3: sector method proposal
Canadian Geographic, Jan/Feb 2008, p 41

[1] S. Fick and A. Julie. Slicing the polar pie. *Canadian Geographic,* January/February 2008, 40-41.

This dispute over Arctic sovereignty raises issues about geographical importance—*about the features of particular geographic phenomena and locations that make them worthy of attention or recognition.* The most obvious issue pertains to the geographic importance of the region: why is the polar cap worth claiming? After all, interest in the disputed territory has been sporadic. For many periods over the centuries the vast ice-bound region was considered of little importance, except perhaps as a geographical curiosity. During the Cold War the region garnered greater attention because of its perceived military significance. More recently, two developments have heightened its perceived importance: its expected oil and mineral resources—perhaps as much as 10-25% of the world's supply—and the expected increased navigational accessibility due to melting ice caps. The rush to capitalize on the economic potential of this region has fuelled what two reporters dubbed "a new kind of Cold War" among northern countries.[2] Clearly this region is important not solely, or even largely, for its economic value. Many recognize its enormous ecological and scientific significance: the environmental impact of a changing Arctic will be global in its reach.

Questions of geographical importance are invoked at another level—beyond questions about the importance of the region or features of the region. Which factors should be deemed important in making geography-related decisions—in this case, in deciding which markers to use as the basis to apportion the region among the claimants? Physical or regional integrity seems to be an important consideration. Under current law, countries are seen to have a right to control the sea space immediately off their shores. This principle has been extended to include a country's continental shelf and the undersea ridges that extend from this continental shelf. The extension of the continental shelf is the dominant consideration behind the median line proposal. The implicit principle behind the sector method would appear to be access to the North Pole. It is interesting that this "constructed" place—the northernmost point of the globe—little more than a psychological or political concept, is suggested as the determining factor in a decision where billions of dollars are at issue.

It is also interesting to speculate on the other factors that might or should be treated as important when deciding how best to carve up the polar region. For example, should the historical roots and the economic and cultural needs of indigenous inhabitants be considered? Should a circumpolar perspective that spans the interests of all northern nations and peoples be taken into consideration? If we were to take the region's scientific and environmental importance seriously, this could be grounds for denying national jurisdiction over the unclaimed area and for instead placing it under international protection.

As this example illustrates, we must help students learn to question what are often unstated and taken-for-granted conclusions about what is important, geographically speaking. As we have seen, issues involving geographical importance are of two broad types:

- assessing the absolute or relative significance of geographic places, features, and phenomena; and
- determining the weight that various geographic factors or considerations deserve when making decisions.

[2] R. Boswell and A. Mayeda. Stalking Canada's Arctic claim. *Vancouver Sun*, August 16, 2008. A6.

Dimensions of geographical importance

Students will be better able to make sense of the implications of geographical importance if they understand the following aspects or dimensions of this concept.

Determining geographical importance is unavoidable. The need to determine importance arises because of our inability to attend to or deal with all aspects of a given geographic phenomenon or place. This means we must make choices between sites, development plans, navigational routes, and land use, among others. These choices reflect what we consider important. For example, a textbook writer cannot discuss every region in the world, nor can a mapmaker include every building in Vancouver on a city map. Only those places or features judged to be of significance or those that exemplify a particular characteristic will be included. Similarly, the decision to apportion the unclaimed area in the polar region will inevitably give greater importance to some factors than to others—for example, geographic integrity may be emphasized over environmental stewardship.

Recognizing the importance of location. In geography, as in real estate, location is a key factor in understanding the importance of a place. As discussed in the last chapter, the arrival of the ship in Churchill is significant both because of Churchill's absolute location in the Canadian North and its remote location relative to the populous South.

Importance can be broadly based or context-specific. Features may be considered important because of their generally (or publicly) recognized significance or because of context-specific significance. Generally recognized features are accepted as important because of their obvious and broadly applicable value. These features include national boundaries, international cultural and financial capitals, and major rivers and mountain ranges. These are the kinds of features that appear as a matter of course on world and regional maps—there is consensus on their public importance. However, these broad interests are not static. For example, with heightened interest in laying claim to the North, regional geology and hydrology has eclipsed interest in traditional practices of the Inuit people and regional plants and animals.

Context-specific significance depends on particular purposes or perspectives. Features are important only in light of what we want to achieve or because of the perspective from which they are viewed. Examples of features with specific significance include an individual's home or birthplace, unusual plants and animals, and tourist landmarks. They may be important given our specific purpose, but there is no consensus on their general importance. These are the kinds of features that appear only on personal maps or on special-purpose maps.

Assessments of importance are often implicit. Though we all are constantly prioritizing geographic features, we are often unaware that we are making these assessments. In the same way, we often do not see the assessments that others have made that determine what is presented to us as "fact." Decisions of importance determine what we read in textbooks and newspapers, observe on maps and pictures, and see and hear on television. In other words, all information is someone's presentation of what they or others thought to be worth reporting or describing. Becoming aware of assessments helps us to evaluate information

that we are presented with, to understand that information has been selected or omitted on the basis of perceived importance.

Geographical importance is not simply a matter of personal preference. Although conclusions about what is important, or how important one thing is relative to another, reflect differing perspectives and purposes, determinations of geographical importance are not simply matters of personal assertion. Many sports fans may feel that the local hockey team is an important fixture of their city (and not simply a matter of personal attachment). They may be right in this regard. On the other hand, after examining relevant considerations such as audience attendance, economic benefit, entertainment value, tourist appeal, and so on, it may turn out that the team fares very poorly when compared with other municipal attractions. Learning to assess geographical importance requires being clear about the criteria upon which these assessments are to be made. Geographical importance can be assessed on the following interrelated criteria:

- ***Spatial influence.*** The extent or scale of impact that a geographic feature has on the surrounding areas and its inhabitants. This influence can be seen in physical importance (for example, the influence of a river system on the surrounding terrain, flora, and fauna) or human importance (for example, the influence of a river system on the economic and social life of the region). Spatial influence may be positive or negative or mixed (monsoons bring life-giving rain and deadly flooding). Influence can be assessed on three scales:

    - *Magnitude:* How deeply felt or profound is the influence? (Will it result in dramatic or minor changes?)

    - *Scope:* How widespread is the influence? (How geographically dispersed is the affected area?)

    - *Duration:* How long-lasting are the effects? (Will the influence be long- or short-lived?)

    It is easy to see, based on these scales, why climate change is often considered the most important phenomena facing the world today.

- ***Inherent or assigned significance.*** Some features are assigned a particular significance within particular cultural, religious, or historical context. Examples include sacred sites, historic lookout points in a region, graveyards, or ancient ruins. The historical reputation of certain geographic features renders them important, regardless of their current influence. For example, former cultural capitals, by virtue of their former influence, are often accorded importance. The proposed use of the North Pole as the pivotal point for dividing the Arctic region would appear to be based on assigned significance.

- ***Instrumental or strategic value.*** Some geographic features are important because of their role in securing an identified objective that is seen to have value. A road sign or a distinctive tree may be important as a key landmark in getting to a difficult-to-find destination. As we saw, interest in gaining jurisdiction over the unclaimed portions of the polar region is significantly tied with the objective of being able to access oil and mineral deposits that lie beneath the seabed.

Before expecting students to apply the concept in their study of geography, it is helpful to introduce the idea of geographic importance—what it means, the role of perspectives, and how to determine importance.

Teaching the meaning of geographical importance. The following activities may be useful in introducing the idea of geographical importance.

- ***Explore important personal places.*** Invite students individually to identify the four most important places in their own lives and explain in writing why they are important. In a class discussion, compare and contrast their choices and the reasons they have significance. Focus the discussion on what it means to say that a place is important. Ask students whether a place can be important even if an individual is not aware of how it has influenced them.

- ***Create mental maps of the world.*** Ask students to take a few minutes to draw freehand a map of the world. Look to see what conclusions can be drawn about the relative importance attached to certain places by various students from the features, positioning, and level of detail.

- ***Infer cartographers' sense of importance.*** Provide students with several specialized maps of a specific area (for example, a bike route map, a general tourist map, a map of hotels). Invite them to list the important features represented on each map and identify the factors that make these features important (for example, economic or political influence, environmental uniqueness). Alternatively, ask students to tally the frequency in which two categories are noted on the maps: natural features (for example, mountains, bodies of water, vegetation) and human features (for example, cities, streets, political boundaries). Analyze the results to identify the cartographer's criteria for assigning geographical importance in the specific area.

Exploring the role of perspectives. The following activities can be used to introduce the role that perspective plays in geographical importance.

- ***Distinguish generally recognized significance from context-specific significance.*** To help students recognize that importance can be classified into two categories—general (public) and context-specific significance—invite them to sketch a picture, draw a blueprint, or make a bird's-eye-view map of a familiar region (for example, neighbourhood, city, province) showing important human and natural geographical features. As a class, post and compare maps. Challenge students to consider how their representations might differ if they were drawn for a different audience. For example, what features would be important to include in a map of the community if the viewer was one of the following:

  - realtor
  - conservationist
  - business owner
  - visitor

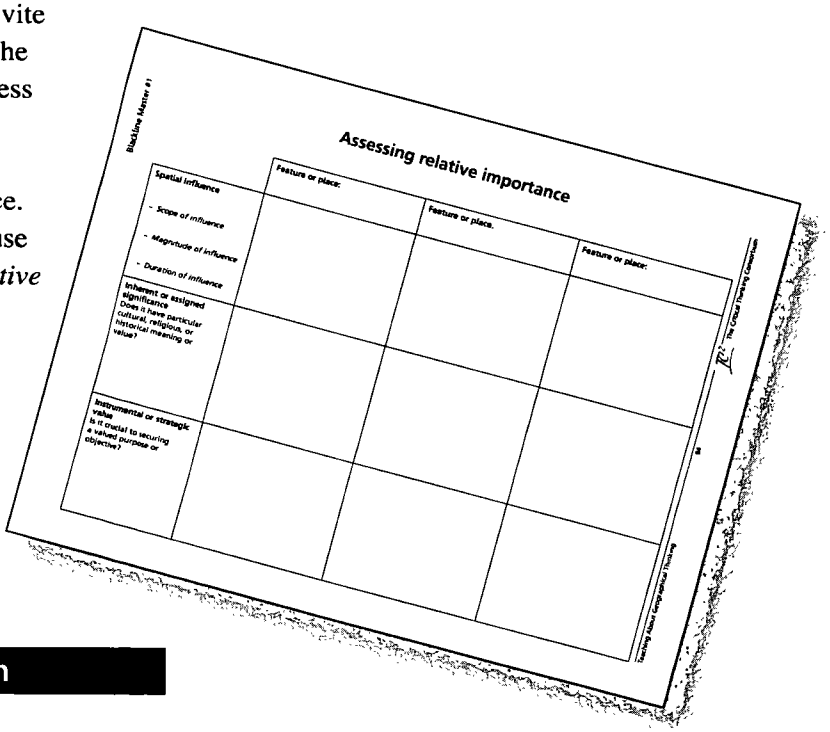
Ask students to draw another picture, blueprint, or map of the same area from an assigned perspective, or to find materials prepared for these purposes. Display and discuss the different representations. Highlight the distinction between features deemed important for general recognition and those of context-specific significance.

- ***Develop consensus on global features or phenomena.*** Instruct students individually, and later in groups, to rank order the three most important features or phenomena in the world from a list you have provided. Invite each group to explain why its chosen features or phenomena were most important. Ask other students to identify the implied values or factors that influenced each group's assessment of geographic importance (for example, economic value, geographic uniqueness, cultural significance, personal meaning).

Introducing criteria for importance. The following activities are intended to introduce students to the criteria for assessing geographical importance.

- ***Assess local features or locations in light of the criteria.*** Present students with criteria for assessing geographic importance. Invite students to identify several important physical features or locations in their community and to explain if and how each criterion applies. Ask students to rank the features or locations in order of importance and to explain their ranking.

- ***Examine the relative importance of selected places.*** Provide students with three prominent cities (for example, Rome, Ottawa, London) or countries (for example, Canada, Iraq, Israel). Invite students to distinguish the relevant features from less important details when considering the relative importance of each place. Encourage students to use the chart *Assessing relative importance* (Blackline Master #1) found at the back of this volume to structure this task. Ask students to rank the places in order of importance and to explain their ranking.



Applications across the curriculum

When students have an understanding of the dimensions of geographical importance, they will be better able to make use of this concept when thinking about the significance of places, features, and phenomena. Following are ways to embed questions involving geographical importance throughout the curriculum.

Explain the importance of a place or phenomenon. Invite students to explain why a particular place or phenomenon is or is not important.

Example: Present students with information about a very large country, such as Australia, and a very small country, such as Israel. (Australia occupies almost 5% of the world's land mass, whereas Israel is one of the world's smallest countries.) Despite its size, Israel occupies a very large space in world politics and geopolitical issues. For example, in 1997 Australia was the focus of 20 articles in the *New York Times* whereas Israel was featured in 500 articles. Encourage students to consider the inherent or assigned significance of the smaller country by asking about the particular cultural, religious, or historical meanings or values attached to it. Also ask students to consider the country's instrumental or strategic value. Finally, invite students to decide, relevant to the larger country, whether the smaller country's more frequent presentation in the media is commensurate with its geopolitical and cultural importance.

Assess the important features of a particular region. Ask students to assess which features of a region under study are the most important. This will involve a close analysis of the criteria for importance, then an examination of what features of a region meet those criteria.

Example: When studying a region such as southern Africa, ask students to generate a list of prominent regional features based on an assigned theme (for example, economic, cultural, natural phenomenon, political). Invite students in groups to gather evidence that supports their choices of features of the assigned theme. Encourage them to consider each of the identified criteria for importance (for example, historical reputation, spatial influence, assigned significance, perceived value). Direct each group to select the five most important features for their assigned theme, and defend their importance in class. Create a collective map that represents the top five features.

Compare or rank multiple locations or phenomena. From a list of locations or phenomena, ask students to select the most important in light of agreed-upon criteria for importance.

Example: Provide students with a list of 5 to 10 cities in Canada in the regions you have studied. In groups, arrange for students to research a city and assess its importance in light of the specific criteria you have discussed. Ask each group to present its importance ranking, and as a class, rank the cities in order of importance.

Evidence and interpretation

What conclusions can we draw about the country profiled below?[1] Can we tell if it is a wealthy or developing country? Mountainous or relatively flat? Coastal or landlocked? Can we determine the likely continent within which it is located? How about identifying the name of the country?

Elevation extremes:	lowest point: 518 m; highest point: 4,374 m
Arable land:	0.76%
Natural disasters:	dust storms, grassland and forest fires, drought, severe winter conditions
Total fertility rate:	2.24 children born/woman (2008 est.)
HIV/AIDS adult prevalence rate:	less than 0.1% (2003 est.)
Literacy total population:	97.8%
Religions:	Buddhist Lamaist 50%, Shamanist and Christian 6%, Muslim 4%, none 40% (2004)
Unemployment rate:	3% (2007)
Population below poverty line:	36.1% (2004)
Exports – commodities:	copper, apparel, livestock, animal products, cashmere, wool, hides, fluorspar, other non-ferrous metals
Internet users:	268,300 (2005)
Telephones—mobile cellular:	775,300 (2006)
Military expenditures: (percent of GDP)	1.4% (2006)

The challenges involved in drawing reliable conclusions, including the identity of the mystery country, raise a host of questions about evidence and interpretation—*How adequately does the geographic evidence justify the interpretations offered, and what interpretations might plausibly be made from the evidence provided?*

On the most basic level, students need to consider which of these statistics are relevant to answering the questions posed and which questions are not answerable by the supplied data. For

[1] *CIA World Factbook*, https://www.cia.gov/library/publications/the-world-factbook/index.html

example, are military expenditures a relevant indicator of GDP? Likely not—levels of military spending may say more about the country's politics than its economic standing. However, internet and cell phone use would appear to be more relevant indicators of a country's wealth, as would the level of population above the poverty line. Determining the relevance of particular statistics is made more complex because several pieces of data may have to be considered in order to answer certain questions. For example, the most relevant clues needed to determine the name of our mystery country include elevation, topography, climate, and religion.

Once students determine the most relevant statistics for particular questions, they can then consider what conclusions to draw from these statistics. For example, is that statistic that 36% of the population live below the poverty line indicative of a very wealthy society, a very poor society, or something in between? In the absence of comparative data, no inferences can be drawn. Data about the number of internet and cell phone users, while relevant, do not on their own allow us to reach any conclusions. Unless we have information about the total population we cannot know whether 775,300 mobile phone users represents the vast majority or merely an elite group. This information may be part of students' general geographic knowledge or they may need to consult additional sources. For example, students may be able to identify Mongolia as the mystery country with the help of an atlas and the available clues—the mystery country it is at a high altitude (no part of it is at sea level), probably landlocked, subject to extreme cold, may be desert-like with little arable land, and is likely in Asia (50% of the population is Buddhist).

Other questions can be raised about the "quality" of the data. Some of the data are several years old and others are estimates. Some percentages, such as those dealing with religious affiliation, are rounded off. Do we have reason to suppose that these may be misleading? Given the reluctance of some individuals and countries to publicly admit to sexually transmitted diseases, we might wonder about the accuracy of the 2003 estimate of the prevalence of HIV/AIDS among adults. More generally, we might worry about the sources of this information. It is unlikely that the 2007 unemployment rate is based on primary data collected by the authors of the website. More likely, it has been compiled from government reports or perhaps even newspaper accounts that may or may not be subject to exaggeration and manipulation.

Even more fundamental questions can be raised about the subjective elements underlying these data. Indicators such as "poverty line" and "literacy" are not straightforward notions—they are constructs that are open to interpretation. For example, is the criterion for basic literacy the ability to sign one's name or to read and understand commonplace documents, such letters, public notices, and newspapers?

It is worth noting that other portal concepts are also relevant to an analysis of these data. For example, questions involving a sense of place invite students to think about the human and physical features and identities that characterize this region. Similarly, we might consider questions of interactions and associations by asking students to identify the human and environmental factors that influence each other. For the purpose of illustrating this portal, however, our discussion has focused on the two broad concerns involving evidence and interpretation:

- the relevance, reliability, accuracy, and clarity of geographic evidence; and
- the validity of any conclusions that are drawn from the evidence.

Dimensions of evidence and interpretation

Before students can make sense of the geographical implications of evidence and interpretation, they must understand key aspects or dimensions of these concepts.

Geographic evidence is not the same as geographic information. A piece of geographic information or datum is a fact about a geographic phenomena: a detail about location, vegetation, altitude, population density, cultural practices, and so on. This information becomes evidence only when it is used to reach or support a particular conclusion. For example, "the lowest point in Mongolia is 518 metres" is a piece of information. This information becomes evidence when we use it to support a conclusion, for example, if the country is landlocked. Students are working with evidence only when they are asked to use information to offer reasoned arguments, reach warranted conclusions, and provide supported explanations.

Geographic evidence is drawn from primary, secondary, or tertiary sources. Sources of geographic information can take three forms: *primary* (raw data), *secondary*, and *tertiary*. The census data cited above on the raw number of households with internet use is a primary source of information. A geographer who writes an article analyzing and interpreting these data has provided a secondary source of information. A student, newsperson, or textbook writer who does not access the actual census data but simply relies on the scholar's analysis when preparing a report would have created a tertiary source of information.

- ***Primary sources*** provide raw or first-hand data. These can be natural records (for example, erosion scars, volcanic ash, soil and water samples) or constructed records (for example, field notes, statistical data, photographs) that are gathered directly from the phenomena under study. Primary sources can be created informally by ordinary individuals (for example, eyewitness' accounts of a landscape, cell phone images of a tornado) or formally by trained researchers through direct observation (for example, field measurements, interviews, geologic surveys, observations) and through remote observation (for example, satellites, spectrometers, or robots). Much of the geographic evidence we use is derived from raw geospatial data. A distinctive property of geospatial data is that they include information on the location or position of an attribute (x and y coordinates) as well as information about the attribute (for example, land use, temperature). Consequently, when assessing the adequacy of the data, we must consider both attribute accuracy and positional accuracy (both horizontal and vertical).

- ***Secondary sources*** have been constructed from primary sources of information—they are second-hand; they are not direct in their access to the phenomenon. These include deliberately prepared accounts (for example, charts, diagrams, maps, travelogues, scholarly articles, movies about a region) that interpret, analyze, and evaluate data obtained from primary sources. Maps are the most common, uniquely geographic source of secondary information, and with increasingly widespread

access to GIS (Geographic information system), almost anyone can create a map from primary data. We cannot always tell whether a report simply reproduces data directly from primary sources or has interpreted or modified the data. The reporting of precise numbers about elevation and arable land are likely verbatim reports from a primary source—and as such are simply reproductions of primary sources—whereas the estimated and rounded off numbers of fertility rates or prevalence of HIV/AIDS are secondary, if not tertiary, reports.

- ***Tertiary sources*** have been complied—simplified and condensed—from secondary sources to make them more convenient and easy to read. They are two degrees separated from the initial phenomenon. These sources are summaries of information derived from analyses of research done by others. Compared to primary data, the potential for error and distortion is magnified. Most high school geography textbooks are derived largely from secondary sources and thus for the most part are a tertiary source of information. Other examples include information found in encyclopedias, reports that summarize the conclusions of other researchers, and newspaper accounts. We cannot distinguish a secondary from a tertiary source until we know where the information was obtained. The list of commodity exports may have been assembled from a summary report and would therefore be a tertiary source of information. Maps that have been developed exclusively through use of other maps are another example of a tertiary source.

Criteria for assessing evidence and interpretation depend upon the source. Each type of information source raises new questions of validity. Thus, the criteria for judging their merits depends to some extent on the type of source. However, many documents—especially textbooks and public media accounts—contain all three kinds of information sources. In practice, then, these criteria are often applied in tandem.

- ***Primary sources.*** When assessing information drawn from primary sources, the principal focus is on the method of data collection or fieldwork. Was the information obtained using careful, consistent, and scientifically credible methods? Is it accurate and complete, or at least drawn from a representative sample? Is it up-to-date? Is it precise?

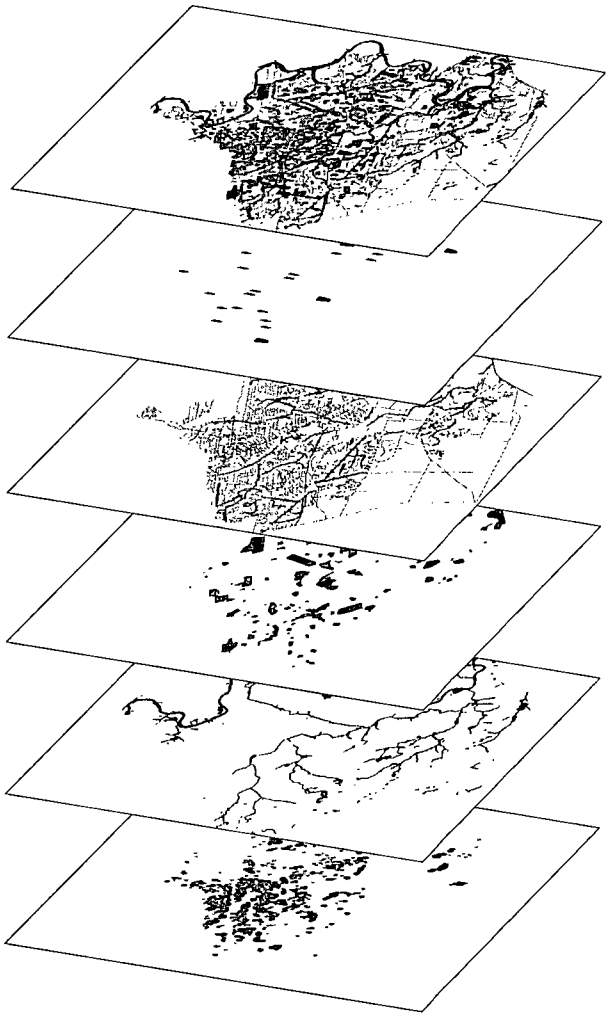
  These were the kinds of questions raised in the discussion of the statistical data about Mongolia found in the *CIA World Factbook*. Strictly speaking, there should be no interpretative element in primary data. However, this is not actually the case. As was mentioned earlier, notions such as "literacy" and "poverty" are interpretative constructs. The measures used to gauge literacy (perhaps a simple reading test) are based on interpretations of the competencies involved and the level needed to qualify as functionally literate. Technically speaking, primary or raw data on literacy would consist of the distribution of scores on the test. But these scores would be meaningless in the absence of direct knowledge of the test. For this reason, many indicators (for example, poverty level, literacy, standard of living, human development index) are provided in an already interpreted form.

- ***Secondary sources.*** Secondary sources can be assessed on two fronts: the quality of the primary evidence upon which the report is based, and the quality of the interpretations or conclusions drawn from the evidence. The first of these two

considerations is essentially the criteria for assessing primary sources. The second consideration focuses on the justification for the conclusions, inviting questions such as: Is the evidence relevant to the proffered conclusions? Has the selection, mode of representation, or interpretation of the raw data created a misleading or skewed effect? Is the collective body of evidence sufficient to draw a conclusion with any confidence? Is any of the evidence inconsistent with the conclusions? Are there other, equally plausible conclusions?

- ***Tertiary sources.*** Because of the derivative nature of tertiary sources, they are the most prone to distortion, omission, and misrepresentation. It is often unrealistic to assess tertiary sources in light of primary evidence because, by their nature, tertiary sources rarely report the evidentiary basis for their findings. The references they provide are typically to the secondary sources they rely upon. In this respect, it is more appropriate to assess the quality and scope of the secondary sources rather than the primary evidence. Do the authors of the secondary sources have solid reputations? Are they credible authorities? Do they represent the spectrum of opinion on the topic? In addition, it would be appropriate to assess the justification of the interpretations or conclusions reached by the authors of the tertiary report. These are similar questions to those used to assess the justification for conclusions drawn in a secondary report.

Maps and other graphic representations are interpreted reports. Mapping and map interpretation are the most important considerations under this portal. Many students may naïvely believe that maps—and for that matter, other visual tools used to present geographic information such as flow charts, cross-sectional diagrams, digital mapping, and GIS—are straightforward representations of the world as it is. In fact, they are not sources of geographic raw data but interpreted representations created for different purposes and through different lenses. Students need to understand that distortions are introduced into geographic information by both the mapmaker and map user. A mapmaker's representation is directly controlled by the scale of the map. Further distortions to the evidence represented on a map arise from the map projection as well as the choice of symbolization and classification of attribute data. The Mercator and Peters projections are perhaps the most famous examples of different ways of representing the world. As such, students must be coached to approach and scrutinize maps as secondary sources of information. In particular, they must learn to ask: Has the selection, mode of representation, or interpretation of the raw data created a misleading or skewed effect? This is especially true with the advent of the Geographic Information System (GIS), which now provides even greater opportunities for geographers and others to digitally organize and modify data into complex visual representations. Are the techniques used for the analysis and representation of the spatial information appropriate and sound? As illustrated below, information on the same geographic region can be layered over each other. For example, a city street map may be supplemented with multi-layers (for example, residences or population density, land parcels or neighbourhoods, street network, landmarks, elevation, natural features, land use). Together, these layers form a constructed image of a particular region. This representation of the region helps us to visualize complex spatial relations, but it also allows more room for error and misrepresentation. An error in one layer can be propagated through all layers. As a result, a multi-layered image of a region is only as accurate as the layer of smallest scale.



Introducing the concepts to students

Before expecting students to apply these concepts in their study of geography, it is helpful to introduce the idea of evidence and interpretation—its various forms and features, and how to assess different information sources.

Explaining the nature of various sources. The following activities may help students recognize the different sources of information and their distinctive features. Present students with criteria for distinguishing among sources of information, including the strengths and limitations of each source in terms of time, effort required, usefulness, accuracy, and precision.

- ***Distinguish primary, secondary, and tertiary sources.*** Present students with a geographical question (for example, Is aquaculture a viable and safe industry?) and a sample of each type of source of geographical information:

  - *primary*: an aerial photograph of a fish farm (search for "aquaculture in BC" or "fish farms in BC" on Google images);

- *secondary*: a discussion of statistics showing production and value of aquaculture in BC (Statistics Canada's Table 1-16 details aquaculture, production, and value by province and Canada [2006][2]);

- *tertiary*: a news article or report describing the fish farming industry (the Canadian Broadcasting Corporation's Marketplace online article: "How 'fresh' is your salmon?"[3]

Ask students to identify which source might provide the most useful evidence to answer the question. You might then present a different question (for example, "Which type of aquaculture is the most profitable?"). Invite students to reassess which source(s) would be the most helpful. Use the examples to discuss the strengths and limitations of each source in terms of time, effort required, usefulness, accuracy, and precision.

- ***Map a photograph.*** Provide each pair of students with a photograph of a landscape with irregular topographical features (*Canadian Geographic* has many suitable photographs for this purpose; see, for example, the picture of the Flathead Valley in British Columbia).[4] Ask students to map the area presented in the photograph. Encourage students to make their own choices about the characteristics of their map:

  - level of abstraction (few or many details)

  - scale selection (small or large)

  - items for representation (elevation, vegetation, roads, and so on)

  - choice of symbolization (contours, coloration, elevation markers, and so on)

  - projection.[5]

  An alternative approach is to present two photographs and ask half the class to draw a map of one or the other of them. Without seeing the original photograph, ask each half of the class to sketch the landscape based solely on another student's map. Regardless of which lesson approach used, compare the results and discuss the distortions that are created by mapmakers and map users.

- ***Generate original primary data and interpret the findings.*** To help students shift from focusing on geographic information to creating and using geographical evidence to make sense of the information, arrange for students to design and carry out a simple investigation of a natural feature such as a local pond or a developed site such as a local park. Agree on a common research question (How effectively is the park used by its users?) and direct students in groups to develop their own data collection methods (for example, interviews, surveys, observations, field measurement). After collecting their data, ask students to interpret their findings and offer an answer to the research question. Arrange for each group to share its

[2] Available at http://www.statcan.ca/english/freepub/23-222-XIE/2006000/t035_en.pdf

[3] This article can be downloaded at http://www.cbc.ca/consumers/market/files/food/salmon/index.html

[4] J. Hull. A river to ruin. *Canadian Geographic*, June 2008, 128 (3): 43-52.

[5] Projection refers to the mathematical formula by which the lines of a grid and the shapes of land and water bodies are transferred from the curved surface of the earth to the flat surface of a piece of paper or computer screen. All projections involve some type of distortion of shape, size, distance, or direction.

conclusions and evidence with the rest of the class, using oral and visual forms of representation. Discuss each group's findings and the problems involved in data collection and interpretation. Ask students to identify and assess the potential sources of error in their data. If appropriate, encourage students to draw upon data from all of the groups to produce a revised, more nuanced conclusion.

- ***Explore the influences of statistical representations.*** Use the following passage from a poem by Cecil Rajendra to introduce the idea that the manner of representing geographical data can significantly alter the impression created.[6]

Statistically
it was a rich island
income per capita
one million
per annum
Naturally
it was a shock to hear
half the population had been carried off
by starvation
Statistically
it was a rich island
A UN Delegation
(hurriedly dispatched)
discovered however
a smallish island
with a total population
of—2
Both inhabitants
regrettably
not each a millionaire . . .
as we'd presumed
But one island owner
Income per annum:
Two million
The other
his cook/chauffeur
shoeshine boy/butler
gardener/retainer
handyman/labourer
field nigger etc. etc.
The very same
recently remaindered
by malnutrition
Statistically
It was a rich island
Income per capita
per annum
one million.

[6] C. Rajendra. *Songs for the Unsung—Poets for unpoetic issues like war, want and refugees.* WCC Publications, Geneva, 1983. Available online at http://www.globaleducation.edna.edu.au/globalperspective/part_b/activity_1/statistics.htm

Discuss the ways in which statistical manipulation of the data leads to misperceptions about the conditions on this fictional island. As a follow up, provide students with information that would lend itself to easy manipulation (for example, the area covered by a forest fire, the population, the number of automobiles, or the increase in the past decade of cell phone use in selected countries such as Canada, India, United States, Egypt, and Japan). Depending on the data, ask students to use mechanical or online programs to create several versions of a map (or chart or graph) to produce significantly different impressions by altering the scale, projection, mode of representation, and selection of data. (The ColorBrewer site allows students to experiment with changing the way a map looks but does work with real data.[7]) Create an award for the most misleading representation. Present students with criteria for assessing which representation most fairly presents the entire data: consistency in reporting, representative of the data set, informative, represents the broader significance of the phenomenon. Discuss the representation and identify the reasons for this choice.

- ***Use visual manipulations to reach conclusions***. Present students with a simulation such as the following to introduce them to the use of GIS or mechanical representations to assist in reaching geography-related conclusions.

  Background

  It's a glorious day so you decide to visit Kitchener, Ontario for one day. You travel from Toronto on a bus, which drops you off at the centre of downtown. You spend about five hours exploring the city.

  You begin your tour of this relatively flat landscape by exploring downtown and admiring the new lofts that are built within 1 km of the city centre, all transformed from old factories. You notice that sprinkled around the new residential neighbourhoods are some ethnic department stores located about 1 km away from the city centre. You visit each of these stores, purchasing gifts for friends.

  Before exploring further, you decide to have lunch by a pond in a park. After a delicious one-hour lunch break, you plan your day, wanting to walk along the bike/pedestrian routes. Along the path, you enjoy the tranquility of the residential neighbourhoods, the creeks, and the forested areas. Since it's a hot day, you decide to spend more time walking in the shaded parks along the bike trail.

  The problem

  After a fruitful but exhausting day, you make your way back to the bus station. You check your watch to make sure that you are making good time. But it's not there! You lost your watch along the way. You frantically recall your day's journey and write down some facts to help you relocate your watch.

  - You travelled a maximum distance of 2.5 km away from the bus terminal located downtown.

[7] ColorBrewer site: http://www.personal.psu.edu/cab38/ColorBrewer/ColorBrewer.html

- You had lunch in a park.
- You estimate your strolling speed to be about 1 km/h.
- You travelled only along the bike trails during the tour.
- The last time you looked at your watch, you were 500 m away from a bank, a department store, and a restaurant.

You are running out of time to catch your bus. With one hour left, which street intersection (or the two most highly probable locations) would you visit to find your watch and make it back to catch your bus to Toronto?

Your tools

If you are using a GIS, consider these operations to examine the spatial relations between layers to narrow down the locations:

- measure tool
- zoom in/zoom out
- buffer
- intersection
- spatial query (select by attributes)
- select features

If working with the map, consider using the following tools:

- ruler (scale conversion, distance measurement)
- compass (to draw circles or buffers)
- pencil (shade in or label areas)

Possible solution with GIS or manual devices:

- Draw a buffer or circle of 2.5 km distance around the bus terminal (or from centre of downtown) (GIS operation: buffer).
- Find all parks that are within a distance of 2.5 km of downtown and have water running through them (GIS operation: select by attribute or highlight tool).
- Select all bike trails that are within 2.5 km of downtown (GIS operation: select by attribute or highlight tool).
- Find area where a department store, bank, and restaurant are within 500 m from each other (GIS operation: select by attribute).

- Estimate how far along the bike trail you walked, given the speed and approximate time of travel (use scale as gauge for distance; time is maximum of three hours).

- Based on above clue, select bike trail likely of travel, with more shade or parks (one that is south of downtown).

Assessing the evidence and conclusions. The following activities may help students learn to assess the quality of various sources of evidence and the justifiability of conclusions.

- ***Introduce criteria for assessing statistical data.*** Assemble various reports of statistical data from websites, newspapers, and textbooks. Provide contextual information for each piece of datum (for example, researcher, source of publication, focus and date of the study). Present students with the following criteria for assessing the credibility of statistical data and invite them to sort the example into four categories: (1) obviously credible; (2) no reason to suspect its credibility; (3) credibility may be an issue; (4) obviously not credible.

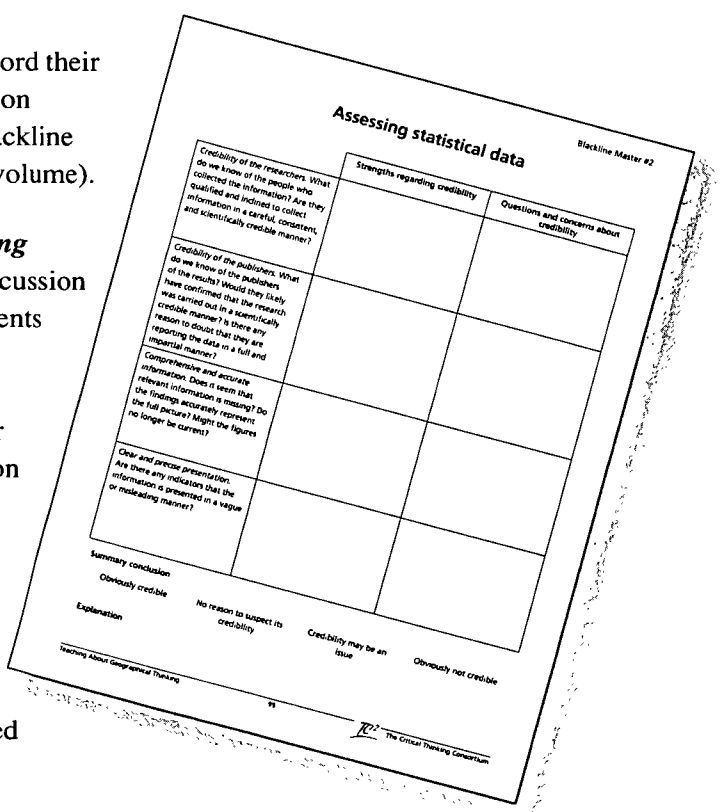
    - *Credibility of the researchers.* What do we know of the people who collected the information that might affect its believability? Are the researchers qualified and inclined to collect information in a careful, consistent, and scientifically credible manner?

    - *Credibility of the publishers.* What do we know of the publishers that might affect their credibility? Is there any reason to doubt that they would have confirmed that the research was carried out in a scientifically credible manner? Is there any reason to doubt that they are reporting the data in a full and impartial manner?

    - *Comprehensive and accurate information.* Does it seem that relevant information is missing? Do the findings accurately represent the full picture? Might the figures no longer be current?

    - *Clear and precise presentations.* Are there any indicators that the information is presented in a vague or misleading manner (for example, loose estimates, ill-defined concepts, undated)?

Encourage students to record their observations and conclusions on *Assessing statistical data* (Blackline Master #2 at the back of this volume).



- ***Introduce criteria for assessing reports and articles.*** Most discussion of geographic issues that students encounter will be from news reports, websites, and articles. Select a newspaper account or website that offers a conclusion on a controversial topic. Invite students to determine the author's position and to assess how well the author has justified this conclusion. Then introduce the criteria for assessing justifiability listed below.

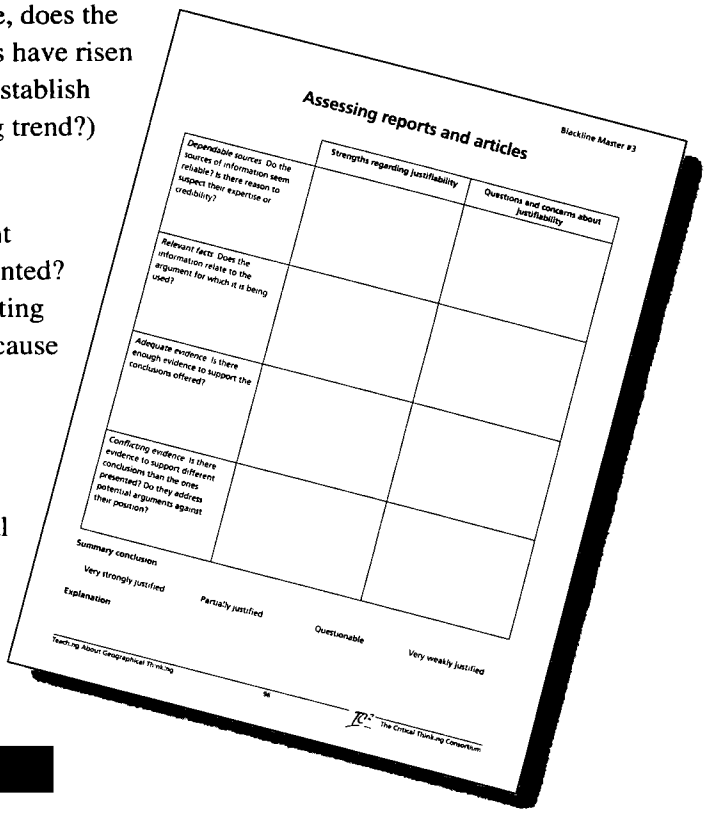
- *Dependable sources:* Do the sources of information seem reliable? Is there reason to suspect their credibility? (For example, is the author of a report on the Alberta oil sands associated with an petroleum company?)

- *Relevant facts*: Does the information relate to the argument for which it is being used? (For example, in anticipating the environmental damage caused by the Alberta oil sands, is the damage done in Middle Eastern oil fields relevant?)

- *Adequate evidence.* Is there enough evidence to support the conclusions offered by the scientist? (For example, does the fact that average temperatures have risen for most of the last 10 years establish that the world is in a warming trend?)

- *Conflicting evidence.* Is there evidence to support a different conclusion than the one presented? (For example, is there conflicting evidence about the principal cause of global warming?)

Provide an additional article that reports the issue differently. Ask students to assess the original article by completing the chart *Assessing reports and articles* (Blackline Master #3 found at the back of this volume).


Assessing reports and articles

Blackline Master #3

	Strengths regarding justifiability	Questions and concerns about justifiability
Dependable sources. Do the sources of information seem reliable? Is there reason to suspect their expertise or credibility?		
Relevant facts. Does the information relate to the argument for which it is being used?		
Adequate evidence. Is there enough evidence to support the conclusions offered?		
Conflicting evidence. Is there evidence to support different conclusions than the ones presented? Do they address potential arguments against their position?		

Summary conclusion

Very strongly justified | Partially justified | Questionable | Very weakly justified

Explanation

Teaching About Geographical Thinking

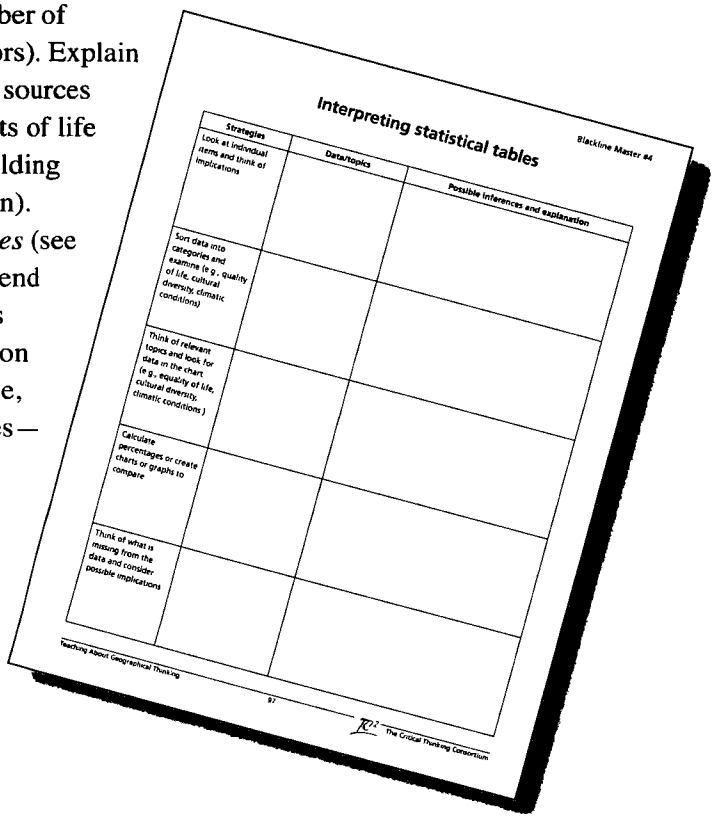
The Critical Thinking Consortium

Applications across the curriculum

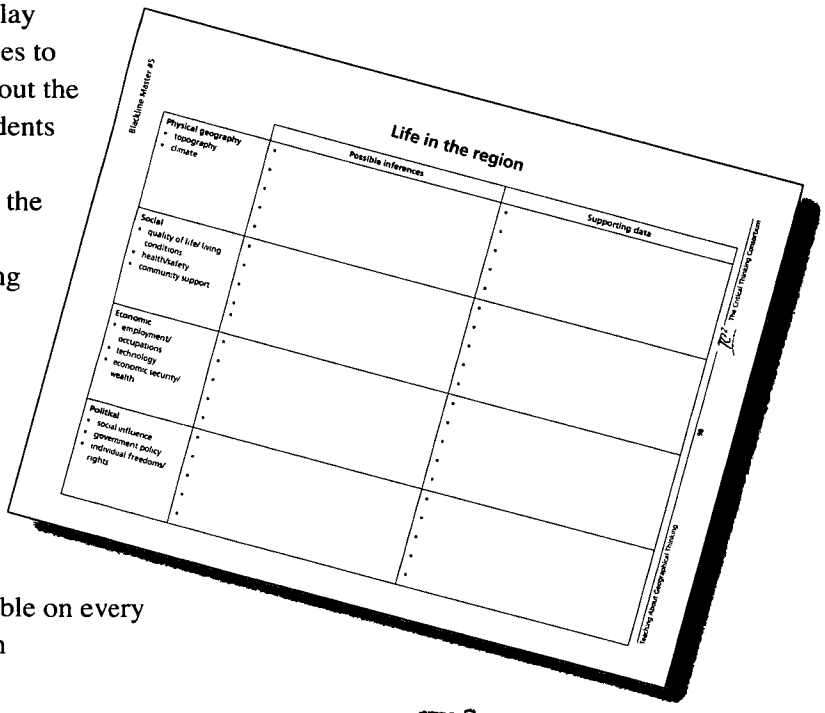
When students have an understanding of the dimensions of evidence and interpretation, they will be better able to make use of these concepts when thinking about the conclusions geographers reach and the adequacy of the support for these claims. Below are ways to embed questions about geographic evidence and interpretation throughout the curriculum.

Interpret statistical and graphic representations in textbooks. Geography textbooks are filled with all varieties of maps, graphs, tables, charts, cross-sectional diagrams, onsite and aerial photographs, and other visual representations. Regularly invite students to interpret these sources of information at two levels: the literal and inferential. The literal level consists of a rather straightforward "reading" of the contents of the graphic representation. To do so, students must understand the symbols, scale, and other variables represented in the graphic. This is analogous to knowing the meaning of the words in a paragraph in order to decode its literal message. The more challenging interpretations are at the inferential level where students go beyond what is actually presented to draw fresh conclusions (for example, deciding from a map which sites are most likely to have particular climatic conditions). Wherever possible, provide students with strategies or clues to assist them in digging deeper into data. Encourage students to pose and answer their own inferential questions about the topic that might be illuminated by these visual representations.

Example: Provide students with a table showing the breakdown by trade or profession of occupations in a given region. Ask students to draw an inference about the wealth of the region based on information in the table and to justify this inference with reference to the data (for example, the number of unemployed, the number of doctors). Explain to students that tables can be rich sources of information about various facets of life in a region (for example, diet, building material, industrial base, and so on). Using *Interpreting statistical tables* (see Blackline Master #4 found at the end of this volume), introduce various strategies for extracting information from statistical tables (for example, sorting occupations into categories—perhaps manual and skilled—or looking to see what occupations are missing—perhaps high tech jobs or service industry workers). Encourage students to examine the table carefully, paying attention to detail as they look for possible inferences and supporting explanations.



Draw conclusions from multiple data sources. Early in the study of a region (for example, Canadian Boreal Shield) or a geographic phenomenon (for example, Hurricane Katrina) assemble a collection of disparate pieces of information on the topic. Collect these from different geographical sources (for example, satellite images, contour maps, physical maps, geological surveys, maps showing natural vegetation, pie charts, quality of life indicators). Invite students individually or as a class to play "What am I? by using the clues to glean as much as they can about the mystery item. Encourage students to use *Life in the region* (see Blackline Master #5 found at the end of this volume) to record their inferences and supporting evidence.



Example: Instead of asking students to collect evidence about a region or country, provide them with selected statistics on a particular country (available on every country in the world from

CIA World Factbook[8] and several world maps (seasonal precipitation, population, physical geography). Invite students to look for clues in the statistical data (land mass, precipitation, standard of living) and match this with information on the maps and with their own background knowledge to identify the mystery country.

Assess the warrants for textbook and media conclusions. Regularly engage students in critique of the conclusions offered in a geography textbook or newspaper account. Invite students to consider the specific information (both from primary and secondary sources) that would be needed to support these claims and what data might contradict them. Encourage students to identify sources where they might locate this information. Ask students to research these sources or present them with a background sheet that you have prepared, containing relevant information. Ask students to read the surrounding sections of the document to ascertain how adequately the authors have supported their claims.

Example. When studying about the Pacific Rim, present the following statements taken from a textbook:[9]

> *The cultural geography of the Pacific Rim is marked by the contrast (sometimes collision) of modern and traditional societies.*
>
> *Much of the economic success of the economic tigers of the Pacific Rim is due to high skills and low wages.*

As a class, brainstorm the kind of information that would help to establish or refute each claim (for example, the incidence of tensions between "traditional" and "modern" practices in various fields—architecture, business, education, agriculture; comparative figures with other regions in the world—Africa, Europe). Identify potential sources for this information (for example, gazetteer) and try to locate relevant data from these sources. As a final task assess the adequacy of the author's support for the claims by reading the appropriate section of the textbook. If desired, ask students to assess the textbook claims by completing the chart *Assessing reports and articles* (Blackline Master #3 found at the back of this volume). If the authors have not supported the claims adequately, remind students that this does not mean that the statements are false, merely that the reader has not been provided with good reasons to believe them.

Assess competing explanations or arguments. Present students with two or more newspaper or website accounts that offer differing conclusions or theories on a topic (for example, fish farms, climate change). Ask students to identify the arguments and conclusions offered in the sources. Discuss the following questions: Where do they differ? What do they agree on? What is included in each position? What is omitted? Invite students to assess the credibility of each position by looking at the amount and quality of the evidence and the conclusions drawn. If desired, ask students to assess both articles by completing the chart *Assessing reports and articles* (Blackline Master #3 found at the back of this volume).

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[8] *CIA World Factbook*: https://www.cia.gov/library/publications/the-world-factbook/index.html

[9] H.J. De Blij and P. O. Miller. *Geography: Realms, regions, and concepts* (seventh edition). (John Wiley & Sons, Toronto, 1994, p. 222.)

Example: Present student with arguments for and against fossil fuels as the major cause of global warming. Introduce the topic by inviting students to listen to the contrasting audiovisual presentations found on the websites of the Friends of Science website[10] and the Canadian Online Atlas.[11] Direct students to specific sections on "Climate change" on the Canadian Online Atlas website and "Climate science" on the Friends of Science site. Invite them to compare and assess the evidence and conclusions offered by each side.

[10] Friends of Science: http://www.friendsofscience.org/

[11] The Canadian Atlas Online: http://www.canadiangeographic.ca/atlas/

Patterns and trends

The aerial photographs on the following page show the city of Coquitlam, a suburb to the east of Vancouver, during three periods of its development—1954, 1969, and 1980. They provide interesting opportunities to explore the trends in this area over a 25 year period. As well they invite investigation of the patterns of distribution at any given time—of the diversity and homogeneity within the community at one stage in its development.

As suggested above, these photos provide clues about change and constancy in this community. Perhaps the most inviting question concerns the chronology of the photos. What trends in the development of this community help us sequence the photos? For example, we can see increasingly more buildings, houses, and streets in each of Photo 2 (1969) and Photo 3 (1980) and a freeway appears in the lower left-hand corner in the Photo 2 and remains in Photo 3. The largest areas of farmland and trees are in Photo 1 (1954).

We may also ask how land use has changed and whether these changes have dramatically altered the conditions for local inhabitants. For example, have property sizes and housing options changed during this period? Many of the properties appear to be acreages in 1954 and look to have been subdivided into individual lots by 1980. By this time, large apartment blocks appear on the edge of the commercial area. The area around the intersection of Lougheed Highway and North Road is entirely commercial by 1980 and large parking lots are positioned around the main building. What changes have occurred in the natural vegetation? It looks, for example, that large coniferous trees are still evident on the golf course, in the valley of the Brunette River, and in some of the gullies. The cleared farmland in the 1954 photo suggests that removal of the natural vegetation had already taken place to a large extent. The 1969 and 1980 photos indicate continued removal of vegetation. We might also ask which period—1954-1969 or 1969-1980—saw the greater changes in this community.

Other questions focus on trends in the community over time. For example, we might look to identify those features that have remained relatively constant over the time span. For example, the road patterns do not seem to change across the three photos, although they appear to have been widened in latter photographs and more streets were added to the established pattern. Had the area become suburban by 1954, or did this development not become evident until 1969?

Yet more questions can be raised about the community at a given point in time. For example, is the area in 1980 a relatively homogeneous community, or do land use patterns vary? Is there disparity in housing values, amenities, and quality of life among neighbourhoods? What is the look of development by 1980? Has the community created a core business district with residential development around the periphery?

Clearly, other portal concepts are relevant to the study of these aerial photographs. For example, we might raise questions about evidence and interpretation by considering the accuracy of our interpretations. Questions about geographical value judgments arise when asking if these development practices are desirable. For our purposes, the focus has been on the patterns and

distribution of land cover changes over a 25 year period. As this discussion illustrates, questions of patterns and trends invite us to identify constancy and variation within and across regions over time and at a given point in time—*What can we conclude about the variation and distribution of geographic phenomena over time and space*?

Note: These photos are oriented so north is at the top of the image. The major north/south route in the centre of each photo is called North Road. The major east/west route that angles from the southeast to the northwest is called Lougheed Highway.

Photo 1: 1954

Photo 2: 1969

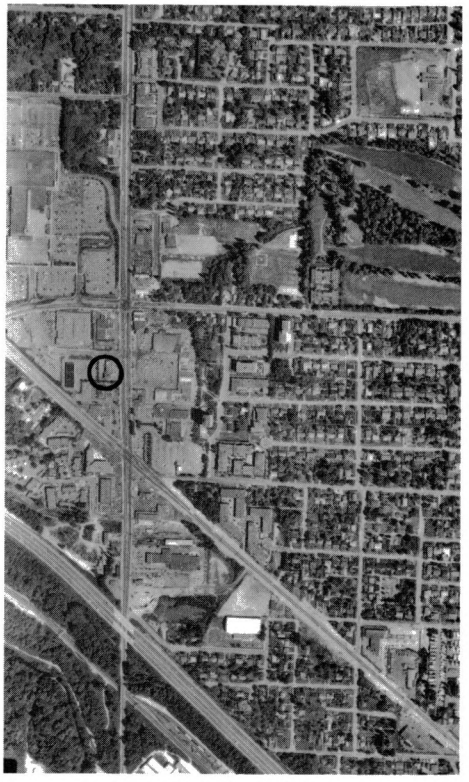


Photo 3: 1980

Dimensions of patterns and trends

Before students can make sense of geographical patterns and trends, they must understand the following aspects or dimensions of these concepts.

Constancy and variation are ever present over time and across space. Change and continuity can be seen in all natural and human phenomena, whether it is regional disparity, patterns of resource use, communication and road networks, innovation diffusion, species and ecosystems, cultural groups, or demographics. Things may seem to be changing, at least in some respects, all the time, while in other respects they may seem stable for extended time periods. Taking a long view, all phenomena go through periods of both constancy and change. Many natural phenomena reoccur in cyclic fashion, ranging from seasonal cycles (for example, monsoons or snowfall) to multi-year cycles (for example, earthquakes or volcanoes). Even during cycles, there are periods of stability and constancy (for example, consistent temperature and precipitation patterns).

Temporal and spatial variation take many forms. Patterns and trends vary for different phenomena, and over different time scales. Temporal and spatial variation can be tracked in terms of the rate, pattern, and distribution.

- ***Rate.*** Temporal and spatial variation may occur at rates that range from gradual to very quick. Some changes are difficult to detect over short periods of time (for example, plate tectonics and climate patterns) while others are completed within minutes or hours (for example, weather shifts and water levels). Some phenomena show abrupt rates of change across space (for example, the popularity of CBC Radio between the U.S. and Canada; rainfall patterns on either side of the Coastal Mountains), while others vary gradually over space (for example, linguistic accents across Canada; real estate density and prices with distance from the Toronto subway line). Even phenomena that seem to be static are changing gradually (for example, mountain erosion). The rate of variation is relative to the norm for that phenomenon—depending on the temporal (geologic, historic) and spatial (global, national, local) scales that apply. For example, climate change over a 20-year period is rapid, whereas changes in temperature over a two-week period are slow. Similarly, changes in tree species in a forest over several hundred metres is relatively rapid whereas changes in a demonstration forest over several hundred metres would be relatively gradual.

- ***Distribution.*** Temporal and spatial variation may be distributed uniformly or inconsistently. Temporal variation is sometimes a matter of steady change (for example, the tides) or inconsistent changes (for example, the boom and bust of Canadian immigration). Similarly, spatial distribution may vary from uniformly present (for example, oxygen in the inner atmosphere) to highly irregular (for example, gold deposits that are plentiful in some regions and absent in others).

- ***Pattern.*** Temporal and spatial change may occur in recognizable or in random patterns. Temporal variation ranges from recurring patterns (for example, the tides and seasons) to unidirectional change (for example, soil erosion and river currents), while some changes exhibit mixed patterns (for example, ground water—only some aquifer water is returned to the surface and much remains

permanently underground). Spatial variation may appear in predictable patterns, such as linear, cluster, or concentric zones (for example, noise levels as one moves away from a factory) or randomly over an area (for example, noise levels within a school). Various phenomena have distinctive configurations (for example, drainage patterns include trellis, dendritic, and radial; and transportation patterns include radial, grid, and garden).

Patterns and trends are measured in varied units. Spatial scale is often measured in area (km^2 or square miles). But geographers use many different scales to measure particular forms of variation and constancy. These scales include *volume* (cubic feet, km^3), *length* and *elevation* (metres, feet, kilometres, light years), *time* (seconds, hours, years, centuries, millennia), *heat* (degrees), *pressure* (psi), and *quantity* (PPM, number, number per thousand, percent).

Geographical models describe and predict patterns and trends. Geographers develop models to generalize and predict temporal and spatial rates, patterns, and distributions of occurrences in space at a given time or over time. Geographic models may be digital (for example, GIS models), physical (for example, reconstructed models of a site, globes) or theoretical (for example, theories of technological adoption). For example, distance decay theory suggests that phenomena such as disease, heat, and noise levels may either increase or decrease with intensity as their distance from the source increases. Models may be assessed on the extent of their fit with the data, their predictive potential, and the spatial breadth and temporal duration of their application—how widely the theory holds and how enduring the theory will be.

Patterns and trends can be compared over time and across space. Geographers often find it useful to assess the relative degree of constancy and variation operating in a space. They would do this when deciding whether a particular location should be assigned to one region or another. Three criteria are useful for this purpose:

- ***Breadth of occurrence*** (spatial scale). How widely is the phenomenon found? For example, some diseases, such as Ebola, have a limited geographic distribution while other diseases, such as cancer and AIDS, are found in virtually every country.

- ***Duration of occurrence*** (temporal scale). How long has the phenomenon lasted? For example, sand dune patterns are ephemeral, depending on the wind, whereas historically the migration of birds and butterflies has persisted year after year.

- ***Depth of impact*** (superficial or deep implications). How profoundly does the constancy or variation affect the area where it occurs? For example, the invasive species kudzu is distributed extensively across the southern United States, where it poses a major threat to indigenous vegetation. On the other hand, non-native species such as purple loosestrife and garlic mustard do not have a significant impact on native plants or animals.

Introducing the concepts to students

Before expecting students to apply these concepts in their study of geography, it is helpful to introduce the idea of geographical patterns and trends—their various forms and features, and how to assess the degree of variation across space and over time.

Recognizing the pervasiveness of constancy and variation. The following activities may help students to appreciate how human and natural phenomena remain constant and inevitably differ over time and across space.

- ***Examine the relativity of rates of variation.*** Share with students the following allegory involving a bug whose lifespan is one day. Discuss what students can learn about the relative nature of change in their own lives.

  A bug whose life spans exactly one day is born in the morning, by midday is middle-aged, and dies within 24 hours. Imagine that the bug lives its entire life on a tree. Later in the evening we have an opportunity to ask the bug a few questions.

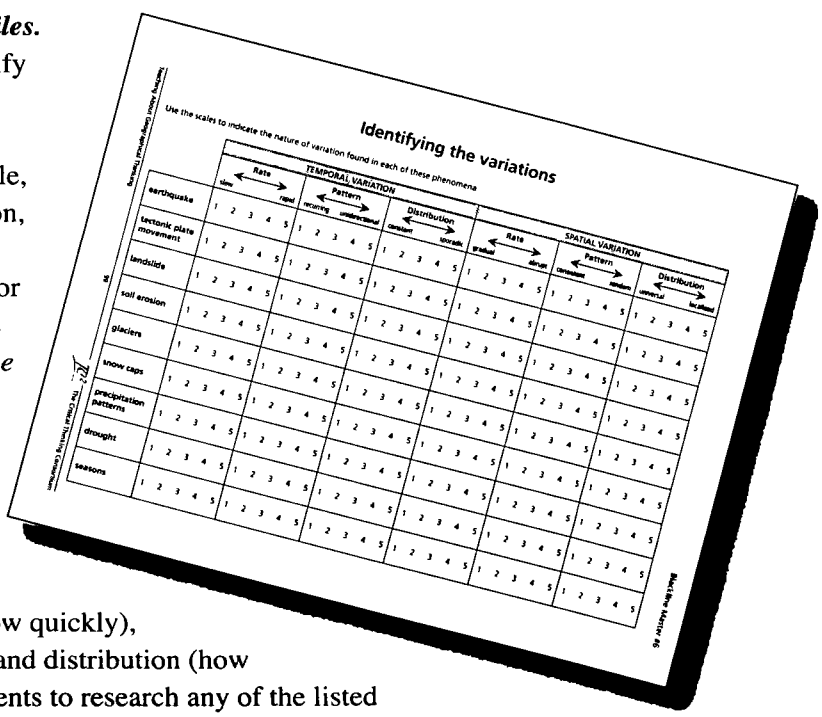
  We ask, "How long have you lived on this tree?"

  "My whole life," he replies.

  "Has anything changed?" we inquire.

  "No, not at all," says the bug. "The tree has remained exactly the same throughout my entire life."

- ***Identify variation profiles.*** Invite students to identify patterns and trends for a familiar geographical phenomena (for example, earthquakes, soil erosion, icebergs, avalanches). Distribute to each pair or small group of students a copy of *Identifying the variations* (Blackline Master #6 found at the back of this volume). Explain each of the dimensions of temporal and spatial change: rate (how quickly), pattern (how orderly), and distribution (how consistently). Ask students to research any of the listed phenomena they are not sure of and to identify the form of variation for each.



- ***Sequence regions over time.*** Present students with a series of satellite images, aerial photographs, or archival images of a familiar location or geographical phenomena (for example, deforestation, pine beetle epidemic), taken over months, years, or decades. Ask students to place the images in chronological order and explain their reasons. Direct them to look for patterns and trends in the images that provide clues as to their chronology. Several websites have useful comparative image archives:

  - National Resources Canada's National Air Photo Library has aerial photographs of major cities in Canada;[1]

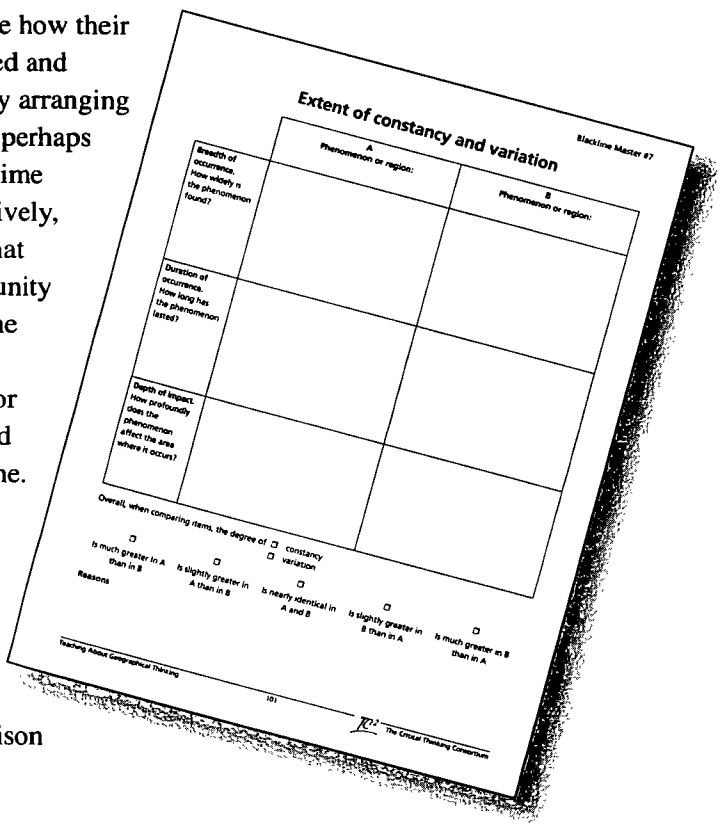
  - the Atlas of Canada's Map Archive provides maps of major Canadian cities over a period of years;[2]

  - McCord Museum's Urban Life Through Two Lenses has images of the same areas of Montreal at different times;[3]

  - many city archives such as the Edmonton Archives have maps and architectural drawings suitable for examination.

Assessing the degree of constancy and variation. The following activity may help students learn to assess the extent of constancy and variation—either temporally or spatially.

- ***Examine changes over time and across space.*** Help students appreciate how their own communities have changed and remained constant over time by arranging a visit to the local archives, or perhaps conduct interviews with long-time community residents. Alternatively, download a series of images that show scenes from your community over several decades or over the last 100 years. Ask students to note the clues in the accounts or images about what has changed and what has remained the same. Invite students to use *Extent of constancy and variation* (Blackline Master #7 found at the end of this volume) to assess the degree to which the city is more alike than different over the comparison periods.


Extent of constancy and variation

Blackline Master #7

A
Phenomenon or region:

B
Phenomenon or region:

Breadth of occurrence. How widely is the phenomenon found?

Duration of occurrence. How long has the phenomenon lasted?

Depth of impact. How profoundly does the phenomenon affect the area where it occurs?

Overall, when comparing items, the degree of ☐ constancy ☐ variation

☐ Is much greater in A than in B

☐ Is slightly greater in A than in B

☐ Is nearly identical in A and B

☐ Is slightly greater in B than in A

☐ Is much greater in B than in A

Reasons

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[1] http://airphotos.nrcan.gc.ca/photos101/images_e.php
[2] http://atlas.nrcan.gc.ca/site/english/maps/archives
[3] http://www.mccord-museum.qc.ca

When students have an understanding of the dimensions of patterns and trends, they will be better able to make use of these concepts when thinking about the geographic regions and phenomena. Below are ways to embed questions about patterns and trends across the curriculum.

More different than alike. Ask students to determine the extent to which two or more regions or phenomena are more similar than they are different.

Example: Explain to students that there is some confusion as to whether the island of Newfoundland is part of the Boreal Shield or the Atlantic Maritime region of Canada. Looking at maps of landforms across the country, and comparing those maps with provincial boundaries, ask students to identify landforms that cross boundaries and unite different provinces. Distribute information on the topography, vegetation, and economic activity of Newfoundland and provide information on the characteristics of the Boreal Shield and the Atlantic Maritime region. Ask students to consider the following criteria when deciding whether Newfoundland is more Boreal or Maritime:

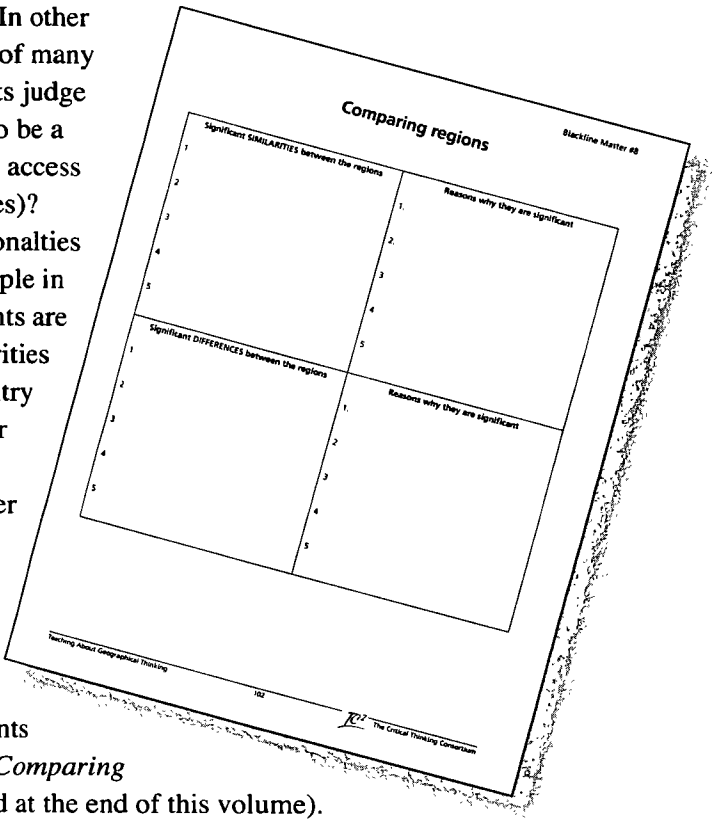
- *Breadth of pattern* (spatial scale). How widely are the Boreal or Maritime patterns distributed on the landscape of the island of Newfoundland?
- *Depth of pattern* (superficial or deep implications). How profoundly have the distinctive features of the Boreal or Maritime regions affected natural and human activity in the area?
- *Duration of pattern* (temporal scale). For how long have the distinctive features of the Boreal or Maritime shaped natural and human activity in Newfoundland?

Invite students to use *Extent of constancy and variation* (Blackline Master #7 found at the end of this volume) to record and justify their conclusions.

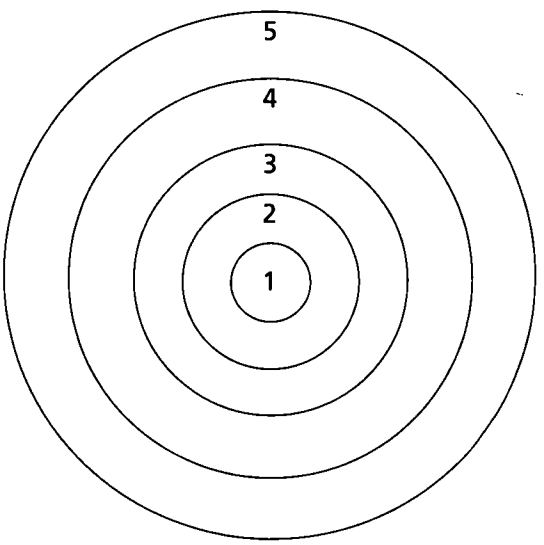
Biggest difference and/or similarity. Provide students with data on two or more regions or on two or more phenomena. Data sources can include primary, secondary (census numbers, climate data, photographs, topographic maps), or tertiary (newspaper accounts, textbooks). Ask students to identify the biggest differences and/or similarities between the compared regions or phenomena.

Example: Ask students to identify five significant differences and similarities between Brazil and Canada. Provide a few comparative facts about the two countries (for example, northern location versus equatorial location, substantial coastline versus partial coastline, relative size) and invite students to think about the effect of these facts on life for the people who live in each country. Discuss, for example, the implications of different locations (for example, differing climates and neighbouring countries) and the impact these would have on people (for example, warmer or colder temperatures, wetter or drier weather, differences in housing, clothing, lifestyle and recreation). Invite students to think about the *significance* of these differences. Would students judge location (and, by implication, climate) to represent a significant difference

between Brazil and their country? In other words, would it alter the daily life of many people? Conversely, would students judge both countries having a coastline to be a significant similarity (for example, access to ocean fish, sea ports, and beaches)? Would it suggest important commonalties between the daily life of many people in both countries? Explain that students are about to look for additional similarities and differences between their country and Brazil. When deciding whether the similarities and differences are significant, students should consider their impact on the lives of people in each country. Direct students to consult the *CIA World Factbook*[4] for additional information on three categories: geography, people, and economy. Direct students to record their significant facts on *Comparing regions* (Blackline Master #8 found at the end of this volume). Ask students to indicate the reasons why each fact is significant.



Test or apply a geographical model. Provide students with the details of a geographical model and ask them to determine whether or not the model applies in a particular instance.



5 Commuters' area (high-quality homes outside the city limits)

4 Middle class area (inhabited by professional people and white collar workers and small business owners)

3 Labourers' homes (workers who have moved from the transitional zone, but want to be near their work)

2 Transitional zone (deteriorating homes, slums, and light manufacturing)

1 Central business district (focal point of commerce, transportation, and social and civic life)

[4] *CIA World Factbook:* https://www.cia.gov/library/publications/the-world-factbook/index.html

[5] This activity is adapted from H.I. London, *Social science theory, structure and application* (Transction Publishers, New Brunswick, N.J., 1989, pp.169-170).

Example: Introduce students to the concentric zone theory developed by Ernest Burgess describing the pattern of urban development in Chicago.[5] According to the theory, cities have five generalized zones as illustrated in the diagram. Provide students with demographic information about a specific urban area and ask them to determine how accurately this theory describes the assigned city. Demographic information by postal code is available in Canada using census tract profiles from Statistics Canada.[6]

Predict or identify the pattern. Provide students with data on a particular occurrence and ask them to formulate a theory that identifies and explains the temporal and/or spatial rate, pattern, or distribution of the occurrence.

Example: Provide students with varied data about a number of tornadoes or hurricanes. Invite them to use climate graphs (hythergraphs) to compare the similarities and differences between the behaviour of these storms. Encourage students to look for patterns across these occurrences.

[6] http://www12.statcan.ca/english/census06/data/profiles/ct/

Interactions and associations

How bad might it get if (and when) a "big one" hits Vancouver? Consider the following data on severe earthquakes in the 20th century.

Severe earthquakes in the 20th century[1]

Location	Year	Fatalities	Magnitude (Richter scale)
Kocaeli, Turkey	1999	25,000	7.4
Kobe, Japan	1996	5,500	6.9
Northridge (Los Angeles), United States	1994	57	6.7
San Francisco, United States	1989	63	7.1
Tangshan, China	1976	255,000	8.0
Northern Peru	1970	66,000	8.0
Erzincan, Turkey	1939	30,000	8.0
Yokahama-Tokyo, Japan	1923	143,000	8.3
Messina, Italy	1908	100,000	7.5
San Francisco, United States	1906	700	8.3

The probability is widely accepted that an earthquake will hit the Vancouver area in the coming decades.[2] Although the event may be inevitable, its consequences are not. But how can we tell whether a Vancouver disaster would likely be on the scale of several dozen fatalities, as experienced in San Francisco in 1989 and Los Angeles in 1994, or as many as a quarter-million deaths, as suffered in Tangshan, China in 1976?

Certainly magnitude is important, but it is not just size that matters. In fact, the most severe earthquake on the list (8.3 in San Francisco in 1906) had only a percentage of the fatalities of smaller quakes in other areas. Only by understanding the constellation of natural and human factors that influence the extent of earthquake damage can we determine what to expect in Vancouver. Besides magnitude, the following factors influence the extent of earthquake damage:

- natural and physical properties of the foundation rocks;
- local ground and soil conditions that could amplify ground motion;
- resistance of the constructed environment to ground movement;
- proximity to human populations, population density, and the time of day.

[1] U.S. Geological Survey, 2004.

[2] The likelihood of the occurrence in Vancouver of a "major" earthquake (between 7.0 and 7.9 on the Richter scale) is every 20 to 50 years, while a megathrust (8.0 or greater on the Richter scale) is likely to occur every 200 to 600 years.

Identifying the particular conditions present in Vancouver enables us to anticipate the extent of destruction that is (reasonably) likely to occur as a result of an earthquake. For example, the alluvial soil (clay, silt, sand, gravel) in the area of Tangshan, China is highly susceptible to liquefaction. This no doubt contributed to the high death toll in 1976. Whereas liquefaction susceptibility is low in the Vancouver area because the soil is composed mainly of ice-age sediments (clay, silt, sand, and stones ranging from pebble- to boulder-size). Similar comparisons can be made with other conditions, and collectively these associated factors suggest that the destruction in Vancouver is likely to be less severe than in many other earthquake zones. But not all the contributing factors are *associated*—where a combination of forces act together to produce a particular result. There is, at least in one respect, an *interacting* or reciprocal effect between earthquakes and human behaviour. Widely publicized media images and accounts of earthquake destruction around the world have helped sensitize citizens and governments to the need for preparedness. Greater awareness has led to measures such as preparedness for increased self-reliance to reduce the stress on public services in the critical hours after a quake, seismic upgrading of schools and other public buildings, and more stringent building codes and zoning regulations. Thus, the publicity surrounding past earthquakes has changed human behaviour which, in turn, reduces the destructive impact of future earthquakes.

As this discussion illustrates, these two kinds of causal forces—interactions and associations—are crucial to understanding the likely impact of earthquakes and more generally to addressing a fundamental geographical question: *How do human and environmental factors influence each other?*

Dimensions of interactions and associations

Before students can make sense of geographical interactions and associations, they must understand key aspects or dimensions of these concepts.

Contributing factors are not the same as determining factors. Contributing factors have an influence on an event or outcome, but they do not guarantee or determine any particular result. Fitness, leg strength, lung capacity, and body weight contribute to the running speed of an individual, but these factors do not guarantee that the person will be a fast runner. On the other hand, reaching the finish line first is a determining factor in deciding who wins a race. Clearly in geography the vast majority of causal factors contribute to but do not determine a result. This distinction was overlooked by advocates of environmental determinism—a theory suggesting that environmental factors could pretty much determine humans' conditions and activity in a given region.

In deciding whether or not a factor contributes to a result, three conditions are required:

- ***Evidence of difference.*** The evidence should indicate that a difference is associated with the factor under question.

- ***Evidence of a causal connection.*** The evidence should suggest that the association is not simply coincidental (for example, I may walk just before breakfast but taking the walk does not cause me to have breakfast). These mere correlations are referred to as

peripheral factors. Causes that have a strong influence are referred to as *primary* or major factors, and those exerting weaker influences are called *secondary* factors.

- ***Absence of alternative explanations.*** There should be no reason to suspect that some other factor, closely aligned with the suggested causal factor, can explain the outcome.

Causal relations can be interactive or associative. An interaction occurs when two or more objects or phenomena engage with each other and have an effect on one another. Cattle grazing is an example of interaction. The cattle influence what grows and how frequently; the growing vegetation then influences the health and quantity of cattle. Their ongoing interactions influence the overall vegetation and soil quality in the area. Interacting factors often give rise to systems where forces operate in mutually influential relationships. Globalization, for example, is driven by forces such as technology, economics and trade, culture, and communication. These forces feed upon each other and greatly accelerate the magnitude and frequency of global connections. Associations occur when two or more factors operate together for common purpose or result—they neither influence each other nor are they influenced by phenomena they affect. For example, clouds and cold weather combine to produce snow. The contributing causes of earthquake destruction discussed earlier are examples of associated factors.

Causal factors have varied sources and effects. Causal factors vary in terms of their nature and effects. Several of the more significant variations are described below:

- ***External and internal factors.*** Certain factors are internal to the region or system that it affects and others are external to it. Often both external and internal elements will influence a particular phenomenon at any given time. For example, culture is influenced by external forces (for example, television and movies from other countries, imported products, international travel) and internal forces (for example, domestic regulations, community groups, socialization at school and home, local media).

- ***Contributing and counteracting factors.*** Some factors influence an event by bringing it about—these are called contributing factors. Other forces—called mitigating or counteracting factors—influence an event by delaying or acting against its occurrence. The buildup of pressure as tectonic plates press together is the main contributing factor to an earthquakes; the release of pressure through small-scale quakes is a factor that mitigates major earthquakes.

- ***Direct and indirect effects.*** Some phenomena have a direct impact on other objects or phenomena (for example, the direct effects of an earthquake are tremors and buckling of the earth's surface). Other effects are indirect where a particular factor influences other phenomena and these, in turn, affect a subsequent outcome (for example, an earthquake causes tremors and fissures, which in turn cause water and gas mains to break and houses to crumble. These consequences, in turn, give rise to other effects, such as homelessness, water shortages, and fires).

- ***Positive or negative impacts.*** Factors can have a positive, negative, or mixed impact. Much of an earthquake's impact—notably death, suffering, and destruction—is highly negative. The heroic actions of individuals and heightened civic responsibility

in response to earthquakes are among the few positive results. As suggested earlier, the massive destruction is substantially but not exclusively negative. It is mixed to the extent that the publicity surrounding these disasters helps to mobilize communities to improve their earthquake readiness.

Events exert different degrees of influence. The influence of phenomena varies greatly in light of three variables:

- ***Breadth or extent of impact.*** Some factors may influence their immediately surrounding area, whereas others will affect large expanses (for example, fires burning large tracks of forest) or regions that are far away (for example, contagious diseases may travel long distances, affecting people in various parts of the world).

- ***Depth of impact.*** Factors may have a superficial effect on their human and physical environment (for example, the loss of electrical power may be an inconvenience, but nothing more serious) or they may profoundly alter the state of things (for example, major earthquakes can demolish the entire infrastructure and all development in the affected area).

- ***Duration of impact.*** The duration of impact may range for a short period of time (for example, flooding may subside after a few days or weeks) to long-term changes (for example, the effects of urbanization or glaciation on the landscape).

Introducing the concepts to students

Before expecting students to apply these concepts in their study of geography, it is helpful to introduce the different causal relations and the distinctive features of interactions and associations.

Distinguish cause and effect—associated or interactive. Present students with a list of paired items, beginning with relatively simple examples of causal and non-causal relationships (clouds and rain; clouds and sun; dust and sun) and proceeding to more complex examples (minimum-wage laws in Canada and industrial pollution in Thailand; corporate taxes in Canada and home ownership in India). For each paired item provide students with four options:

- A influences B;

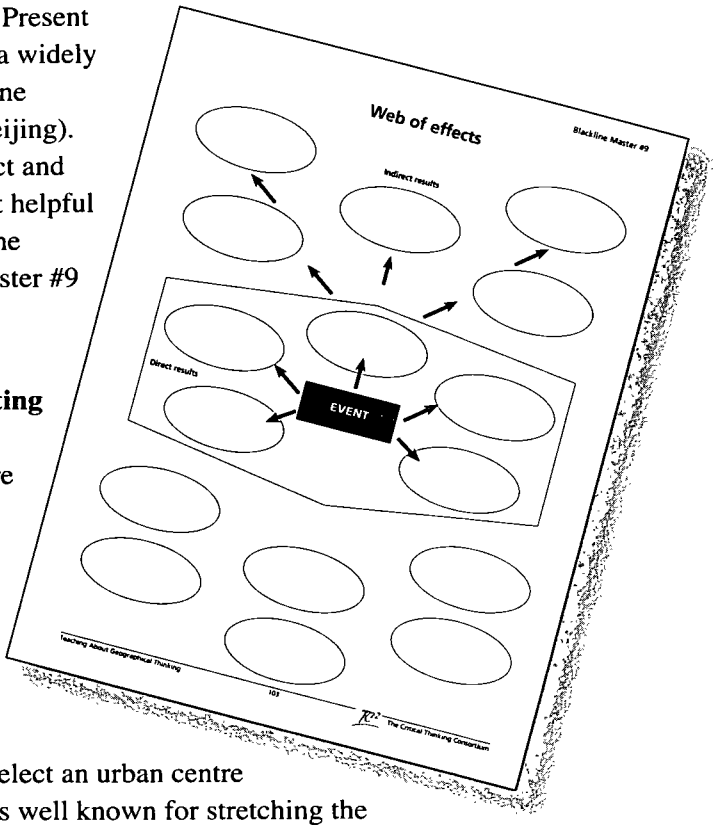
- B influences A;

- A and B influence each other;

- A and B have no influence on each other.

Invite students to determine the most appropriate answer for each paired item and to explain their reasoning.

Trace the direct and indirect effects. Present students with a detailed description of a widely publicized event (for example, Hurricane Katrina, 2008 Summer Olympics in Beijing). Invite them to identify the event's direct and indirect outcomes. Students may find it helpful to visualize these ripple effects using the organizer *Web of effects* (Blackline Master #9 found at the end of the volume).



Identify contributing and counteracting factors. Often contributing factors are emphasized while mitigating factors are overlooked. This may be especially true when looking at humans' role in shaping the landscape while ignoring the physical constraints of the environment on human behaviour. While human ingenuity can work around many limitations, it is useful to recognize these constraining factors. Select an urban centre that is familiar to students or one that is well known for stretching the limits of its human carrying capacity (for example, Hong Kong or Mexico City). Invite students to discuss and research the factors that influence urban expansion in the selected centre. List the range of contributing factors to urban growth (for example, birth rates, immigration, affluence, industrialization) and mitigating factors (for example, water supply, air quality, opportunities for garbage disposal, legislation, limited land, quality of life). Invite students to create a visual representation of the interactions among the contributing and mitigating factors that affect growth in the identified urban centre.

Examine positive and negative impact. Identify a common phenomenon that has positive and negative effects on the human and physical environment (for example, forest fires, schooling). Create a comparison chart with the headings "positive impact" and "negative impact" (and possibly "mixed impact"). As illustrated below, invite students to identify the phenomenon's negative and positive effects. Afterwards, rate the most significant positive and negative effects in light of the following criteria:

- breadth (how widespread the area of impact is);
- depth (how deeply the impact affects the area); and
- duration (how long the phenomena occurs in the area).

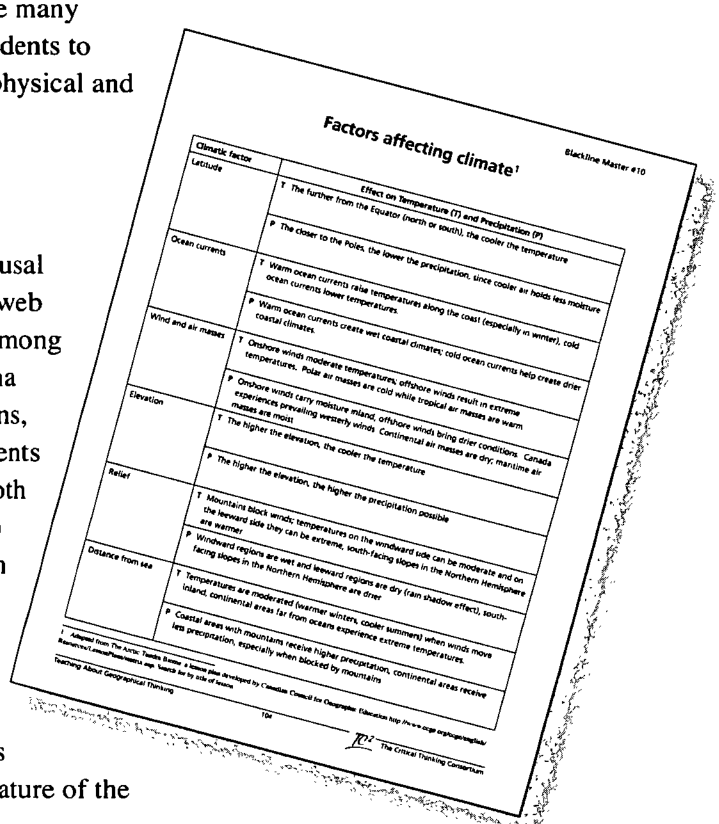
Positive and negative effects of forest fires

Positive impact	Negative impact
• *encourages growth of new plants*	• *results in loss of human, plant, animal life*
• *is a germination mechanism for some species*	• *destroys the environment*
• *maintains biodiversity*	• *blackens the landscape*
• *clears out dead or weak trees*	• *upsets the ecosystem*
• *releases nutrients from decaying vegetation into the soil*	• *is costly to fight*
• *burned-out trees provide shelter for small mammals and birds*	• *results in expensive property damage and personal loss*
	• *results in loss of valuable lumber*

Applications across the curriculum

When students have an understanding of the dimensions of interactions and associations, they will be better able to make use of these concepts when thinking about the geographic factors that influence the human and physical world. Below are various ways teachers can embed questions about interactions and associations across the curriculum.

Identify significant factors. There are many opportunities in the curriculum for students to explore the factors that influence the physical and human environments.



Blackline Master #10

Factors affecting climate[1]

Climatic factor	Effect on Temperature (T) and Precipitation (P)
Latitude	T The further from the Equator (north or south), the cooler the temperature
	P The closer to the Poles, the lower the precipitation, since cooler air holds less moisture
Ocean currents	T Warm ocean currents raise temperatures along the coast (especially in winter), cold ocean currents lower temperatures.
	P Warm ocean currents create wet coastal climates; cold ocean currents help create drier coastal climates.
Wind and air masses	T Onshore winds moderate temperatures; offshore winds result in extreme temperatures. Polar air masses are cold while tropical air masses are warm
	P Onshore winds carry moisture inland, offshore winds bring drier conditions. Canada experiences prevailing westerly winds. Continental air masses are dry; maritime air masses are moist
Elevation	T The higher the elevation, the cooler the temperature
	P The higher the elevation, the higher the precipitation possible
Relief	T Mountains block winds; temperatures on the windward side can be moderate and on the leeward side they can be extreme, south-facing slopes in the Northern Hemisphere are warmer
	P Windward regions are wet and leeward regions are dry (rain shadow effect), south-facing slopes in the Northern Hemisphere are drier
Distance from sea	T Temperatures are moderated (warmer winters, cooler summers) when winds move inland, continental areas far from oceans experience extreme temperatures.
	P Coastal areas with mountains receive higher precipitation, continental areas receive less precipitation, especially when blocked by mountains

1 Adapted from The Arctic Tundra Biome, a lesson plan developed by Canadian Council for Geographic Education

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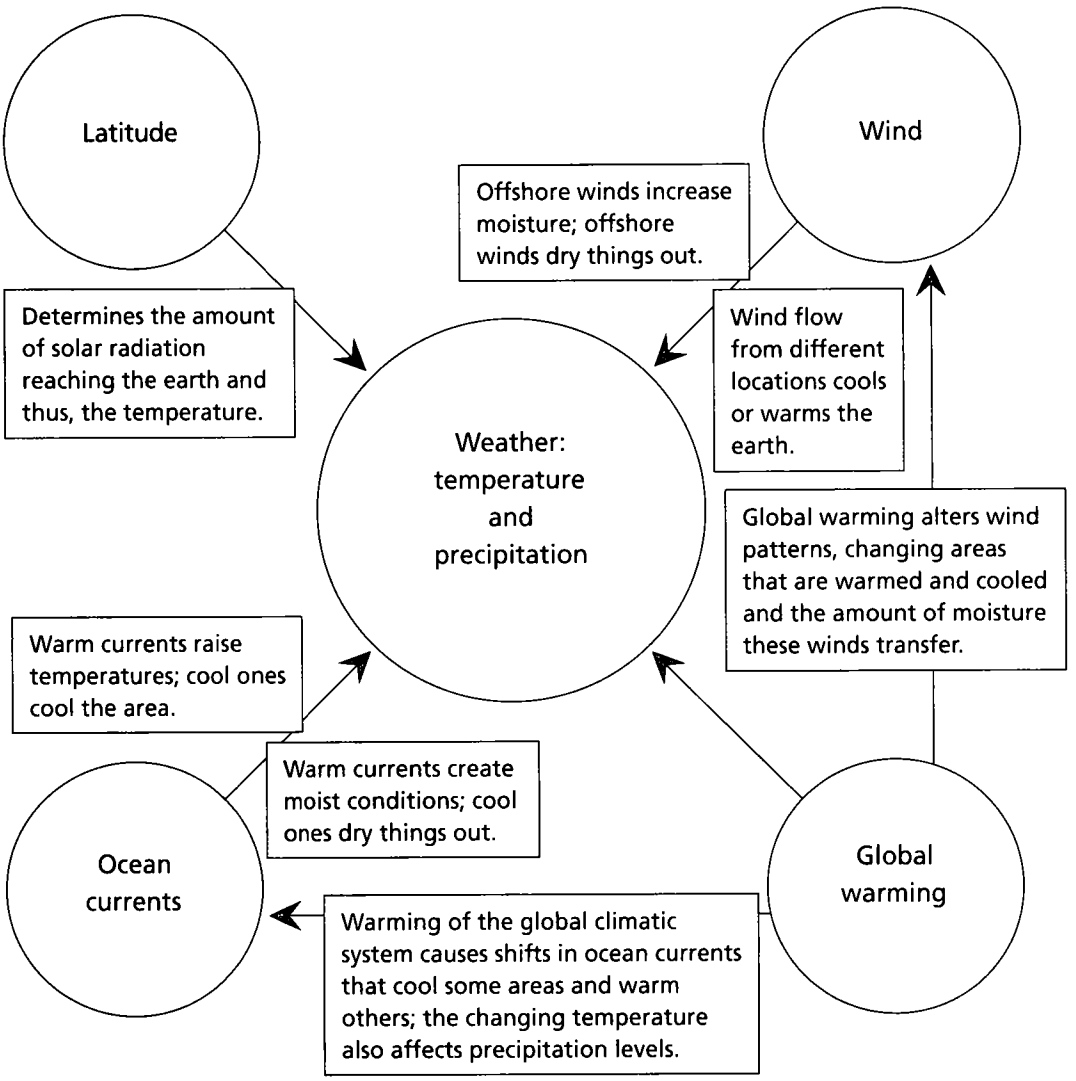
- ***Explore dynamic interactions.*** To help students appreciate the dynamic interactions among causal factors, invite them to create a web diagramming the interactions among mutually reinforcing phenomena (for example, climatic conditions, land use practices). Direct students to record a list of influences (both contributing and counteracting) on a piece of paper and position them on the board or on poster paper. Draw varying sizes of circles around the factors to represent the magnitude of the influence. Direct students to draw arrows indicating the nature of the

connections between the factors. Annotate the arrows with a short description of how each phenomenon affects the other.

Example: Provide students with the information about climatic influences contained in *Factors affecting climate* (Blackline Master #10 found at the back of this volume). Ask students to illustrate the interconnections of these factors in a web. Their diagram might resemble the one below. Invite students to explain the analysis of the interactions represented in their web.

Climatic influences on weather



- ***Rank the importance of factors.*** Ask students to rank order different physical or social phenomena in terms of their influence on a specified feature of a region.

  Example: Provide students with information about a host of forces operating within a region (for example, rainfall, transportation networks, local agriculture, international investment, indigenous culture, immigration). Select one or more features of the region (for example, housing, schooling, road networks) and ask students to determine which of the identified forces (both external and internal)

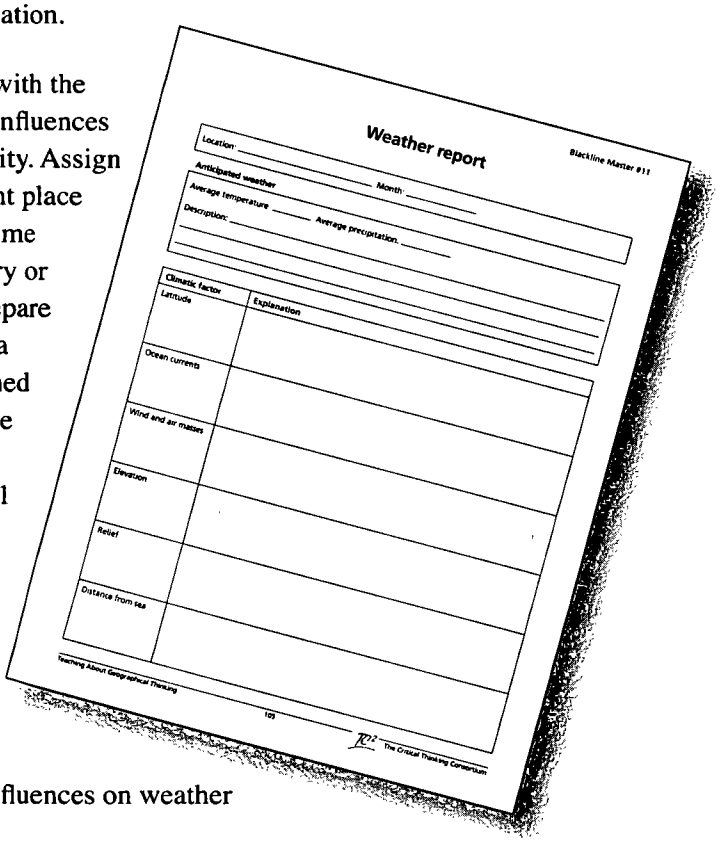
actually influences the specified feature (for example, is the style of housing directly influenced by rainfall in the region or is it a function of cultural practices imported from another region?). Encourage students to consider three conditions when deciding whether or not a factor contributes to the regional feature:

- *evidence of difference:* evidence indicates that a difference is associated with the identified factor;
- *evidence of a causal connection:* evidence suggests a causal link between the factor and the attributed outcome;
- *absence of alternative explanations:* no reason to suspect that other factors account for the outcome.

Identify the impact. In addition to investigating why things occur as they do, students can be invited to examine the impact of phenomena on the physical and human environments.

- ***Anticipate the results.*** Provide students with information about the contributing and mitigating factors that influence a given phenomenon (for example, earthquake damage, weather, desertification). Ask them to anticipate the associate effects of these factors in a particular location.

  Example: Provide students with the information about climatic influences suggested in an earlier activity. Assign groups of students a different place in Canada and designate a time of year (for example, January or July). Ask each group to prepare a weather report that offers a likely forecast for the assigned place and time of year. Invite students to use *Weather report* (Blackline Master #11 found at the back of this volume) to explain their forecast in terms of each of the contributing and mitigating factors. Ask students to determine which factors are primary, secondary, and peripheral influences on weather in their assigned region.


Weather report

Blackline Master #11

Location: _____ Month: _____

Anticipated weather

Average temperature _____ Average precipitation _____

Description:

Climatic factor	Explanation
Latitude	
Ocean currents	
Wind and air masses	
Elevation	
Relief	
Distance from sea	

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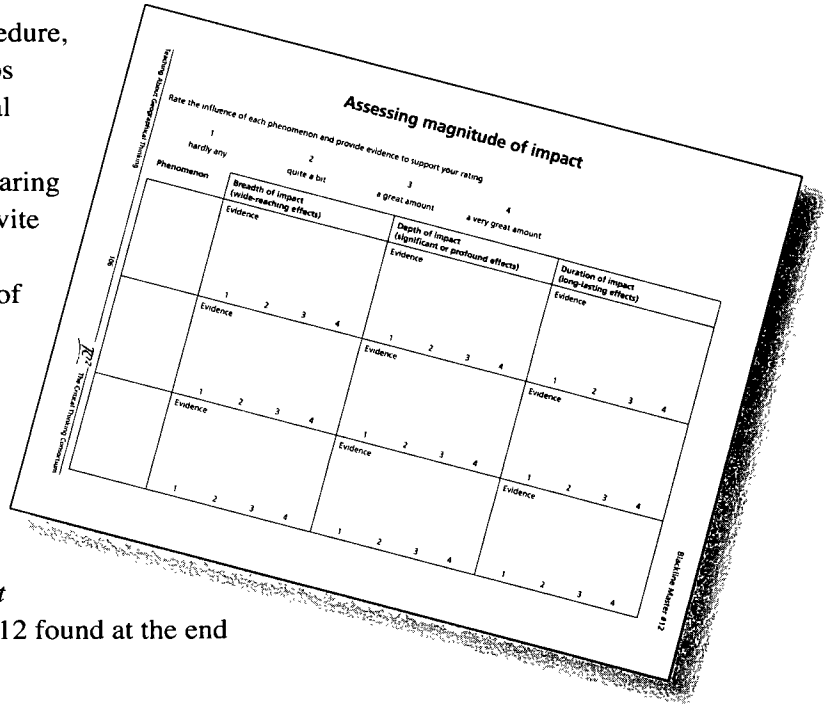
- ***Assess degrees of impact.*** Going beyond identifying outcomes, ask students to assess the relative magnitude of the impact of different phenomena (for example, rank order the three factors that have most significantly affected the nature of vegetation in the Boreal Shield region) or of the same phenomenon for different groups or locations (for example, which of the three selected regions has been most affected—in physical and in human terms—by monsoons).

Example: Select a local, national, or international environmental campaign (for example, 100 Mile Diet, UN's Billion Tree Campaign, David Suzuki's Nature Challenge). Provide students with a brief overview of one project via video, website orientation, images, or newspaper articles.[3] As a class, assess the impact of the campaign on people's behaviour and ultimately on the environment. Encourage students to look for evidence to support their assessments in light of the following criteria:

- breadth or extent of impact—spatially narrow or far-reaching implications;
- depth of impact—superficial or profound differences;
- length of impact—short-time or long-lasting effects.

Once students understand the procedure, direct them in groups to investigate several other environmental campaigns. After hearing from each group, invite the class to rank the campaigns in order of their environmental impact. Ask students to record and explain their rankings using the data chart *Assessing magnitude of impact* (Blackline Master #12 found at the end of this volume).



- ***Conduct an impact assessment.*** Extend the idea of calculating an ecological footprint by asking students to determine the impact of any number of phenomena on their surrounding environment (for example, the impact of globalization on personal freedoms, of the Olympics on China or on Canada). Encourage students to consider which of the effects are negative and which are positive.

  Example: Invite students to assess the impact of incandescent light bulbs and other more energy-efficient alternatives, such as compact fluorescent lamps (CFLs) and LED lamps. Explain that Canada's federal government aims to phase out traditional light bulbs by 2012. The ban is expected to reduce greenhouse gas emissions by more than six million tonnes annually and save homeowners about $60 annually in electricity costs. Compact fluorescent bulbs are much more energy-efficient than traditional incandescent bulbs. The equivalent compact fluorescent bulb consumes up to 75% less energy than an incandescent one and

[3] Information about various campaigns is available on the internet. For example, 100 Mile Diet (http://100milediet.org); Billion Tree Campaign (http://www.unep.org/billiontreecampaign/informationmaterial/); and Nature Challenge (http://www.davidsuzuki.org/NatureChallenge/What_is_it/).

lasts up to 10 times longer. Incandescent lights heat a filament inside a tube until it is white-hot and produces light. But in the process, over 90% of the energy used is dissipated in heat, usually without any real purpose. Natural Resources Canada estimates enormous savings could be realized if each of the country's 12 million households changed just one incandescent bulb for a compact fluorescent. This would save $73 million in collective electricity bills and a corresponding reduction of 397,000 tonnes in greenhouse gas emissions—the equivalent of taking 66,000 cars off the road. But CFLs and LEDs have their drawbacks:

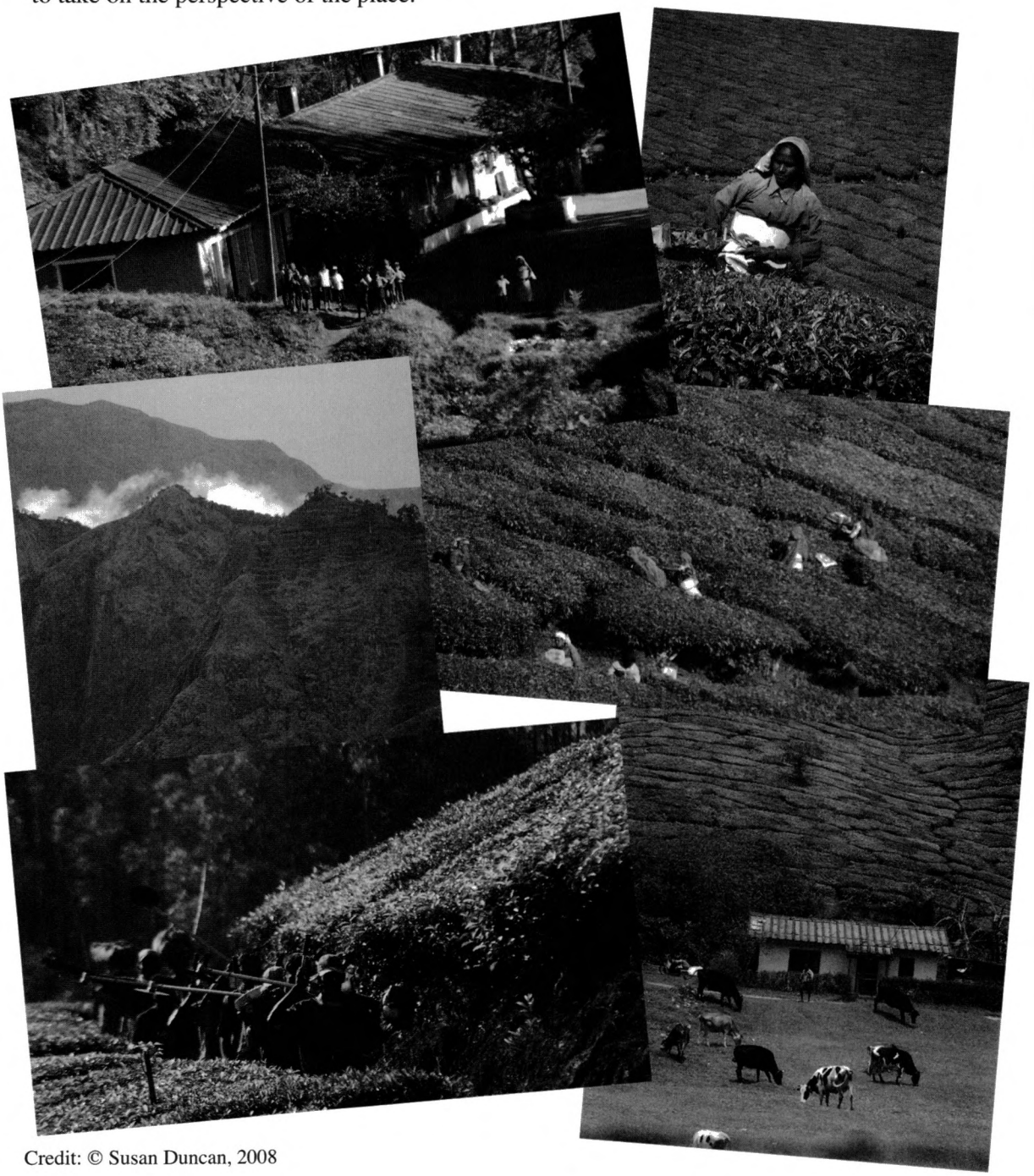
- they are more expensive than their incandescent counterparts;
- they emit less heat than incandescent light bulbs, so people may be inclined to turn up the heat in their homes;
- CFLs contain poisonous methylmercury that may leach mercury into the water supply and create a public health hazard;
- discarding mercury-laden fluorescent bulbs is illegal in many Canadian jurisdictions; with few light bulb recycling options, consumers have difficulty disposing safely of their old bulbs.

Invite students to calculate the environmental "footprint" of each light source—including the energy required to earn the money to purchase and dispose of them. Decide which kind of light source has the least negative impact on the environment.

Sense of place

7

The following scenes are of a tea plantation in the Munnar district of Kerala in southwestern India. While these are mere glimpses of the region, they offer six windows on the place and its way of life. They shed light on the standard of living and on the quality of life. They invite us to wonder about the connectedness of this place with the rest of the world. They hint at the local inhabitants' world view—their views about what is important, and their relationships to others and to the environment. In a phrase, they invite us to develop a feel for the life and conditions—to take on the perspective of the place.



Credit: © Susan Duncan, 2008

The most obvious impressions of Munnar created by these images are of a pastoral setting, a pristine environment, and a peaceful and seemingly remote lifestyle. It would likely not surprise students to learn that these are the world's highest tea-growing estates. This impression of harmony is consistent with the fact that the religious tensions that trouble much of India are rarely found among the Hindus, Muslims, Christians, and Jews that inhabit this region. Students may well glean from these images a sense of the contrasting features: hand-manicured slopes set against craggy peaks, a seemingly modest standard of living sustaining an apparently satisfying quality of life, and a suspicion that the gender division of labour may signal deeper social inequalities.

However, the images do not reveal other contradictions. Despite the settled surroundings, many in this region are itinerant labourers, working six days a week or more to support struggling families in the neighbouring state of Tamil Nadu. Students might be surprised to learn that Kerala's literary rate is 91%, the highest in India, and that it is widely regard as India's most progressive state where—have greater freedoms than elsewhere in the country. The fact that Kerala had the first freely elected communist government in the world stands in contrast to the school, tea estates, and other vestiges of British colonial rule.

As with previous examples, other portal concepts could be used to investigate these photographs. For example, what aspects of Kerala's location are worthy of attention? How adequately does the available geographic evidence support our conclusions about this place? Similarly, we may ask questions about the human and environmental factors that influence life here. For the purpose of illustrating this chapter's portal, the task is to identify the features and identities that characterize this area near Munnar.

This invitation to develop a sense of place lies at the heart of a geographical perspective—*What are the human and physical features and identities that characterize a place?* Taking on this perspective requires more than acquiring geographic facts about a place—it requires developing a tangible sense of what it means to "inhabit" the space. Inevitably students will form impressions about other places based on personal experience, postcards, television, travelogues, and textbooks. Without a sensitive understanding of the realities of place, students may unintentionally develop mistaken or "foreign" perceptions of the experiences of the people and the characteristics of other places. Our challenge is to help students recognize and challenge what may be misleading, ethnocentric, and over-simplified impressions of other places.

Dimensions of a sense of place

Students will be better able to develop a sense of place if they understand the following aspects or dimensions of this concept.

Every place is both unique and connected. Place refers to the mix of physical and human features that characterize and give meaning to a particular location. Every place in the world has it own feel—the embodied characteristics and identities of the space. These unique features are adaptations in response to common human needs, social interactions, and physical forces. Yet these forces operate across the planet. Thus, every place, although unique, shares much in common with places in other geographic locations.

Regions are the units by which places are delineated. The concept of the region is a fundamental unit of geographic analysis—it refers to an area with some defined uniformity. Geographers organize the great diversity of the planet into manageable chunks based on selected features that are common in an area and distinct from regions around it. But the choice of defining features and, by extension, the designation of a region can vary dramatically. Any particular location may be identified within a region defined by physical properties (for example, vegetation or geologic/geographic conditions), cultural or political properties (for example, ethnic population or linguistic traits), functional characteristics (for example, residential, commercial, or industrial use) or simply by convention (for example, Old Montreal). In many cases, a region is the product of several of these features. The designation of Ontario/Quebec as the "heartland" of Canada, for example, is a social construction, reflecting a combination of location, history, population size, industrial power, and political influence.

Geographical perspective taking must recognize commonality and diversity. Any attempt to develop a sense of place—to see and feel what it means to exist within a particular region—will be a generalized account. This arises partly because regions—the units by which places are delineated—capture broad forces and features rather than particular experiences. On the other hand, no particular environment determines what goes on in a region, though it may influence it. Every region will be characterized by a diversity of lived experiences and physical features. In fact, the larger the region, the greater the likelihood of a diversity of features. Thus the dilemma in geographical perspective-taking is to vividly and accurately capture a broad range of physical and human elements that characterize a place and, at the same time, convey a sense of the diversity of features and lived experiences.

Ethnocentricism is the antithesis of taking on the perspective of a place. Ethnocentricism, or perhaps more aptly "geocentricism," is the imposition of a parochial perspective when interpreting the characteristics of another place. Students may be inclined to apply lenses that distort what the practices mean for people living there. This problem is exacerbated by popular media that portray regions in exotic or stereotypical ways. Understanding that "reality" is different for other people in other places is both one of the most fascinating and challenging tasks in geography. At the most basic level, this means students should not presume that the social practices and natural features in one place mean the same to people in another place. And it certainly requires that students, when drawing conclusions about a place, become informed about and remain conscious of the values and sensitivities of the locals.

Introducing the concepts to students

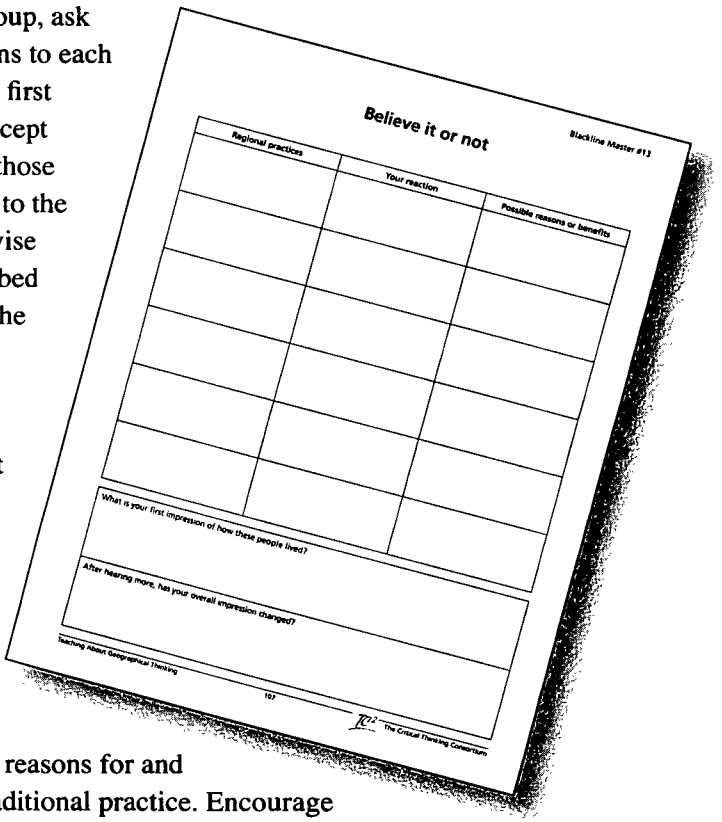
Before expecting students to apply the concept in their study of geography, it is helpful to introduce the idea of a sense of place—what it entails and how to assess it.

Explaining the nature of a geographical perspective. The following activities may help students understand the key elements involved in developing a sense of a place.

- ***See beyond "unusual" practices.*** Invite students to react to "unusual" practices in a particular region. Select regional customs that some students may find "odd,"

"stupid," or "funny." The ultimate objective is to encourage students to suspend judgment on what may initially seem "foreign" until after they have learned the reasons for these practices. Below are several "unusual" traditional practices of the Inuit:

- They once lived in snowhouses all winter.
- They play soccer at midnight.
- At one time, their babies wore moss as diapers.
- In the past they softened animal skin by chewing it.
- They used to make sleds out of frozen fish.
- They made sails for their boats from animal intestines (part of the stomach).

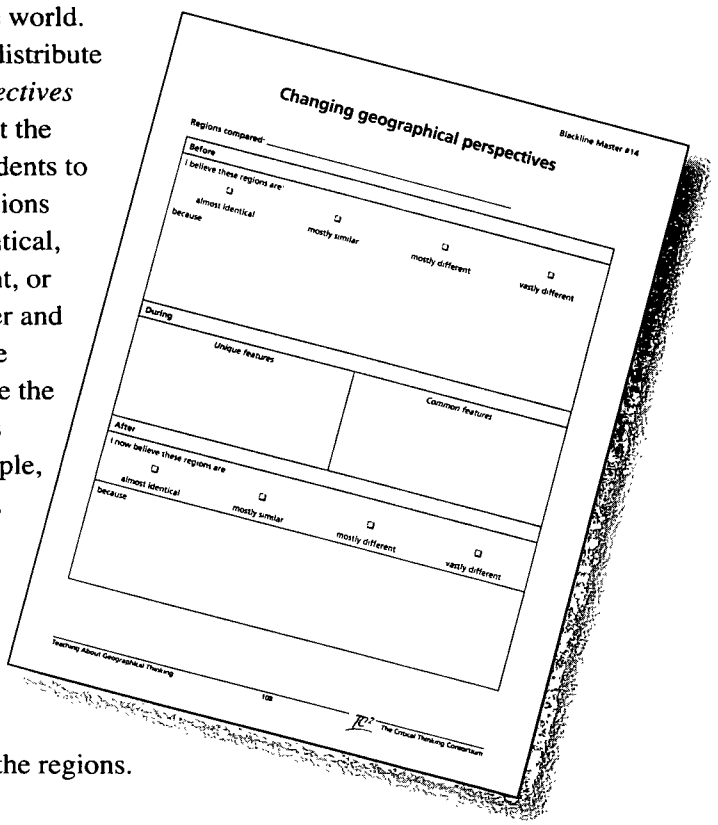


Without identifying the group, ask students to record their reactions to each practice and to offer an overall first impression of these people. Accept without any negative reaction those comments that lack sensitivity to the Inuit. After a suitable time, advise students that the actions described were practised at one time by the Inuit. If needed, point out the traditional territory of the Inuit on a map of northern Canada. Explain that about 40,000 Inuit live in northern Canada. If available, display pictures highlighting the rather stark and icy northern landscape. Invite students to speculate, from the perspective of people living in such a "bare bones" environment, about the reasons for and possible advantages of each traditional practice. Encourage students to record their thoughts on *Believe it or not* (Blackline Master #13 found at the end of this volume). To get students started, provide a rationale for one or two practices. Below are suggested reasons for the use of moss as diapers and of intestines for making sails.

Cultural practice	Rationale
moss diapers	• *moss is widely available* • *moss can be stored in the winter* • *moss diapers are free, absorbent, and soft* • *moss diapers are environmentally friendly (moss is biodegradable)* • *moss can be packed tightly and is lightweight for travel*
sails made of intestines	• *intestines are strong (won't rip easily)* • *intestines are lightweight (will not slow down the boat and can be transported easily)* • *intestines are waterproof (won't get soggy if dipped in the water)* • *intestines are easy to sew together* • *intestines are available any time animals are killed* • *the sails are environmentally efficient (use parts of animals that may not be eaten or otherwise be used)*

After the rationales have been shared, invite students to think of how, if at all, their overall impression of the Inuit has changed as a result of learning more about these people. Highlight the point that the practices of different regions might seem unusual at first glance, but once we see the reasons why people live a certain way, we can better understand and learn from them.

- ***View similarities and differences across regions.*** Use an application such as Google Earth (create your own Sightseeing Tour), aerial photographs, a video (*Over Canada* provides a bird's-eye view of Canada's vast landscape), or tourist brochures to illustrate the unique but connected features of two or more regions in your province, Canada, North America, or the world. Before studying the material, distribute *Changing geographical perspectives* (Blackline Master #14 found at the end of this volume). Invite students to indicate whether or not the regions they will study are almost identical, mostly similar, mostly different, or vastly different from each other and in what ways. As they view the material, direct students to note the uniqueness and commonalities between the regions (for example, landforms, human settlements, economic activities, evidence of daily life). Discuss their findings as a class. Direct students to reassess their initial impressions and draw general conclusions about the diversity and homogeneity of the regions.



- ***Explore overlapping regions***. Introduce the idea that regions are delineated in a myriad of ways by specifying a particular location familiar to students (for example, their school) and asking them to identify many different kinds of regions within which this place is located (for example, the school ground; block; neighbourhood; municipality; school division; federal, provincial, or municipal electoral region; postal zone; provincial region; province; national region; nation; continent). Extend this discussion by introducing other kinds of criteria for delineating regions (for example, climate, vegetation, geology, language, land use). Develop an expanding scale of regional designations for several of these criteria (for example, the school grounds may be non-forested and cultivated, the surrounding area may be mixed vegetation, the larger region may be boreal forest, and so on). Compile a list of these regional designations and invite students to brainstorm several key or defining features for various regions (for example, the school grounds may be noisy, crowded, and treeless, whereas the neighbourhood may be quiet, spacious, and verdant; the local community may be largely of Asian heritage, but the city may be largely of European descent). Discuss the relationship between the scale of the regional designation and the geographic features that characterize the region. Note how the features of the specific location (the school) may or may not be similar to the broader defining features of the region, depending on the scale.

- ***Anticipate the perspectives of others***. Another aspect of understanding the sense of a place is to imagine, based on what you know about a place, how someone from there would respond to a new place. This requires students to understand the key aspects of life in a given place and recognize what features of life would be different if they were somewhere new. After studying life in a particular region, ask students to consider how a family from that region might respond if they moved to your city. Invite students to create a product (for example, a letter, a photo essay, a diary entry) that showcases the newcomers' likely response to their new city. Arrange for a guest speaker from that region to share their experiences in visiting or moving to your town. Students might also interview someone from that place. Ask students to compare their predictions with the actual experience of the guest speaker, noting reasons for the similarities and differences in the two accounts.

Assessing the adequacy of a geographical perspective. The following activities may help students assess the adequacy of attempts to adopt a geographical perspective.

- ***Deconstruct a stereotype.*** Select a location (for example, Hollywood, Moscow, Ottawa, Florida, Caribbean, Iran) that students will know something about and may hold stereotypical impressions about. You might even consider using their community as the focus of study. Invite students to formulate statements that capture their views on the essential features of the designated place—politically, culturally, economically, environmentally. Introduce students to statistical, textual, and visual resources and perhaps to people who are knowledgeable about the area. Encourage students to try to see the place from the perspective of those who live there. If studying their own community, direct students to interview several people from different sectors and social groups. Using a "before" and "after" structure, ask students to compare what they used to think and what they now think about the place. Introduce the following criteria and invite students to assess their collective perceptions of the designated place:

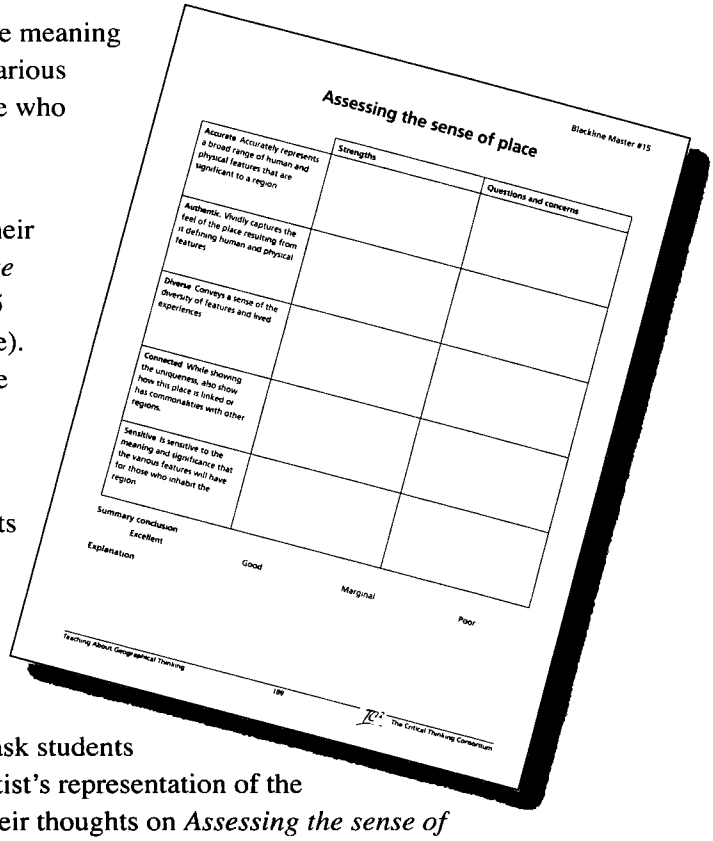
- *Accurate.* Accurately represents a broad range of human and physical features that are significant to a region.

- *Authentic.* Vividly captures the feel of the place resulting from its defining human and physical features.

- *Diverse.* Conveys a sense of the diversity of features and lived experiences.

- *Connected.* While showing the uniqueness, also show how this place is linked or has commonalities with other regions.

- *Sensitive.* Is sensitive to the meaning and significance that the various features will have for those who inhabit the region.



Invite students to record their thoughts on *Assessing the sense of place* (Blackline Master #15 found at the end of this volume). Encourage students to compare their conclusions with others.

- ***Explore an artist's interpretation.*** Provide students with an artistic representation of a place (for example, landscape paintings by the Group of Seven, a selection from literature). Using the previously discussed criteria, ask students to assess the richness of the artist's representation of the sense of place and to record their thoughts on *Assessing the sense of place* (Blackline Master #15 found at the end of this volume). If students have not yet worked with these criteria, invite them to consider thinking of an important place in their own lives: their homes or their school. Ask students to examine facts about their own home (number of rooms in the house, square footage, physical location) or their school (number of students and staff, demographics of student population, size of the building, age of the building). Would these pieces of information help someone unfamiliar with the place to develop a sense of what it means to live in that house or attend that school? What if you added pictures of the house or looked at the school yearbook? Would a description of the floor plan help? Encourage students to brainstorm information that would help someone else understand the realities of the place, including activities (for example, the debating club, the environmental club's contributions to the community) and features that contribute to its sense of identity (for example, murals painted on the school walls by former students, an open-concept main floor at home that makes the house feel welcoming). Consider asking students to create a visual or written profile of their school or home that would reflect a rich geographical perspective in light of the five criteria listed above.

When students have an understanding of the dimensions of geographical perspective-taking, they will be better able to make use of this concept when thinking about place. Below are ways to embed questions about developing a sense of place throughout the curriculum.

Examine photographs in the textbook. Typically, textbooks contain many photographs and other illustrations about a region that students ignore or accept unquestioningly. Invite students as a matter of course to examine these images. Ask them to draw inferences about the impression of the region fostered by the illustrations and assess how representative these images are of the lived reality of the place. Pose the following kinds of questions to guide their investigation:

- What aspects of life do these illustrations represent?
- What impressions do they create for you?
- What impressions would inhabitants of the region likely hold toward the objects in these illustrations?
- Do these illustrations represent the lived experience for men as well as women? For all age groups? For different socioeconomic classes?
- What diversity in this region do these illustrations likely not capture?

Example: In a study of northern Africa or the Sahara, invite students to examine the images in the textbook of this region (for example, the pyramids in Egypt). Ask students to describe the impressions of the region fostered by the illustrations (for example, exotic, ancient, solitary). Then ask students to imagine how residents of the region might hold different impressions (ordinary, crumbling, tourist-infested). Use information from the textbook to assess how representative these images are of the broader characteristics of the region.

Critique an account. Ask students to assess an account of a region offered in the public media using the criteria discussed previously. Invite students to record their thoughts on *Assessing the sense of place* (Blackline Master #15 found at the end of this volume). Arrange for students to share their assessments with others.

Example: After learning about a region, provide students with a copy of a *National Geographic* or *Canadian Geographic* article or several newspaper articles (possibly travelogues) about the region. Assess how adequately the accounts represent the breadth of characteristic features and lived reality of the place.

Represent the sense of a place. Provide students with a collection of materials (statistical data, images, thematic maps, narratives) about a region they are about to study. You may want to identify the region or leave it unnamed. Invite students to look at the place from an inhabitant's perspective. Ask students to provide a written profile or represent their impressions by selecting five quintessential images and five atypical images. If represented

visually, ask students to explain their choices and describe the different perceptions derived from the two sets of images.

Example: To help students appreciate the western Canadian landscape prior to European colonization in the 19th century, ask them to prepare journal entries following explorer David Thompson's travels through the region. Introduce the activity by reading excerpts from the *Canadian Geographic* article "Travels with Charlotte," written in honour of the 150th anniversary of Thompsons' death.[1] The article celebrates his achievements and also those of his much less well-known wife, Charlotte Small. Small was married to Thompson at the age of 13 in 1799 and throughout their 58-year marriage, she accompanied the explorer on many of his journeys. The article reveals how Thompson, dubbed North America's greatest geographer, filled 77 notebooks with observations on wildlife, weather, and botany encountered during his fur-trading career. Invite students to work in groups to create daily journal entries from Charlotte Small's perspective for an assigned month in 1807 as she and her husband searched for a pass through the Rocky Mountains. The journal entries should detail observations on the topography, weather, wildlife, and botany. They ought also to refer to the aboriginal people encountered on the journey and to explore Small's impressions as a woman and as someone of Cree heritage. Direct students to base their entries largely on the visuals in the article and on material from the Archives of Ontario website.[2] Invite groups to peer-review each others' journals and then publish the collection—perhaps online—as the "Lost Journals of Charlotte Small."

Explore diversity within a place. Since no region contains homogeneous experiences and uniform features, it is important that students learn to recognize how groups within a region may experience life differently. Provide students with varied pieces of evidence representing different perspectives on life in a region (for example, urban or rural, well-educated or not, inland or coastal zone). Ask students to identify and explain the differences they find.

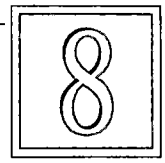
Example: Life in many Western European countries differs greatly depending on whether someone is a citizen or an immigrant. Consider the 2005 race riots in Paris and other large French cities.[3] What are the key differences between how two main groups (French citizens and immigrants from North Africa and their children) experience life in and around Paris? Where do they live? How can they move around the city? What work and school opportunities are open to them?

[1] A. van Herk and J.W. Stewart (illustrator). Travels with Charlotte. *Canadian Geographic* (July/August 2007): 54–66.

[2] http://www.archives.gov.on.ca/English/exhibits/thompson/geographer.htm

[3] Possible sites to consult include: http://www.cbc.ca/story/world/national/2005/11/05/paris-riot051105.html; http://www.cbc.ca/news/background/paris_riots/; http://news.bbc.co.uk/1/hi/world/europe/4413964.stm; http://pas.sagepub.com/cgi/content/abstract/36/1/133

Geographical value judgments



Every day, one million barrels of oil are produced from the oil sands in northeastern Alberta.[1] *Not only has this production brought great wealth to Alberta and Canada, it represents a massive oil supply in a world that is witnessing fast-depleting reserves. However, the process of extracting the oil destroys thousands of hectares of forest, consumes enormous amounts of energy, and leaves huge tailing ponds of polluted water. The site is widely recognized as an environmental disaster zone. Some claim that we cannot afford, environmentally speaking, to allow production to continue or expand. Others insist that we cannot afford the economic and political costs of shutting down the oil supply. We are faced with the dilemma of deciding what should be done.*

Simon Dyer is director of the oil sands project for the Pembina Institute, a respected non-profit environmental research organization based in Calgary. He believes that it is foolish to try to stop oil sand production and the prosperity it brings. However, he maintains that it would be "deferred suicide" to allow operations to continue as presently carried out. Dyer proposes five "fixes" to significantly address the environmental damage in the area:

- ***Capture and store carbon emissions.*** *Carbon emissions should be captured at their release from the production facilities, piped to a different location, and injected into the cracks and strata of deep formations for long-term storage, using old oil or gas wells as entry points.*

- ***Replace wet tailings with dry tailings.*** *At the moment, the only way to retrieve oil is by washing water out of the sand. The result is tailing ponds of water, fine clay, and toxins that cover 50 km^2. Producers should eliminate water from the extraction process and in so doing, create dry tailings.*

- ***Reduce water use.*** *Currently 200 million cubic metres of water are used annually (equal to about 40% of the yearly water supply for Toronto), half of which is drawn from the Athabasca River. Dyer proposes to reduce the use of water in the cleaning process and to store water during the winter months to alleviate the depletion of the river flow during the summer.*

- ***Reduce acid rain causing emissions.*** *The industry should be made to adopt stringent pollution controls such as catalytic reduction and ultra-low nitrogen-oxide burners, both of which are used in California to reduce emissions.*

- ***Create a "no-go zone" for boreal forests.*** *Thousands of hectares of boreal forest are stripped to expose the oil-bearing sands. Dyer wants the government to adopt a sustainable forest policy that protects large sections of Alberta's boreal forest from industrial activity.*

[1] This discussion is based on G. Curtis, Scar sands: Five fixes for Alberta's carbon time bomb. *Canadian Geographic,* June 2008, 128 (3): 64-78.

Dyer claims that these strategies are doable and that the main drawbacks are government unwillingness to legislate and industry's unwillingness to do more than is required by law. Should we endorse this five-part recommendation as the required conditions for continued oil sands development? Do they go far enough? Are they too stringent? In answering these questions, we must assess the wisdom of the plan in light of relevant criteria.

- Are these fixes *feasible* financially, politically, and technologically? It would seem that the available technology for carbon capture and industry's willingness to use it have been present for decades. There is even a carbon capture plant already operating in Weyburn Saskatchewan and California has mandated technologies for emission reduction. However, the high costs of carbon capture and emissions control are a deterrent. Similarly, although some companies have developed new technologies for dry tailing, these are not yet available commercially.

- Will these measures be *effective* in significantly reducing the environmental and health damages? It may be that these steps collectively do not go far enough, or that some of them do relatively little to address the problem. Alternatively they may be more stringent than is needed to safeguard the environment. For example, up to 90% of water is already recycled now in many oil sands operations. Is it realistic to expect substantially greater reductions in water use?

- Will they provide *long-term (sustainable) solutions*? It has been suggested that carbon capture is a stop-gap measure. What is required in the long run is carbon reduction. Similarly, protecting tracks of forest would mean large areas of the oil sands could not be accessed. As oil supplies dwindle further, it is uncertain that these reserves would be protected indefinitely.

- Would this course of action be *fair to everyone* who has a stake in this enterprise? Perhaps adopting this course of action would sacrifice the interests of some groups because they do not have much political power or, conversely, other groups' interests may be privileged because of their political influence. In considering the fairness of the plan for all concerned, it is helpful to identify the "stakeholders"—those whose interests are affected by decisions about the oil sands—and consider each group's "stake"—the legitimate rights and concerns that may be affected one way or another. The main stakeholders and their legitimate interests in oil sands development include the following:

    - oil companies (most of whom are foreign-owned) have invested billions to develop the oil sands and expect a return on their investments and compensations for the considerable financial risks they have undertaken. They would likely shoulder the cost associated with any environmental plan.

    - local inhabitants (including many First Nations and Métis people) living in communities near the development benefit from employment and other business opportunities, but have suffered environmental damage to their water and air quality, and a resulting impact on their health and quality of life.

    - environmentalists are concerned about the dangers this development poses for humans and for natural ecosystems.

- the Alberta government and citizens benefit from the economic activity and royalty revenue generated by developing the oil sands but must also help to pay for the significant environmental and health costs—in personal as well as financial terms.

- the Canadian government and citizens benefit from the economic activity and access to energy generated by developing the oil sands. However, we may be in danger of developing a reputation as the creator of one of the world's most toxic human-made environments.

- other governments and their citizens may be entitled, through free trade arrangements and direct investments in oil sands development, to a share of these large oil reserves.

Since many of these group's interests are in tension with one another, deciding what is fair to all requires trying to balance the valid interests of as many groups as possible. For example, it would likely require reducing the profits to some extent in order to safeguard the health of local residents.

Students will recognize the relevance of this issue to other portal concepts. For example, we may ask questions about the spatial distribution of the oil sands and about how human and environmental factors influence each other to generate this issue. For the purpose of illustrating this portal, however, the compelling question is whether or not to support Simon Dyer's plan. Clearly there is no easy answer. What is clear, however, is that this judgment should be based on rigorous consideration of the facts in light of a broad range of criteria, including fairness to all who may be affected. This kind of deliberation is required whenever individuals or groups seek to make geographical value judgments—*How desirable are the practices and outcomes associated with particular geographic actions and events?*

Dimensions of geographic value judgments

Students will be better able to make sense of the implications of geographical value judgments if they understand the following aspects or dimensions of this concept.

Value judgments are assessments about what should or should not be. Value judgments do not describe the world as it is; they are evaluations of what should occur or what would be desirable to occur. Value judgments represent individual and group beliefs about what is "good" and "bad"—beneficial/harmful, morally right/wrong, and effective/ineffective. They pertain to current practices (for example, the oil sands are a great boost to the province of Alberta) and prescribe what should happen in the future (for example, allowing oil sands operations to continue as presently carried out will be "deferred suicide").

Value judgments can be made from differing perspectives. Judgments involving geographical matters can be offered from varying disciplinary perspectives:

- ***economic*** (the oil sands will be the greatest boon to Canada's economy over the next decades).

- ***political*** (the government of Alberta should show more political will in taking on the difficult issues raised by the oil sands).

- ***legal*** (it would not be constitutional for the federal government to impose regulations on the oil sands producers).

- ***environmental*** (pollution from oil sands production has been a disaster for the local environment).

- ***ethical*** (local residents are being treated fairly by the multinational companies working on the oil sands project).

In addition to discipline-based perspectives, judgments can be made from the point of view of different regions (northern Alberta, Western Canada, Middle East, United States) and groups (humans, animals, oil producers, oil sands workers, First Nations). These assessments may be positive from one perspective and undesirable from another perspective. For example, developing the Alberta oil sands would appear to be economically desirable but environmentally undesirable. But even that is simplistic. It may be economically desirable for those employed in the oil business, but economically undesirable for producers of alternative energy sources. Such a proposal might be desirable for Canadians, as it would strengthen our economic position internationally, but undesirable from the perspective of other oil producing countries, or for people who lose their livelihood because of the pollution. The challenge in many geography-related issues is to reach a "global" or inclusive judgment—one that would accommodate, to the extent possible, various disciplinary, group, and regional perspectives and offer what seems best, all things and all people considered.

There is value in withholding judgment until adequate information has been acquired. Because value judgments are often based on deeply held and highly personal values, it is common to make such judgments instinctively. Such judgments may not be the wisest or most defensible. Withholding judgment until key perspectives are understood helps in reaching value judgments that are defensible and fair-minded. Alternative perspectives often provide valuable information that deepens one's understanding of the issue. Individuals who are entrenched in a position are unlikely to learn from others.

Value judgments can be assessed on a number of criteria. Value judgments are often dismissed as expressions of a self-serving desire or preference for some outcome—a mere opinion. When deciding on matters of public policy that affect the common good, value judgment can and should be based on a careful and informed assessment of the options. To do this requires that individuals evaluate the merits of each side in light of relevant factors, including what would be fair to everyone concerned. Thus the quality of value judgments can themselves be assessed in light of the following criteria:

- ***Based on accurate and adequate evidence.*** Value judgments should be ground in evidence that is accurate, representative, and extensive enough to provide an informed opinion on the issue.

- ***Consider a variety of factors or criteria.*** Value judgments should not be based on one dimension of the issue—for example, does it make economic sense?—but to

consider a range of factors (for example, technologically feasible, ethically justified, environmentally sustainable).

- ***Represent a range of significant interests.*** Value judgments should not focus exclusively on one's own interests, or those of one's associates, but on a range of significant, often competing interests. The interest of key stakeholders should at least be considered when assessing what ought to be done.

- ***Fairly assess the pros and cons.*** Value judgments should not only reflect multiple perspectives and factors, but do so fairly. It is important to weigh the evidence impartially; to empathize with others and try to see things from their point of view; and to ensure that one's own preferences and needs are not being given undue preference.

Introducing the concepts to students

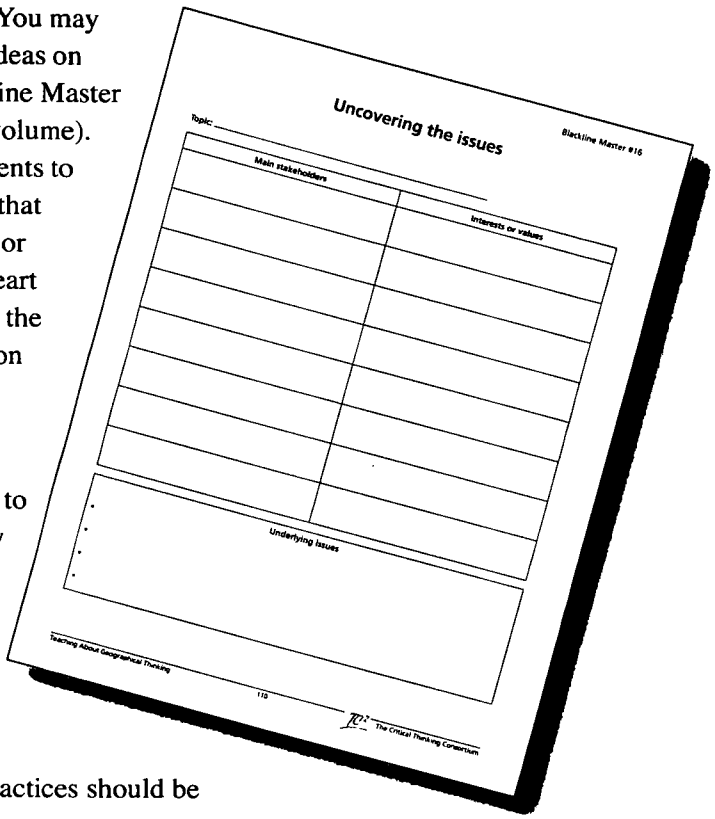
Before expecting students to apply the concept in their study of geography, it is helpful to introduce the idea of geographical value judgments—learning to recognize them and identify the interests behind various positions.

Recognizing the judgments and interests promoted in geographical materials. The following activities may help students recognize the value judgments offered and the underlying perspectives they represent.

- ***Identify judgments in geographical accounts.*** Present students with an excerpt from a textbook, government publication, or news article on a contemporary issue (for example, preservation of urban agricultural land, Beijing's attempts to reduce air pollution for the 2008 Olympics, rising water temperatures). Encourage students to focus on the language in the account, distinguishing factual statements (descriptive, non-evaluative information) from value statements (evaluative, non-neutral terminology). On the board, create a chart with the headings *Factual statements* and *Value statements*. Invite students to record corresponding words and phrases. Discuss the differences between the two sets of statements. For example, factual statements describe details about the issue, whereas value judgments offer an evaluation. Invite students to look for the perspective embedded in the judgments and those that may be missing. Consider both the groups or regions that seem to be represented (for example, it may benefit Canada, but what about other nations?) and the factors or criteria that are emphasized (for example, it may make sound economic sense, but is it fair, realistic, and sustainable?).

- ***Uncover stakeholder interest and tensions.*** Present student with a brief account of varying perspectives on a controversial topic (for example, deforestation, responses to climate change). You might use a simple children's book (for example, *The Lorax* by Dr. Seuss) that focuses on human impact on the environment. Invite students to identify the groups and regions that may have a stake in the matter—both those that are explicitly mentioned in the account and those that have a less direct stake. For each stakeholder, ask students to think of the possible interests that may be affected by any resolution of the issues (for example, some people may lose their homes, others may gain employment, some will lose access to pristine wildlife, the lives of

animals may be endangered). You may want students to record their ideas on *Uncovering the issues* (Blackline Master #16 found at the back of this volume). From this analysis, direct students to identify the underlying issues that emerge (the contested matters or disagreements that lie at the heart of the situation). For example, the issues surrounding deforestation may include:



- Under what conditions should loggers be allowed to harvest in environmentally sensitive areas?
- Who should decide what counts as an endangered species?
- Which forest protection practices should be mandatory?

Ask students to record the underlying issues in the box at the bottom of the chart. Invite students to resolve the issues in a manner that accommodates the legitimate interests of as many stakeholders as possible.

- ***Defend the other side.*** Invite students to express their position on a controversial issue. Discuss the criteria that might be considered in deciding this issue (for example, respect for personal liberties, fairness, environmental sustainability, economic benefit, convenience). Sensitize students to the viewpoint of those who disagree with them by asking students to assemble the most convincing arguments for the side of an issue they do *not* support. If possible, arrange for students to present their arguments to someone who has been asked to prepare the opposing side. After some discussion, invite students to defend the position they personally support. Discuss how successfully students were able to present the opposing side and what effect having to do so had on they way they look at the issue.

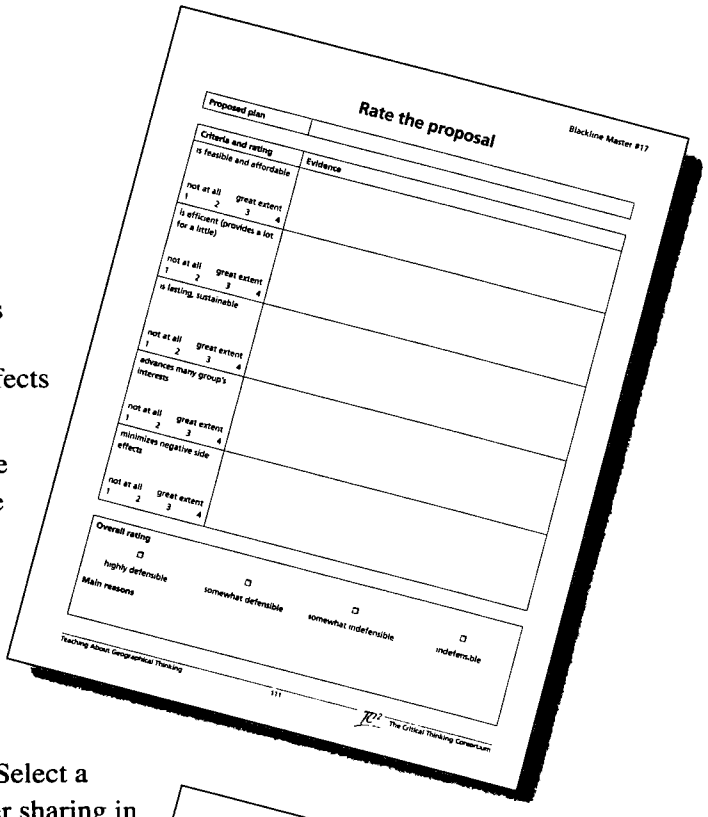
Applications across the curriculum

When students have an understanding of the dimensions of geographical value judgments, they will be better able to make use of this concept when thinking about their actions and those of others regarding the physical world. Below are various ways teachers can embed invitations to offer geographical value judgments across the curriculum.

Rate the proposal. Provide students with a justification or, alternatively, assign them to prepare a justification for a recommended course of action to address a geography-related problem. Invite students to assess the adequacy of the proposed plan(s).

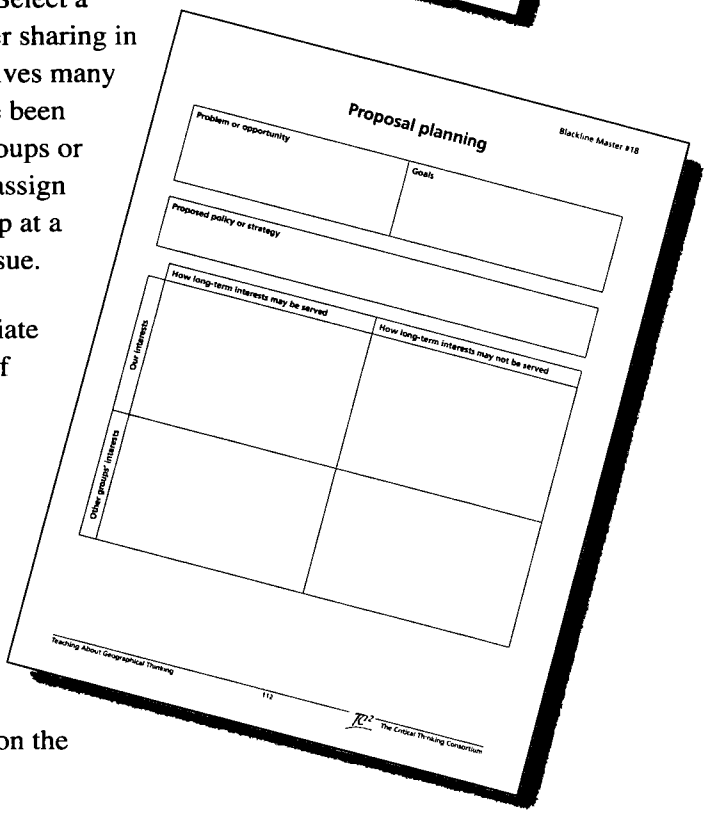
Example: Present students with a case study on a controversial issue, such as what to do about housing developments on steep hillsides, water shortages, or the impact on climate change. Ask them to write a letter to the editor in which they identify the problem and justify a course of action to remedy the situation. Specify criteria such as the following that the proposed solution should satisfy:

- feasible and affordable
- efficient
- sustainable
- advances own interests
- advances interests of others
- minimizes negative side effects



Invite other students to use the chart *Rate the proposal* (Blackline Master #17 found at the back of this volume) to assess the adequacy of the plan in light of the criteria on the chart or other criteria they might provide.

Role-play perspectives on an issue. Select a controversial issue (for example, water sharing in southwestern United States) that involves many geography-related ideas students have been studying. Identify a handful of key groups or regions with a stake in this issue and assign students to represent a particular group at a conference intending to resolve the issue.



Example: Invite students to negotiate a development plan for a region of the Brazilian rain forest.[2] Identify several key stakeholder groups: environmentalists, Brazilian farmers, Brazilian government officials, indigenous people, World Bank-IMF officials, and representatives of multinational companies. Ask students to research and present one of the stakeholder group's perspectives on the

[2] Fully developed lessons for this activity are found in D. Northey, J. Nicol, and R. Case. *Brazilian rain forest* (The Critical Thinking Consortium and British Columbia Ministry of Education, Vancouver, 2003).

issues facing the Brazilian rain forest. Encourage students to prepare and ask probing questions of other students about their assigned stakeholder group. As representatives of their group, ask students to draft proposals for developing the rain forest area. You may want students to use a chart such as *Proposal planning* (Blackline Master #18 found at the back of this volume) when preparing their plan. Arrange for students to meet with representatives of other stakeholder groups to reach consensus on a solution. When all plans have been shared, ask students to assess the impact of each proposal on various stakeholder groups. Finally, ask students to write a position paper justifying their chosen development plan. In the debriefing, discuss the effectiveness of the recommended approaches and whether inclusive solutions can be found to the problems facing the Brazilian rain forest.

Take a position along a continuum. Rather than require students to write a position paper for or against an issue, invite them to identify their position on a scale from "strongly support" to "strongly oppose." Encourage students to consider the following criteria as they formulate their opinion:

- ***based on adequate, accurate evidence*** (Am I basing my judgment on evidence that is accurate and extensive?);
- ***representative of a range of significant interests*** (Am I taking into account a range of important, and perhaps conflicting, interests?);
- ***consider a variety of factors or criteria*** (Have I considered a number of relevant factors?);
- ***fairly consider the pros and cons*** (Am I trying to be fair as I weigh the evidence in support of the different perspectives?).

Arrange for them to explain their views to students who hold different positions along the spectrum.

Example: A particular format to engage students in discussing issues in terms of degree of support is to arrange the classroom chairs in a U-shape. Position students who strongly support a proposed idea at one tip of the U and those strongly against the policy at the other end. Direct students with mixed opinions to sit at appropriate spots along the "U." Begin by asking students at each tip of the "U" to state their positions. Encourage students to provide one or two supporting reasons. Alternate from side to side until students from all locations along the "U" have shared their views. Encourage students to physically move along the "U" if they have changed their opinion on the issue. Following the discussion, invite students to record their final thoughts on the issue.

Exemplars: Ecozones of Canada

9

In this chapter, we provide detailed activities to support six critical thinking tasks—one for each of the portal concepts discussed in this resource. These tasks focus on six ecozones of Canada:[1]

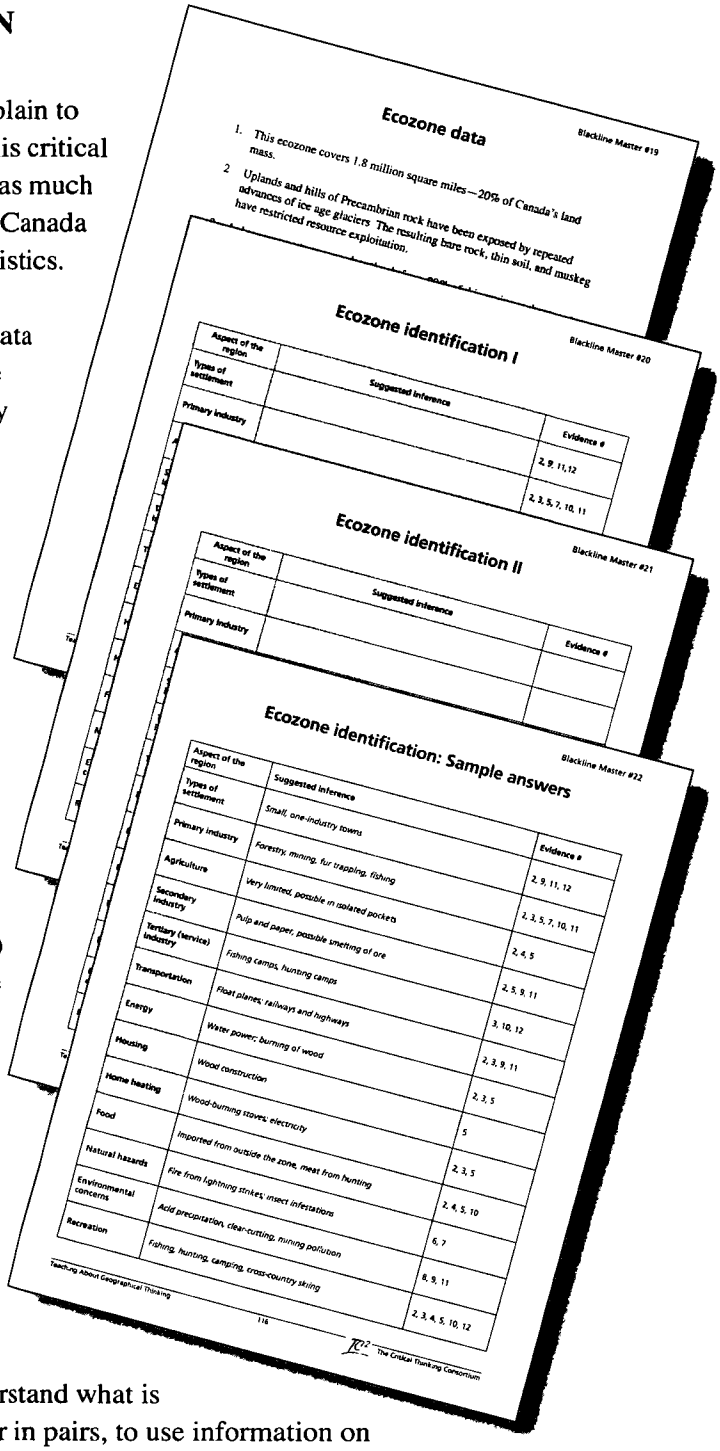
- Pacific and Western Mountains
- Arctic and Taiga
- Central Plains
- Boreal Shield
- Mixedwood Plains
- Atlantic Maritime

Our intention is to show how the portal concepts can be infused systematically into a teaching unit. We designed the activities as though every lesson was to be taught in the order in which it is presented. When using these lessons with an actual class, you may want to select from them, reorder them, and alter the ecozone featured in each challenge. However, when adapting these lessons, check that students have all the tools they need to address the tasks presented to them.

Portal concept	Critical challenge
Sense of place	*Ecozone identification*: Based on statistical data provided, develop a profile of a mystery ecozone in Canada. Determine the identity of the ecozone and select five features to add to a prepared website to provide a better sense of the "feel" of the place.
Patterns and trends	*Identifying regional designations*: Which is the more appropriate regional designation for the island of Newfoundland—Boreal Shield or Atlantic Maritime?
Geographical importance	*Sustainable development in the St. Lawrence Lowlands*: Rank order three sectors—agriculture, industry, and transportation—in terms of their importance to future sustainable development for the Mixedwood Plains region.
Evidence and interpretation	*Exposing climate change myths:* Examine two sides of a selected "myth" about climate change and determine which side overall seems more convincing.
Interactions and associations	*Climate change on the Central Plains*: Anticipate the changes that will take place in the Central Plains as a result of global warming by 2050, and decide which of these effects will be the most significant.
Geographical value judgments	*Environmental plans for the Western Mountains:* Propose a course of action that would provide a long-term solution to an environmental challenge, satisfying the needs of the main groups involved.

[1] The following designations are from the Canadian Atlas Online: http://www.canadiangeographic.ca/atlas/

ECOZONE IDENTIFICATION

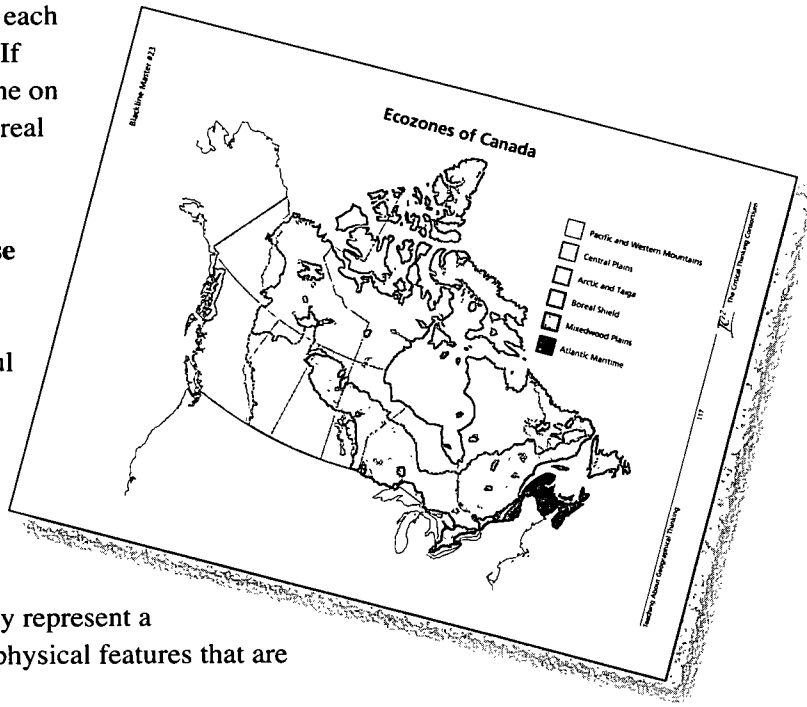


Introduce the critical challenge. Explain to students that there are three parts to this critical challenge. First they are to determine as much as they can about a mystery region of Canada simply by examining a handful of statistics. Next, they will use this information to identify the ecozone from which the data is provided. Finally, they will enhance the geographical profile of the mystery ecozone found on an existing website. Although there is a great deal of information on this site, students are to select five additional pieces of information that would give readers a better "feel" for the place.

Draw inferences about the mystery region. Present students, individually or in pairs, with the facts about the mystery ecozone found on *Ecozone data* (Blackline Master #19). Distribute copies of either *Ecozone identification I* (Blackline Master #20) or *Ecozone identification II* (Blackline Master #21). The first chart is an easier version because the numbers of the relevant evidence from the data sheet are indicated for each aspect of the region; the second chart is more challenging because clues about the relevant evidence are not indicated. Explain the "aspects of the region," if necessary, and discuss the term inference. Provide an example to confirm that students understand what is expected. Ask students, individually or in pairs, to use information on the data sheet to draw inferences about key aspects of life in the region listed on the chart. Once students complete their charts, discuss the inferences made and the supporting evidence. Compare these inferences with the ones offered in *Ecozone identification: Sample answers* (Blackline Master #22).

Identify the mystery ecozone. Review the concept of ecozones. Encourage students to draw on their own background knowledge and on the profile developed on Blackline Master #20 or #21 when trying to identify the mystery ecozone. Distribute a map of *Ecozones of*

Canada (Blackline Master #23) to each student or refer to an online map.[2] If students cannot identify the ecozone on their own, indicate that it is the Boreal Shield.



Introduce criteria for a rich sense of place. Explain that before they read a profile of the ecozone they will be enhancing, it will be helpful to think how additional, more descriptive information would provide a clearer picture of the region. Explain the following criteria for a rich sense of place:

- ***Accurate:*** Does it accurately represent a broad range of human and physical features that are significant to a region?
- ***Authentic:*** Does it vividly capture the feel of the place resulting from its defining human and physical features?
- ***Diverse:*** Does it convey a sense of the diversity of features and lived experiences?
- ***Connected:*** While showing the uniqueness of the region, does it also show how this place is linked or has commonalities with other regions?
- ***Sensitive:*** Is it sensitive to the meaning and significance that the various features will have for those who inhabit the region?

Assess the geographic perspective. Direct students' attention to the ecozone profile they are to enhance. This might be the one found at The Atlas of Canada[3] or Environment Canada's Ecozone Vignettes series.[4] Ask students to assess the online profile in light of the criteria listed above. Use the chart *Assessing the sense of place* (Blackline Master #15) to structure this activity. Once students have assessed the profile, ask them to identify gaps and brainstorm the types of information that would provide a richer perspective of the region.

Examine additional resources. Ask students to gather additional information that might be added to the online profile so that it better meets the criteria. Additional resources include:[5]

- The Canadian Atlas Online[6]

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[2] http://atlas.nrcan.gc.ca/site/english/maps/environment/ecology/framework/ecologicalframework

[3] Ibid.

[4] http://www.ec.gc.ca/soer-ree/English/vignettes/

[5] The designation of ecozones in Canada is not uniform and is complicated by many sub-regions within each. Focus students on the six regions presented at the beginning of this chapter and represented in the map in this volume (Blackline Master #23).

[6] http://www.canadiangeographic.ca/atlas/

- The Redpath Museum's Canadian Biodiversity website[7]
- *Ecozone data* (Blackline Master #19)
- various textbooks
- travelogues

Select the crucial additional information. Ask each pair of students to select five pieces of information about the Boreal Shield. Encourage students to select information that would not simply add more facts to the site but would enrich the quality of the profile in light of the five criteria discussed above. Arrange for students to share their choices with the class and discuss which additions enhance the sense of the region.

Critical challenge #2: Patterns and trends

IDENTIFYING REGIONAL DESIGNATIONS

Introduce the critical challenge. Suggest to students that the way that a person or a place is labelled can affect the way that person or place is both presented to and perceived by others. Indicate that there is disagreement about whether the island of Newfoundland belongs to the Boreal Shield or Atlantic Maritime region of Canada. Students' task is to determine which of these is the more appropriate regional designation for the island of Newfoundland.

Discuss the importance of regional designations. Explain that the concept of the region is a fundamental unit of geographic analysis—it refers to an area with a defined uniformity. Geographers organize the great diversity of the planet into manageable chunks based on selected features that are common in an area and distinct from regions around it. But the choice of defining features and, by extension, the designation of a region can vary dramatically. Invite students to consider the importance of designating a region by considering a few familiar examples:

- When thinking about Canada what impressions arise when we describe it as being in the Western Hemisphere? How would this contrast with describing it is as belonging in the Northern Hemisphere?
- Consider where your school is located. Is it in a "city" or a "suburb"? A "town" or a "village"? Could there be disagreement about the appropriate label? What characteristics of the place might cause confusion or disagreement?

Introduce criteria for deciding on regional designation. Explain to students that their decision about the more appropriate designation for Newfoundland should be based on the extent to which the features of each ecozone (Boreal Shield or Atlantic Maritime) are present on the island. Introduce or review the following criteria for making their decision:

[7] http://canadianbiodiversity.mcgill.ca/english/ecozones/ecozones.htm

- ***Breadth of pattern.*** How widely are the Boreal or Atlantic patterns distributed on the landscape of the island of Newfoundland?

- ***Depth of pattern.*** How profoundly do the distinctive Boreal or Atlantic features affect natural and human activity in the area?

- ***Duration of pattern.*** For how long have the distinctive Boreal or Atlantic features shaped natural and human activity in the area?

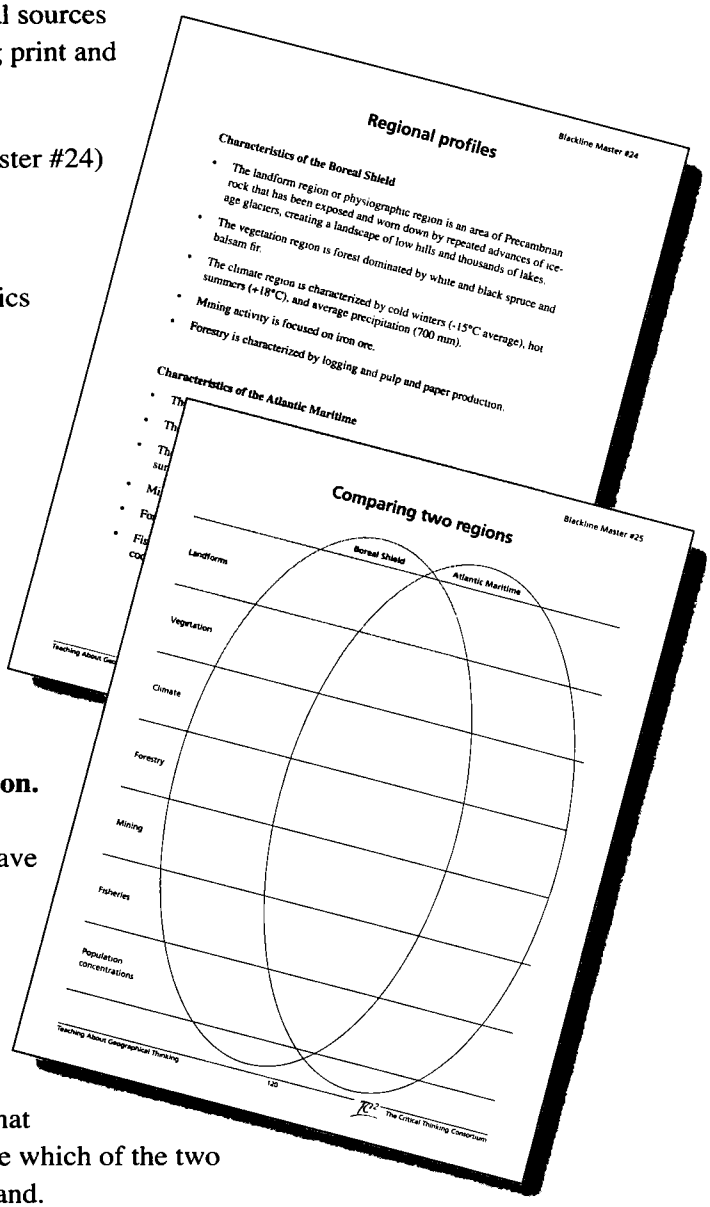
Determine the most significant similarities and differences. Invite students to extend their understanding of the similarities and differences between the Boreal Shield and Atlantic Maritime by consulting several sources of information, including the following print and online references:[8]

- *Regional profiles* (Blackline Master #24)

- Canadian Atlas Online[9]

- Statistics Canada Annual Statistics online: Human Activity and the Environment[10]

- an overview of Canada's ecozones[11]



Ask students to use *Comparing two regions* (Blackline Master #25) to structure this activity. Invite students to examine the differences they uncover.

Decide on Newfoundland's designation. Explain to students that by comparing how the two regions are similar they have begun to uncover the reasons for the confusion regarding Newfoundland's designation. Invite students to choose several characteristics of each region (for example, landforms, climate, vegetation, population concentrations, industry, agriculture) that they will examine in order to determine which of the two ecozones better represents Newfoundland.

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[8] The designation of ecozones in Canada is not uniform and is complicated by many sub-regions within each. Focus students on the six regions presented at the beginning of this chapter, and represented in the map in this volume (Blackline Master #23).

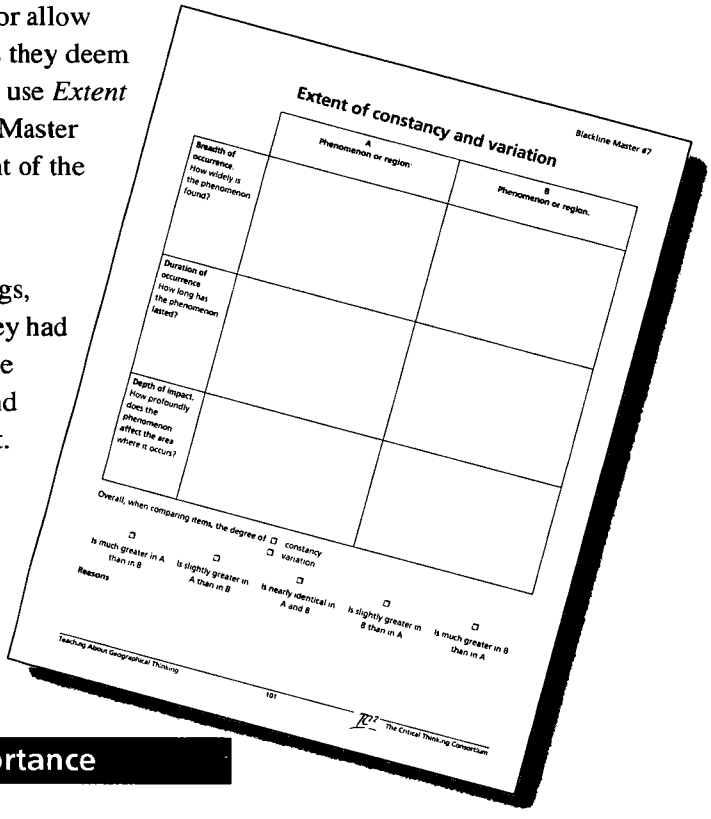
[9] http://www.canadiangeographic.ca/atlas/

[10] http://www.statcan.ca/english/freepub/16-201-XIE/2007000/part2.htm

[11] http://www.parkwardens.com/zone0/1.html

Generate the list of features as a class or allow pairs of students to choose the features they deem crucial to the decision. Ask students to use *Extent of constancy and variation* (Blackline Master #7) to analyze the characteristic in light of the criteria listed above.

Share the findings. Discuss the findings, asking students in which categories they had difficulty making a decision. Determine how many students gave Newfoundland a regional designation of Boreal Forest. Ask them to justify their designation. Repeat the procedure with the Atlantic designation. Finally, ask students who believe it is equally representative of both regions to justify their conclusion.


Extent of constancy and variation

Blackline Master #7

A Phenomenon or region:

B Phenomenon or region.

Breadth of occurrence. How widely is the phenomenon found?

Duration of occurrence. How long has the phenomenon lasted?

Depth of impact. How profoundly does the phenomenon affect the area where it occurs?

Overall, when comparing items, the degree of ☐ constancy ☐ variation

☐ Is much greater in A than in B

☐ Is slightly greater in A than in B

☐ Is nearly identical in A and B

☐ Is slightly greater in B than in A

☐ Is much greater in B than in A

Reasons

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Critical challenge #3: Geographical importance

SUSTAINABLE DEVELOPMENT IN THE ST. LAWRENCE LOWLANDS

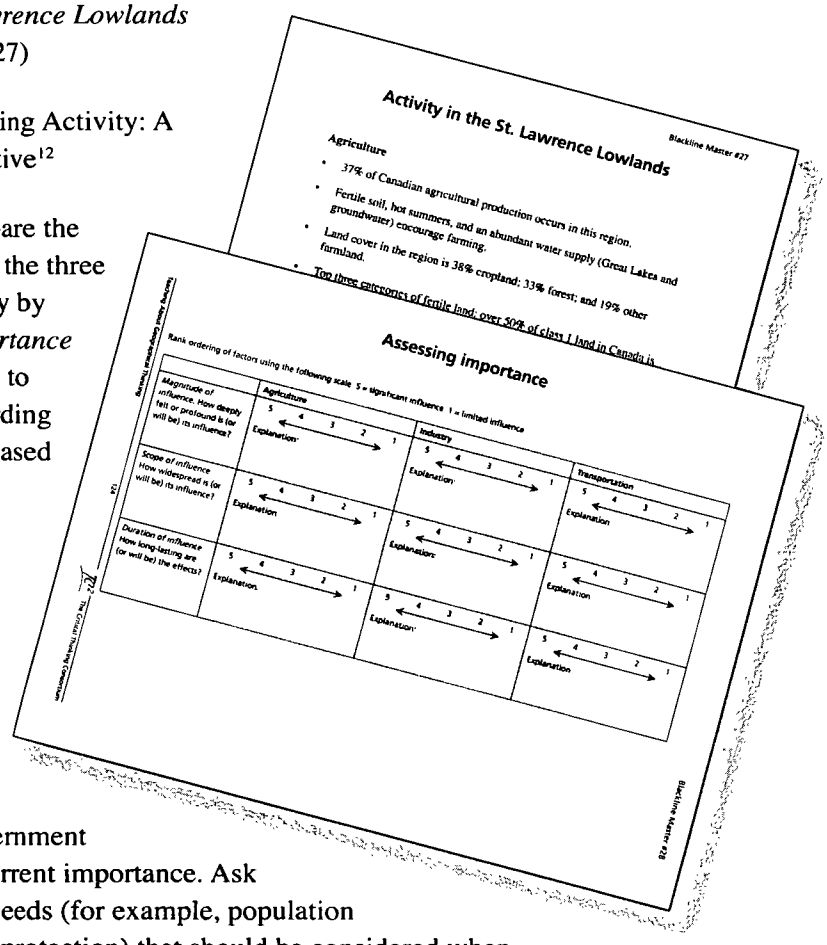
Introduce the critical challenge. Explain to students that they are to assume the role of government consultants on development in the St. Lawrence Lowlands of the Mixedwood Plains region. The government endorses sustainable development and has decided to devote attention to the various components of the economy by allocating resources and passing legislation to regulate them. Students are to examine three major components of the economy—agriculture, industry, and transportation—to help the government rank them in order of their importance to a sustainable future for the region.

Introducing criteria for geographical importance. Suggest to students that in deciding on the relative importance of each of these economic components, they are to consider both the current importance and potential future impact. Introduce or review criteria for determining the relative geographic importance of each component:

- ***Magnitude of influence.*** How deeply felt or profound is its influence?
- ***Scope of influence.*** How widespread is its influence?
- ***Duration of influence.*** How long-lasting are the effects?
- ***Instrumental or strategic value.*** Is it crucial to securing the valued objective of sustainable development?

Assess current relative importance. Provide students with a few general resources on agriculture, industry, and transportation in the St. Lawrence Lowlands today. These might include:

- *Activity in the St. Lawrence Lowlands* (Blackline Master #27)
- Canadian Manufacturing Activity: A Geographic Perspective[12]



Invite students to compare the information gathered about the three components of the economy by completing *Assessing importance* (Blackline Master #28) and to rank each component according to its current importance. Based on the evidence gathered, ask students to justify their ranking in light of the criteria provided on the sheet.

Consider challenges to sustainability. Discuss with students the implications of basing government decisions exclusively on current importance. Ask them to brainstorm future needs (for example, population projections, environmental protection) that should be considered when setting government priorities. Suggest to students that a major factor for geographic importance lies in the issue of sustainability. Invite students to brainstorm responses to the following question: What will be required by each component of the economy in order for it to keep pace with the needs and demands of the growing population in this region? Invite students to record their initial answers to this question on *Considering future challenges* (Blackline Master #29). Explain that students will use these ideas to reassess their priorities with respect to the three economic components. Provide students with additional references on the environmental impact of the three sectors of the economy and the challenges they present to sustainable development:

- Canadian Atlas Online–Themes: Canada 2050[13]
- Environmental Commissioner of Ontario website[14]
- 2006/07 Annual Report of the Environmental Commissioner of Ontario[15]

[12] http://www.statcan.ca/english/research/31F0028XIE/31F0028XIE2000001.htm

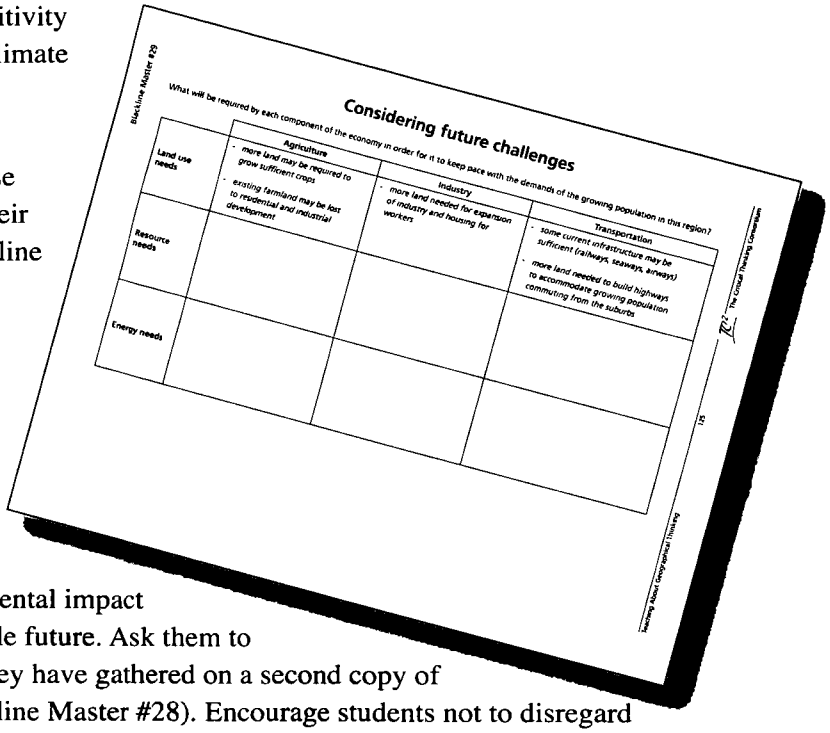
[13] http://www.canadiangeographic.ca/atlas/themes.aspx?id=canada2050&sub=canada2050_canadanow_environment&lang=En

[14] http://www.eco.on.ca/eng/index.php?page=57

[15] http://www.ecoissues.ca/wiki//index.php?title=2006/07_Annual_Report

- Atlas of Canada: Sensitivity of River Regions to Climate Change[16]

As students examine these resources, ask them to add their ideas to the data chart (Blackline Master #29).

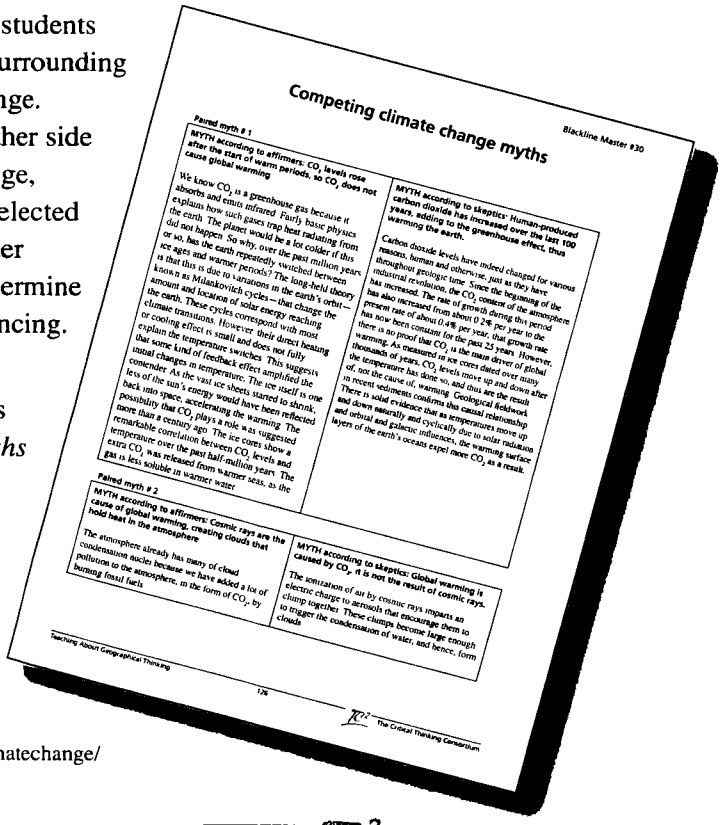


Reassess relative importance. Invite students to revisit their original ranking of agriculture, industry, and transportation in light of the additional evidence regarding environmental impact and challenges to a sustainable future. Ask them to synthesize the information they have gathered on a second copy of *Assessing importance* (Blackline Master #28). Encourage students not to disregard the evidence that led them to their original ranking but, rather, to rethink it in light of anticipated changes in the region. Arrange for students to discuss their conclusions about the relative importance of the three components.

Critical challenge #4: Evidence and interpretation

EXPOSING CLIMATE CHANGE MYTHS

Introduce the challenge. Explain to students that there is continuing controversy surrounding the causes and impact of climate change. Proponents of each side accuse the other side of perpetuating myths. In this challenge, students examine the two sides of a selected "myth" about climate change and, after sharing their findings with others, determine which side overall seems more convincing.



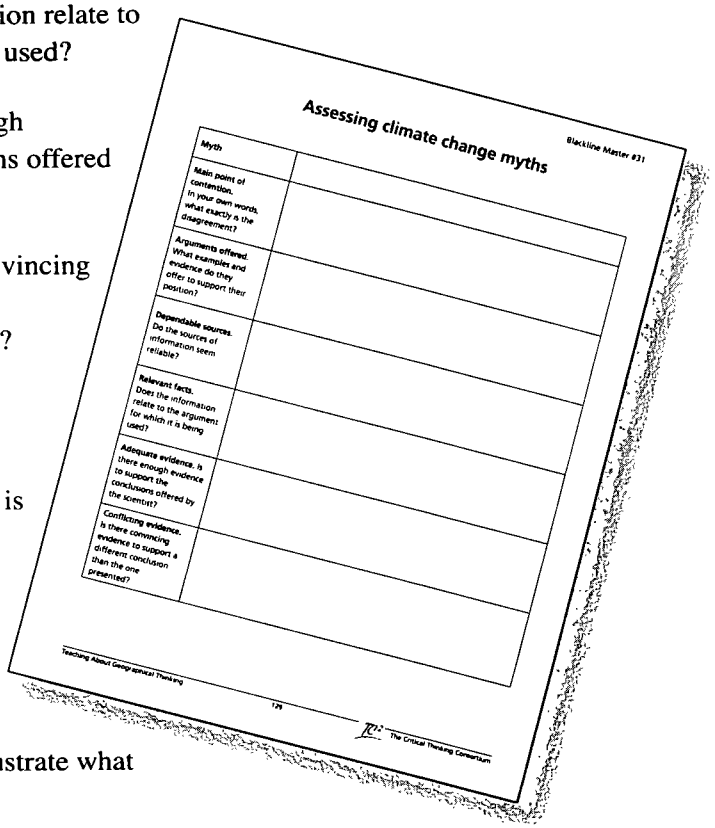
Identify the myths. Distribute copies of the *Competing climate change myths* (Blackline Master #30) to students. Emphasize that this is a summary sheet of the arguments and as such leaves out much information that may be crucial. Ask students to read the six paired or offsetting

[16] http://atlas.nrcan.gc.ca/site/english/maps/climatechange/potentialimpacts/sensitivityriverregions

myths. Explain that the arguments beneath each myth are attempts to explain why the group believes that the claim is a myth—that it is not true. Explain that these are a partial list of the disputed issues surrounding climate change.

Discuss criteria for assessing credibility. Present students with the following criteria for assessing the credibility of scientific reports:

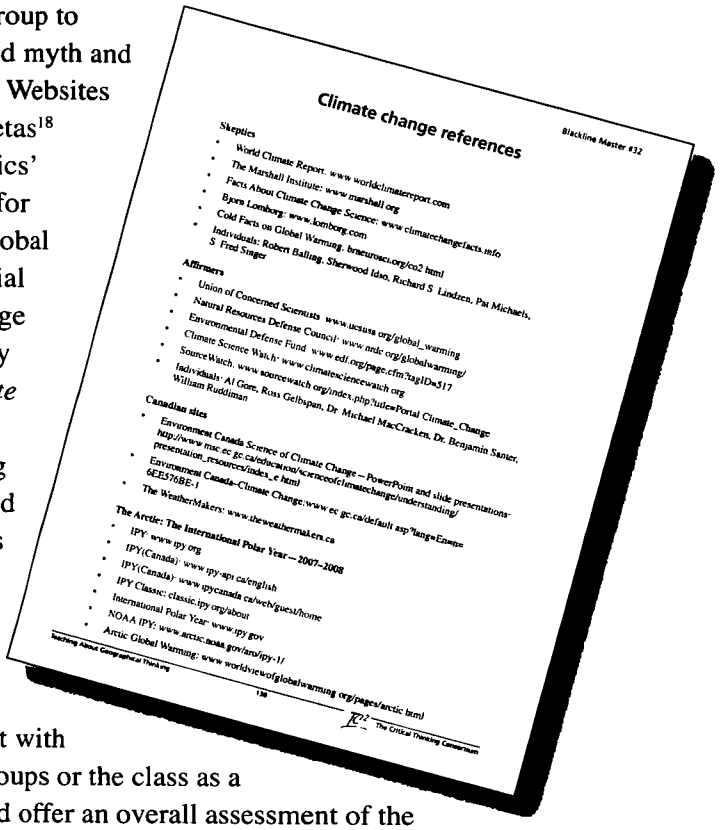
- ***Dependable sources:*** Do the sources of information seem reliable? Is there reason to suspect their credibility?
- ***Relevant facts:*** Does the information relate to the argument for which it is being used?
- ***Adequate evidence:*** Is there enough evidence to support the conclusions offered by the scientist?
- ***Conflicting evidence:*** Is there convincing evidence to support a different conclusion than the one presented?



Review the requirements. Assign each group of students one of the pair set of myths to research. An optional approach is to establish paired teams of three or four students who will debate the two sides of one of the myths. Distribute two copies of *Assessing climate change myths* (Blackline Master #31) to each group—one for each of the paired myths. Use the following example to illustrate what is required of students.

Myth according to skeptics	CO_2 is a pollutant
Main point of contention	The effect of CO_2 on the atmosphere
Arguments offered	*Skeptics*: CO_2 is essential to life on earth and allows plants to grow. The Canadian Government lists it as a pollutant for political purposes. *Affirmers*: Oxygen is essential to human life. An excess of anything can be a problem. CO_2 is a pollutant when there is an excess as a result of the burning of fossil fuels.
Are the sources *dependable?*	*To be determined based on student research*
Are the arguments *relevant*?	*To be determined based on student research*
Do they seem *plausible*?	*To be determined based on student research*
Is there convincing *conflicting* evidence?	*To be determined based on student research*

Conduct the research. Direct each group to research information about an assigned myth and to record their ideas on the data chart. Websites of the Friends of Science[17] and DeFrietas[18] are suggested references for the skeptics' perspective. Recommended websites for the affirmers of climate change are Global Warming Myths and Facts[19] and Special Report on Climate Change.[20] Encourage students to go beyond these sources by consulting references found on *Climate change references* (Blackline Master #32) or by searching the internet using a short phrase describing their assigned myth (for example, search for "CO_2 as a pollutant"). Allow groups time to research their assigned myth.


Climate change references

Blackline Master #32

Skeptics

- World Climate Report. www.worldclimatereport.com
- The Marshall Institute: www.marshall.org
- Facts About Climate Change Science: www.climatechange-facts.info
- Bjorn Lomborg: www.lomborg.com
- Cold Facts on Global Warming. fraeuroaci.org/co2.html
- Individuals: Robert Balling, Sherwood Idso, Richard S. Lindzen, Pat Michaels, S. Fred Singer

Affirmers

- Union of Concerned Scientists. www.ucsusa.org/global_warming
- Natural Resources Defense Council: www.nrdc.org/globalwarming/
- Environmental Defense Fund. www.edf.org/page.cfm?tagID=517
- Climate Science Watch. www.climatesciencewatch.org
- SourceWatch. www.sourcewatch.org/index.php?title=Portal:Climate_Change
- Individuals: Al Gore, Ross Gelbspan, Dr. Michael MacCracken, Dr. Benjamin Santer, William Ruddiman

Canadian sites

- Environment Canada. Science of Climate Change – PowerPoint and slide presentations: http://www.msc.ec.gc.ca/education/scienceofclimatechange/understanding/presentation_resources/index_e.html
- Environment Canada–Climate Change: www.ec.gc.ca/default.asp?lang=En&n=6EE576BE-1
- The WeatherMakers: www.theweathermakers.ca

The Arctic: The International Polar Year – 2007–2008

- IPY: www.ipy.org
- IPY(Canada): www.ipy-api.ca/english
- IPY(Canada): www.ipycanada.ca/web/guest/home
- IPY Classic: classic.ipy.org/about
- International Polar Year: www.ipy.gov
- NOAA IPY: www.arctic.noaa.gov/aro/ipy-1/
- Arctic Global Warming: www.worldviewofglobalwarming.org/pages/arctic.html

Teaching About Geographical Thinking

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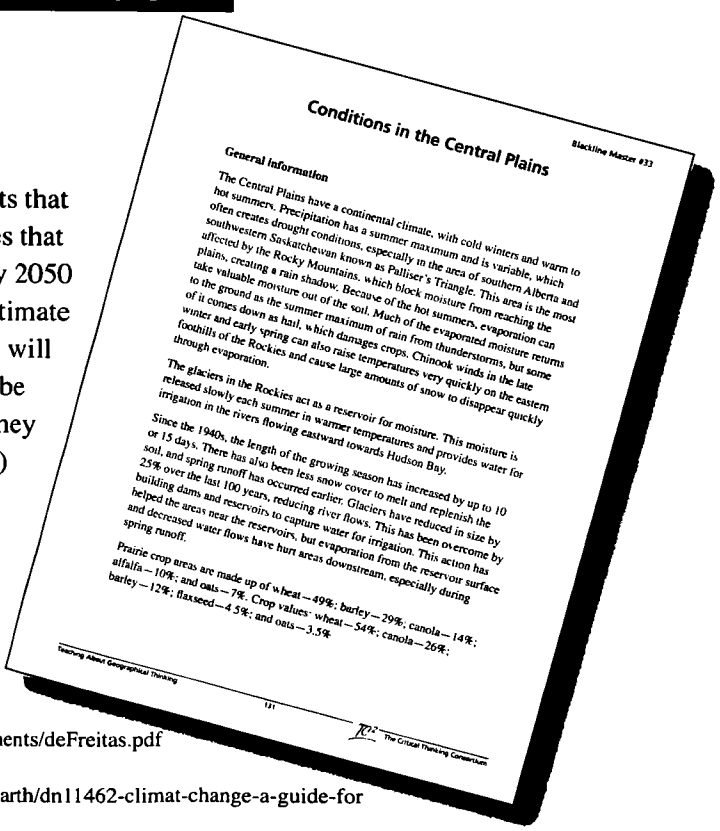
TC2 The Critical Thinking Consortium

Debate the findings. Invite each group to share an oral or written report with the rest of the class. Ask individual groups or the class as a whole to discuss the overall results and offer an overall assessment of the more credible camp in the climate change debate—the skeptics or the affirmers. Note that it is not necessary that all of the myths for one side be justified. Each side may have better arguments on one or more of the myths.

Critical Challenge #5: Interactions and associations

CLIMATE CHANGE ON THE CENTRAL PLAINS

Introduce the task. Explain to students that they are going to anticipate the changes that may take place in the Central Plains by 2050 as a result of global warming. Their ultimate task is to decide which of these effects will be the most significant. (Students will be better prepared to address this task if they have completed Critical Challenge #4.)


Conditions in the Central Plains

Blackline Master #33

General information

The Central Plains have a continental climate, with cold winters and warm to hot summers. Precipitation has a summer maximum and is variable, which often creates drought conditions, especially in the area of southern Alberta and southwestern Saskatchewan known as Palliser's Triangle. This area is the most affected by the Rocky Mountains, which block moisture from reaching the plains, creating a rain shadow. Because of the hot summers, evaporation can take valuable moisture out of the soil. Much of the evaporated moisture returns to the ground as the summer maximum of rain from thunderstorms, but some of it comes down as hail, which damages crops. Chinook winds in the late winter and early spring can also raise temperatures very quickly on the eastern foothills of the Rockies and cause large amounts of snow to disappear quickly through evaporation.

The glaciers in the Rockies act as a reservoir for moisture. This moisture is released slowly each summer in warmer temperatures and provides water for irrigation in the rivers flowing eastward towards Hudson Bay.

Since the 1940s, the length of the growing season has increased by up to 10 or 15 days. There has also been less snow cover to melt and replenish the soil, and spring runoff has occurred earlier. Glaciers have reduced in size by 25% over the last 100 years, reducing river flows. This has been overcome by building dams and reservoirs to capture water for irrigation. This action has helped the areas near the reservoirs, but evaporation from the reservoir surface and decreased water flows have hurt areas downstream, especially during spring runoff.

Prairie crop areas are made up of wheat – 49%; barley – 29%; canola – 14%; alfalfa – 10%; and oats – 7%. Crop values: wheat – 54%; canola – 26%; barley – 12%; flaxseed – 4.5%; and oats – 3.5%

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Drawing inferences about impact. Ask students to read the information found on *Conditions in the Central*

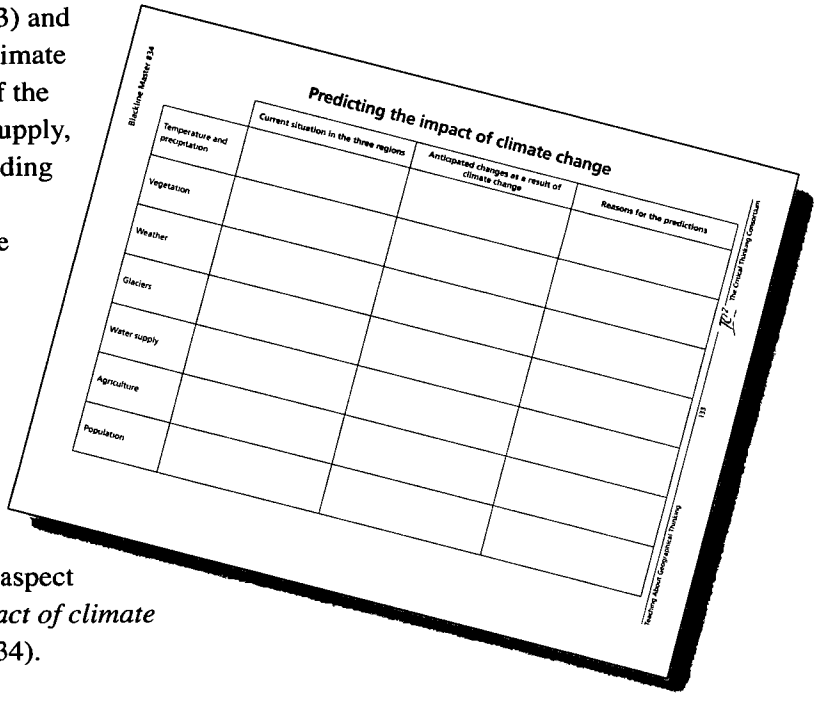
[17] http://www.friendsofscience.org/index.php?id=3

[18] http://www.friendsofscience.org/assests/documents/deFreitas.pdf

[19] http://www.edf.org/page.cfm?tagID=1011

[20] http://environment.newscientist.com/channel/earth/dn11462-climat-change-a-guide-for-the-perplexed

Plains (Blackline Master #33) and to anticipate the impact of climate change to 2050 on aspects of the region (for example, water supply, population, weather). Depending on the level of students, complete this task as a whole class or provide additional background information about the implications of rising temperatures. Ask students to record their thoughts about the current conditions, anticipated future conditions, and supporting reasons for each aspect listed on *Predicting the impact of climate change* (Blackline Master #34).



Check predictions. Once students have completed the questions, invite them to access information about the anticipated effects of climate change found on the Canadian Atlas Online.[21] Follow the following path:

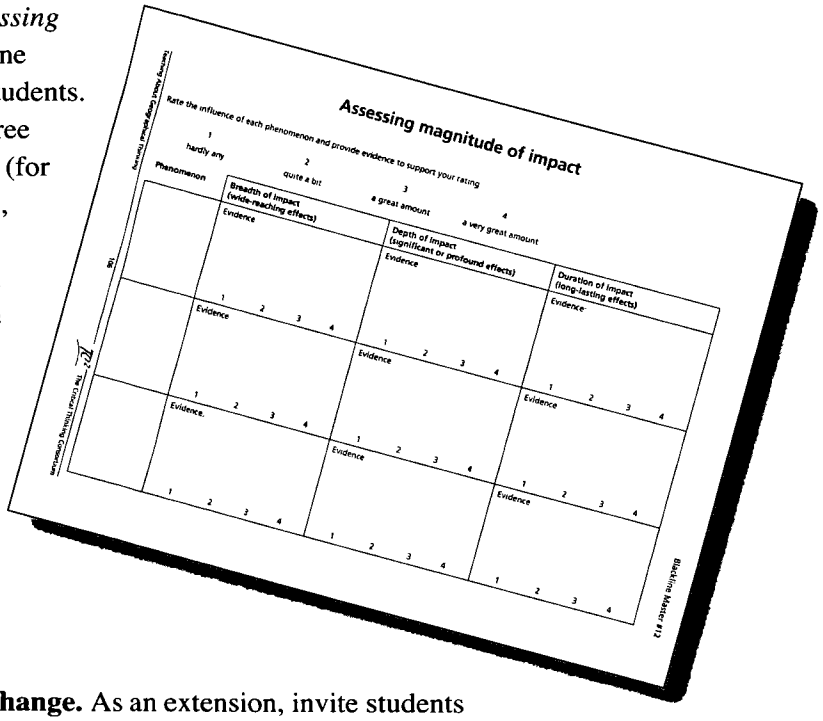
- Click on Themes; then Issues and then Climate Change.
- Click on Changing Landscapes and Prairies to access a map of present and future climate.
- Click on Human Impact and Prairies to see two images of the same area a year apart and an outline of both positive and negative impacts on the ecozone.
- Click on Canada 2050 and then Environment to access the map "Predicting Canada's Climate in 2050". Click on the Central Plains ecozone region to view the changes and scroll the list of anticipated impacts.

Determine most significant changes. When students have a shared understanding of the anticipated impact of climate change, ask them to consider which of these impacts will make the biggest difference on conditions in the Central Plains region. Suggest three criteria for assessing the magnitude of influence:

- ***Breadth or extent of impact.*** Some factors may influence their immediately surrounding area, whereas others will affect large expanses or regions that are far away.
- ***Depth of impact.*** Factors may have a superficial effect on their human and physical environment or they may profoundly alter the state of things.
- ***Duration of impact.*** The duration of impact may range from a short period of time to long-term changes.

[21] http://www.canadiangeographic.ca/atlas/

Distribute a copy of *Assessing magnitude of impact* (Blackline Master #12) to each pair of students. Ask each pair to select the three aspects of anticipated change (for example, weather, population, water supply) that they think will have the most significant influence on conditions in the Central Plains region. Ask students to rate each aspect in light of the three criteria discussed above. Invite students to share their assessment of the most significant result of climate change for this region.



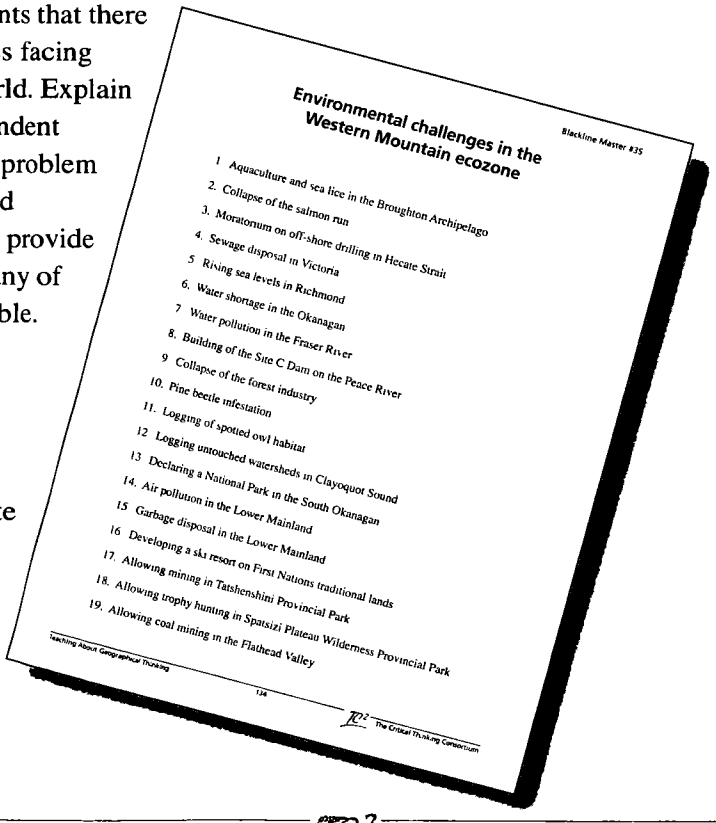
Learn more about climate change. As an extension, invite students to learn more about climate change across Canada and around the world. Direct students to the Climate Change button in the left side menu of the Atlas of Canada website.[22] Review the information provided under each of the headings.

Critical Challenge #6: Geographical value judgments

ENVIRONMENTAL PLANS FOR THE WESTERN MOUNTAINS

Introduce the task. Suggest to students that there are a host of environmental challenges facing most regions in Canada—and the world. Explain that they are going to conduct independent research on a selected environmental problem in the Western Mountains ecozone and propose a course of action that would provide a long-term solution, satisfying as many of the needs of the main groups as possible.

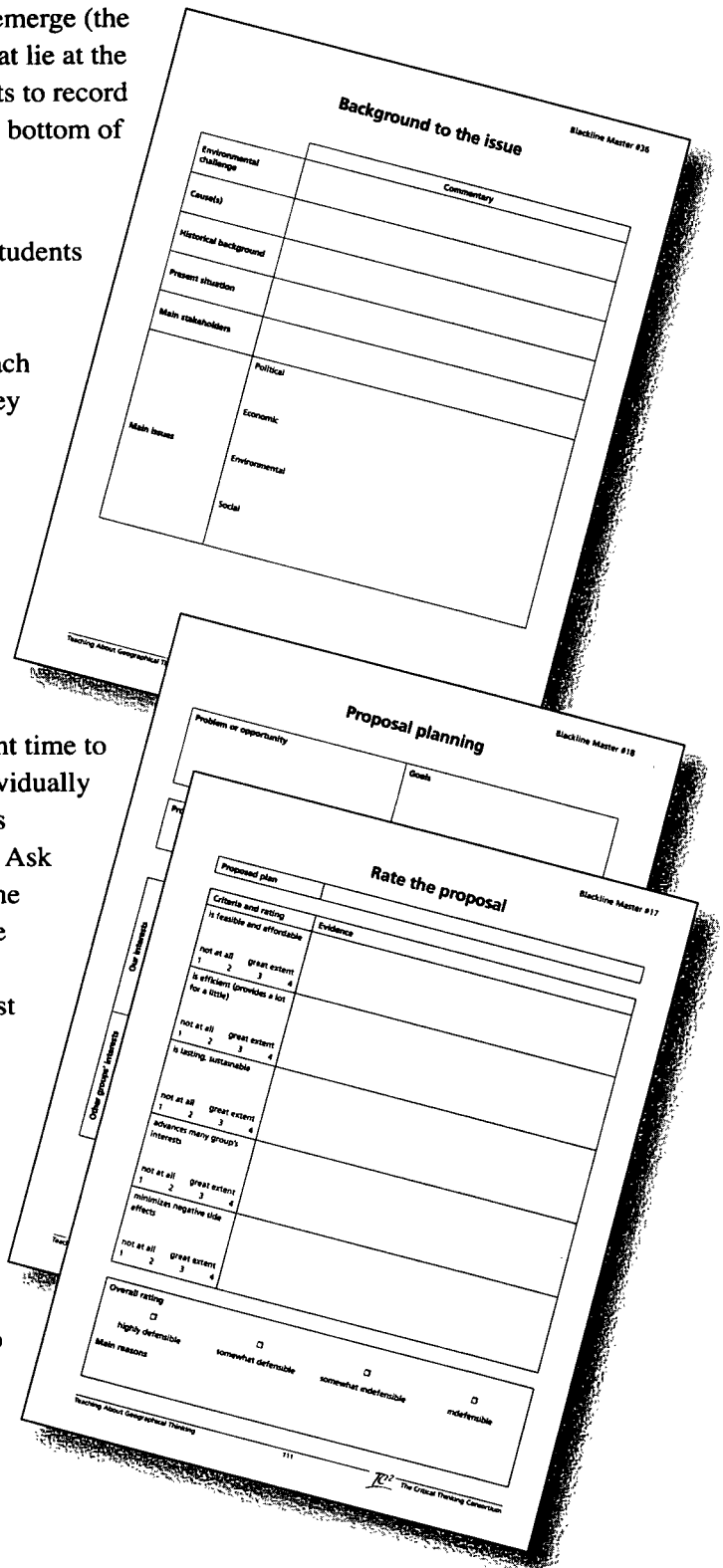
Assign a challenge to take up. Read out the topics from *Environmental challenges in the Western Mountain ecozone* (Blackline Master #35). Invite students in groups of five to select a challenge listed on this sheet. Direct each student to find one article on the internet about their chosen topic.



[22] http://atlas.nrcan.gc.ca/site/

Identify stakeholder interests and tensions. Introduce the idea of stakeholders and invite students to use the articles they have found to identify the people who have a stake in their environmental challenge—both those that are explicitly mentioned in the articles and those that have a less direct stake. For each stakeholder, ask students to think of the possible interests that may be affected by any resolution of the problem (for example, some people may lose their homes, others may gain employment, some will lose access to pristine wildlife, the lives of animals may be endangered). As a group, ask students to record their ideas on *Uncovering the issues* (Blackline Master #16). From this analysis, direct students to identify the underlying issues that emerge (the contested matters or disagreements that lie at the heart of the situation). Instruct students to record the underlying issues in the box at the bottom of the chart.

Conduct in-depth research. Direct students to work as a group or as subgroups to conduct more in-depth research into their environmental challenge. Ask each students to record information that they find in their research on *Background to the issue* (Blackline Master #36). Encourage members of each group periodically to share what they are finding about the environmental challenge.



Prepare and assess individual action plans. After, allowing sufficient time to conduct research, invite students individually to develop a plan to address the issues within their environmental challenge. Ask each student in the group to take on the role of a key stakeholder. Students are to draft a realistic plan of action from that stakeholder's perspective. Suggest that students use *Proposal planning* (Blackline Master #18) to prepare their plan. Arrange for students to meet with the four other stakeholders for their chosen environmental challenge. When all plans have been shared, ask students to assess the impact of each proposal on various stakeholders. Invite the group to use the chart *Rate the proposal* (Blackline Master #17) to assess the adequacy of each plan in light of the following criteria:

- feasible and affordable
- efficient
- sustainable
- advances many groups' interests
- minimizes negative side effects

Prepare a group plan. Based on their critiques of each member's individual plan, ask each group to arrive at a negotiated proposal that best meets all stakeholder interests and provides a long-term solution to their problem.

Rate each group's final proposal. Arrange for each group to present its negotiated plan to the rest of the class. Invite other students to use *Rate the proposal* (Blackline Master #17) when rating how successfully each group has addressed the issues in a manner that accommodates the legitimate interests of as many stakeholders as possible to record. In the debriefing, discuss the effectiveness of the recommended approaches and whether inclusive solutions can be found to the problems facing the challenges.

Blackline Masters

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[3] **Geographical importance**

[4] **Evidence and interpretation**

[5] **Patterns and trends**

[6] **Interactions and associations**

[7] **Sense of place**

[8] **Geographical value judgments**

[9] **Exemplars: Ecozones of Canada**

Assessing relative importance

	Feature or place:	Feature or place:	Feature or place:
Spatial influence – *Scope of influence:* – *Magnitude of influence:* – *Duration of influence:*			
Inherent or assigned significance Does it have particular cultural, religious, or historical meaning or value?			
Instrumental or strategic value Is it crucial to securing a valued purpose or objective?			

Assessing statistical data

	Strengths regarding credibility	Questions and concerns about credibility
Credibility of the researchers. What do we know of the people who collected the information? Are they qualified and inclined to collect information in a careful, consistent, and scientifically credible manner?		
Credibility of the publishers. What do we know of the publishers of the results? Would they likely have confirmed that the research was carried out in a scientifically credible manner? Is there any reason to doubt that they are reporting the data in a full and impartial manner?		
Comprehensive and accurate information. Does it seem that relevant information is missing? Do the findings accurately represent the full picture? Might the figures no longer be current?		
Clear and precise presentation. Are there any indicators that the information is presented in a vague or misleading manner?		

Summary conclusion

Obviously credible	No reason to suspect its credibility	Credibility may be an issue	Obviously not credible

Explanation

Assessing reports and articles

	Strengths regarding justifiability	Questions and concerns about justifiability
Dependable sources. Do the sources of information seem reliable? Is there reason to suspect their expertise or credibility?		
Relevant facts. Does the information relate to the argument for which it is being used?		
Adequate evidence. Is there enough evidence to support the conclusions offered?		
Conflicting evidence. Is there evidence to support different conclusions than the ones presented? Do they address potential arguments against their position?		

Summary conclusion

Very strongly justified Partially justified Questionable Very weakly justified

Explanation

Interpreting statistical tables

Strategies	Data/topics	Possible inferences and explanation
Look at individual items and think of implications		
Sort data into categories and examine (e.g., quality of life, cultural diversity, climatic conditions)		
Think of relevant topics and look for data in the chart (e.g., equality of life, cultural diversity, climatic conditions)		
Calculate percentages or create charts or graphs to compare		
Think of what is missing from the data and consider possible implications		

Life in the region

	Possible inferences	Supporting data
Physical geography • topography • climate	•	•
Social • quality of life/living conditions • health/safety • community support	•	•
Economic • employment/ occupations • technology • economic security/ wealth	•	•
Political • social influence • government policy • individual freedoms/ rights	•	•

Identifying the variations

Use the scales to indicate the nature of variation found in each of these phenomena.

	TEMPORAL VARIATION															SPATIAL VARIATION														
	Rate ← →					Pattern ← →					Distribution ← →					Rate ← →					Pattern ← →					Distribution ← →				
	slow				rapid	recurring				unidirectional	constant				sporadic	gradual				abrupt	consistent				random	universal				localized
earthquake	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
tectonic plate movement	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
landslide	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
soil erosion	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
glaciers	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
snowcaps	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
precipitation patterns	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
drought	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
seasons	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

	TEMPORAL VARIATION															SPATIAL VARIATION													
	Rate ↔					Pattern ↔					Distribution ↔					Rate ↔					Pattern ↔					Distribution ↔				
	slow				rapid	recurring				unidirectional	constant				sporadic	gradual				abrupt	consistent				random	universal				localized
tides	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
migratory patterns	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
urbanization	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
immigration	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
disease distribution	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
tree growth	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
declining fish stocks	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
oil spills	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Extent of constancy and variation

	A **Phenomenon or region:**	B **Phenomenon or region:**
Breadth of occurrence. How widely is the phenomenon found?		
Duration of occurrence. How long has the phenomenon lasted?		
Depth of impact. How profoundly does the phenomenon affect the area where it occurs?		

Overall, when comparing items, the degree of ❒ constancy
❒ variation

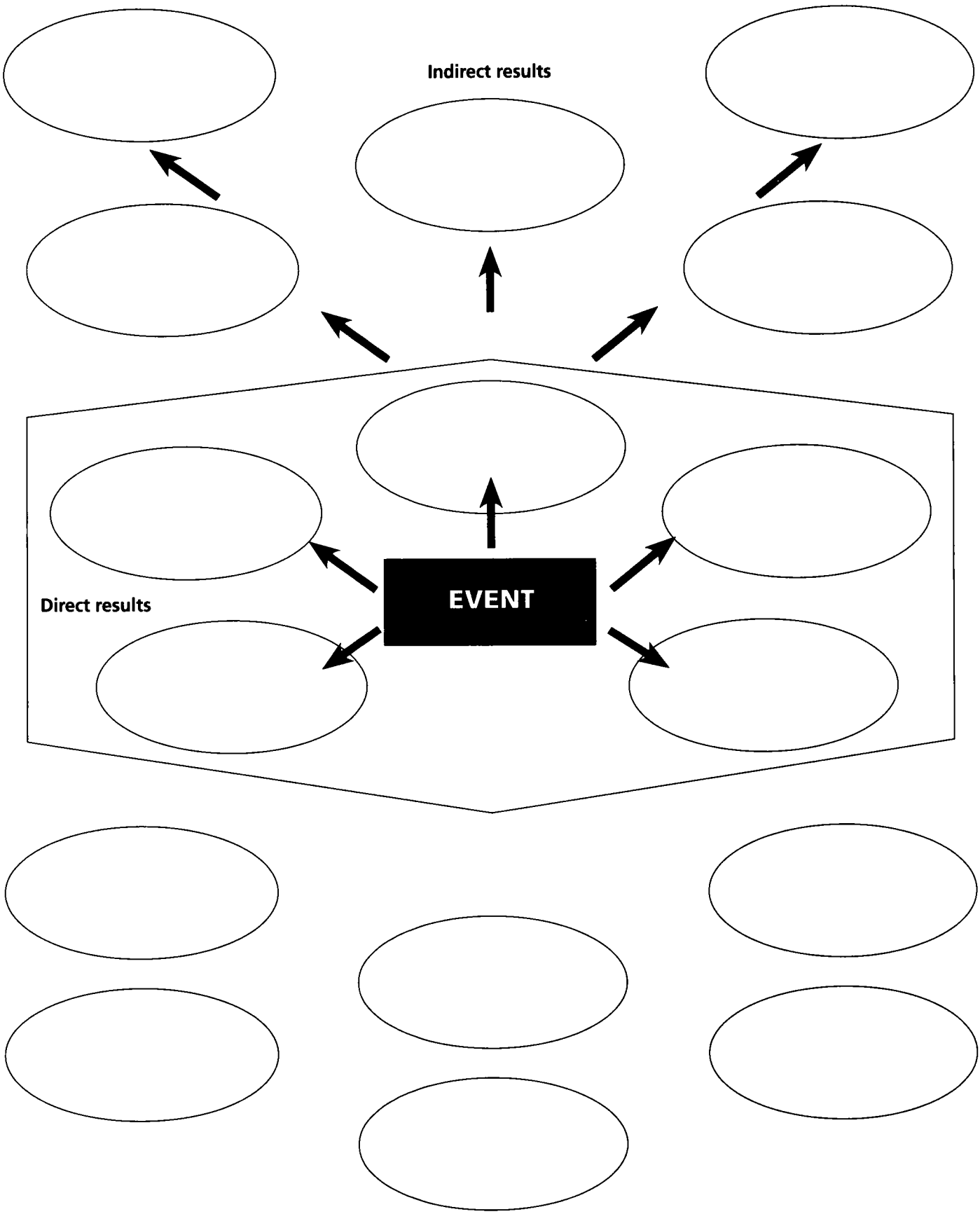
❒	❒	❒	❒	❒
Is much greater in A than in B	Is slightly greater in A than in B	Is nearly identical in A and B	Is slightly greater in B than in A	Is much greater in B than in A

Reasons

Comparing regions

Significant SIMILARITIES between the regions	Reasons why they are significant
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
Significant DIFFERENCES between the regions	**Reasons why they are significant**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Web of effects



Factors affecting climate[1]

Climatic factor	Effect on Temperature (T) and Precipitation (P)
Latitude	**T** The further from the Equator (north or south), the cooler the temperature
	P The closer to the Poles, the lower the precipitation, since cooler air holds less moisture
Ocean currents	**T** Warm ocean currents raise temperatures along the coast (especially in winter); cold ocean currents lower temperatures.
	P Warm ocean currents create wet coastal climates; cold ocean currents help create drier coastal climates.
Wind and air masses	**T** Onshore winds moderate temperatures; offshore winds result in extreme temperatures. Polar air masses are cold while tropical air masses are warm.
	P Onshore winds carry moisture inland; offshore winds bring drier conditions. Canada experiences prevailing westerly winds. Continental air masses are dry; maritime air masses are moist.
Elevation	**T** The higher the elevation, the cooler the temperature.
	P The higher the elevation, the higher the precipitation possible.
Relief	**T** Mountains block winds; temperatures on the windward side can be moderate and on the leeward side they can be extreme; south-facing slopes in the Northern Hemisphere are warmer.
	P Windward regions are wet and leeward regions are dry (rain shadow effect); south-facing slopes in the Northern Hemisphere are drier.
Distance from sea	**T** Temperatures are moderated (warmer winters, cooler summers) when winds move inland; continental areas far from oceans experience extreme temperatures.
	P Coastal areas with mountains receive higher precipitation; continental areas receive less precipitation, especially when blocked by mountains.

1 Adapted from The Arctic Tundra Biome, a lesson plan developed by Canadian Council for Geographic Education http://www.ccge.org/ccge/english/Resources/LessonPlans/matrix.asp. Search for by title of lesson.

Weather report

Location: _____ Month: _____

Anticipated weather

Average temperature: _____ Average precipitation: _____

Description: _____

_____

_____

Climatic factor	Explanation
Latitude	
Ocean currents	
Wind and air masses	
Elevation	
Relief	
Distance from sea	

Assessing magnitude of impact

Rate the influence of each phenomenon and provide evidence to support your rating.

1	2	3	4
hardly any	quite a bit	a great amount	a very great amount

Phenomenon	Breadth of impact (wide-reaching effects)	Depth of impact (significant or profound effects)	Duration of impact (long-lasting effects)
	Evidence: 1 2 3 4	Evidence: 1 2 3 4	Evidence: 1 2 3 4
	Evidence: 1 2 3 4	Evidence: 1 2 3 4	Evidence: 1 2 3 4
	Evidence: 1 2 3 4	Evidence: 1 2 3 4	Evidence: 1 2 3 4

Believe it or not

Regional practices	Your reaction	Possible reasons or benefits

What is your first impression of how these people lived?
After hearing more, has your overall impression changed?

Changing geographical perspectives

Regions compared: _____

Before

I believe these regions are:

❑	❑	❑	❑
almost identical	mostly similar	mostly different	vastly different

because

During

Unique features	*Common features*

After

I now believe these regions are

❑	❑	❑	❑
almost identical	mostly similar	mostly different	vastly different

because

Assessing the sense of place

	Strengths	Questions and concerns
Accurate. Accurately represents a broad range of human and physical features that are significant to a region.		
Authentic. Vividly captures the feel of the place resulting from its defining human and physical features.		
Diverse. Conveys a sense of the diversity of features and lived experiences.		
Connected. While showing the uniqueness, also show, how this place is linked or has commonalities with other regions.		
Sensitive. Is sensitive to the meaning and significance that the various features will have for those who inhabit the region.		

Summary conclusion

Excellent Good Marginal Poor

Explanation

Uncovering the issues

Topic: _____

Main stakeholders	Interests or values

Underlying issues
•
•
•
•

Rate the proposal

Proposed plan	

Criteria and rating	**Evidence**
is feasible and affordable not at all great extent 1 2 3 4	
is efficient (provides a lot for a little) not at all great extent 1 2 3 4	
is lasting, sustainable not at all great extent 1 2 3 4	
advances many groups' interests not at all great extent 1 2 3 4	
minimizes negative side effects not at all great extent 1 2 3 4	

Overall rating

❒	❒	❒	❒
highly defensible	somewhat defensible	somewhat indefensible	indefensible

Main reasons

Proposal planning

Problem or opportunity	Goals

Proposed policy or strategy

	How long-term interests may be served	How long-term interests may not be served
Our interests		
Other groups' interests		

Ecozone data

1. This ecozone covers 1.8 million square miles—20% of Canada's land mass.

2. Uplands and hills of Precambrian rock have been exposed by repeated advances of ice age glaciers. The resulting bare rock, thin soil, and muskeg have restricted resource exploitation.

3. Lakes, rivers, streams, and wetlands form 20% of this region and account for 22% of Canada's fresh water. About 2% of the world's wetlands are found in Canada, mostly in this ecozone.

4. The climate ranges from cold winters (January: -15°C on average) to warm to hot summers (July: +18°C on average) with precipitation ranging from 700 mm inland and 1500 mm near the ocean.

5. The vegetation in the zone is predominantly forest made up of 38% spruce; 19% pine; 8% poplar; 7% maple; 7% birch; 5% fir; and 16% other species.

6. Up to 7 million hectares of this forest is burned annually—85% by lightning.

7. The spruce budworm infests about 10 million hectares annually, causing ten times more damage than fire.

8. Acid precipitation from industry damages trees and kills lakes and streams. It is estimated that over 50% of lakes in this zone are still acidified.

9. 50% of Canada's commercial forest is found in this zone.

10. Wildlife found in this zone includes woodland caribou, moose, wolf, bear, and beaver. Millions of ducks and birds migrate to and breed in this area and lakes host a variety of fish.

11. 98% of the mining output in the zone is iron ore.

12. Less than 10% of Canadians live in this zone.

Ecozone identification I

Aspect of the region	Suggested inference	Evidence #
Types of settlement		2, 9, 11, 12
Primary industry		2, 3, 5, 7, 10, 11
Agriculture		2, 4, 5
Secondary industry		2, 5, 9, 11
Tertiary (service) industry		3, 10, 12
Transportation		2, 3, 9, 11
Energy		2, 3, 5
Housing		5
Home heating		2, 3, 5
Food		2, 4, 5, 10
Natural hazards		6, 7
Environmental concerns		8, 9, 11
Recreation		2, 3, 4, 5, 10, 12

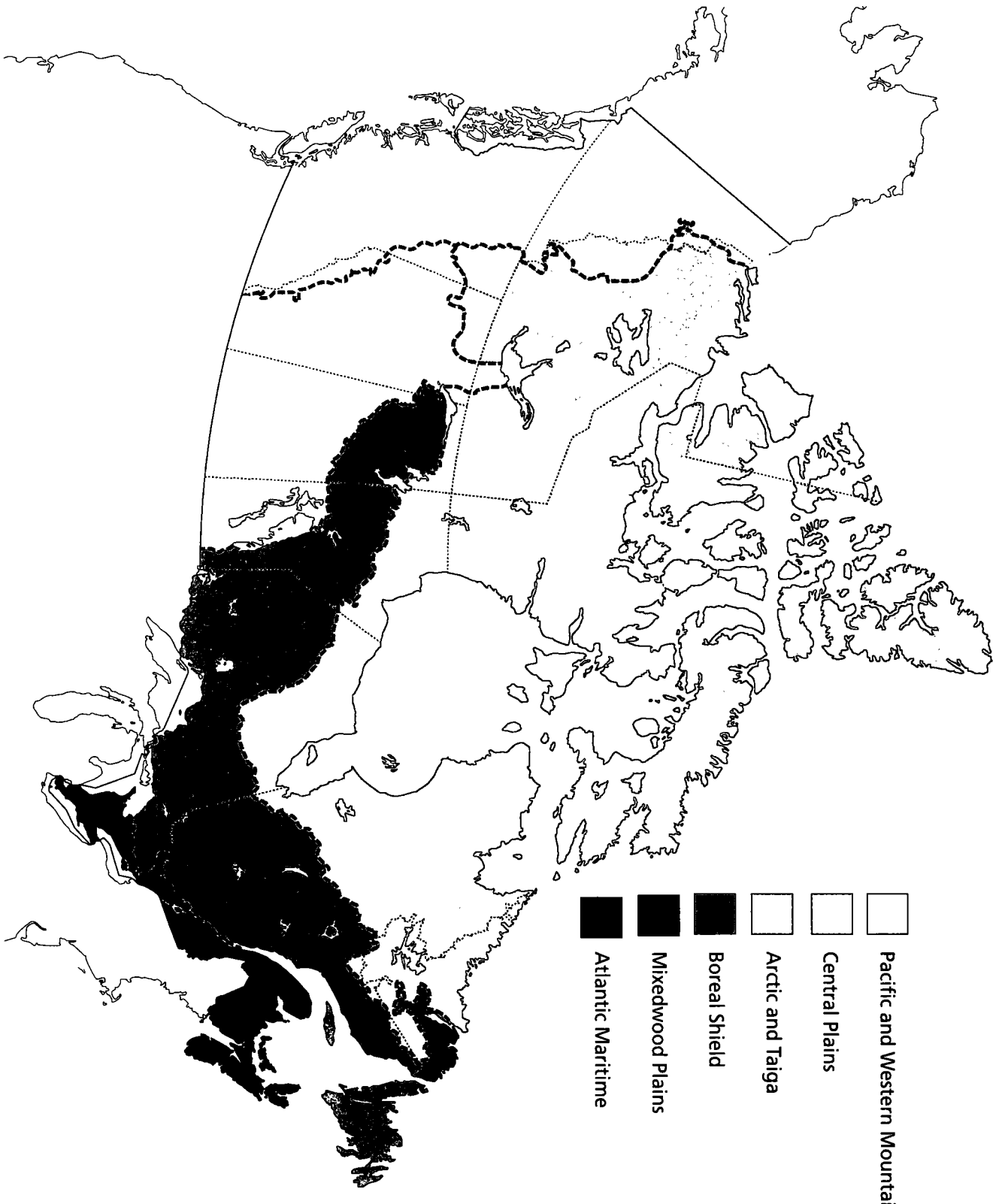
Ecozone identification II

Aspect of the region	Suggested inference	Evidence #
Types of settlement		
Primary industry		
Agriculture		
Secondary industry		
Tertiary (service) industry		
Transportation		
Energy		
Housing		
Home heating		
Food		
Natural hazards		
Environmental concerns		
Recreation		

Ecozone identification: Sample answers

Aspect of the region	Suggested inference	Evidence #
Types of settlement	*Small, one-industry towns*	2, 9, 11, 12
Primary industry	*Forestry, mining, fur trapping, fishing*	2, 3, 5, 7, 10, 11
Agriculture	*Very limited; possible in isolated pockets*	2, 4, 5
Secondary industry	*Pulp and paper; possible smelting of ore*	2, 5, 9, 11
Tertiary (service) industry	*Fishing camps, hunting camps*	3, 10, 12
Transportation	*Float planes; railways and highways*	2, 3, 9, 11
Energy	*Water power; burning of wood*	2, 3, 5
Housing	*Wood construction*	5
Home heating	*Wood-burning stoves; electricity*	2, 3, 5
Food	*Imported from outside the zone; meat from hunting*	2, 4, 5, 10
Natural hazards	*Fire from lightning strikes; insect infestations*	6, 7
Environmental concerns	*Acid precipitation, clear-cutting; mining pollution*	8, 9, 11
Recreation	*Fishing, hunting, camping, cross-country skiing*	2, 3, 4, 5, 10, 12

Ecozones of Canada



Regional profiles

Characteristics of the Boreal Shield

- The landform region or physiographic region is an area of Precambrian rock that has been exposed and worn down by repeated advances of ice-age glaciers, creating a landscape of low hills and thousands of lakes.
- The vegetation region is forest dominated by white and black spruce and balsam fir.
- The climate region is characterized by cold winters (-15°C average), hot summers (+18°C), and average precipitation (700 mm).
- Mining activity is focused on iron ore.
- Forestry is characterized by logging and pulp and paper production.

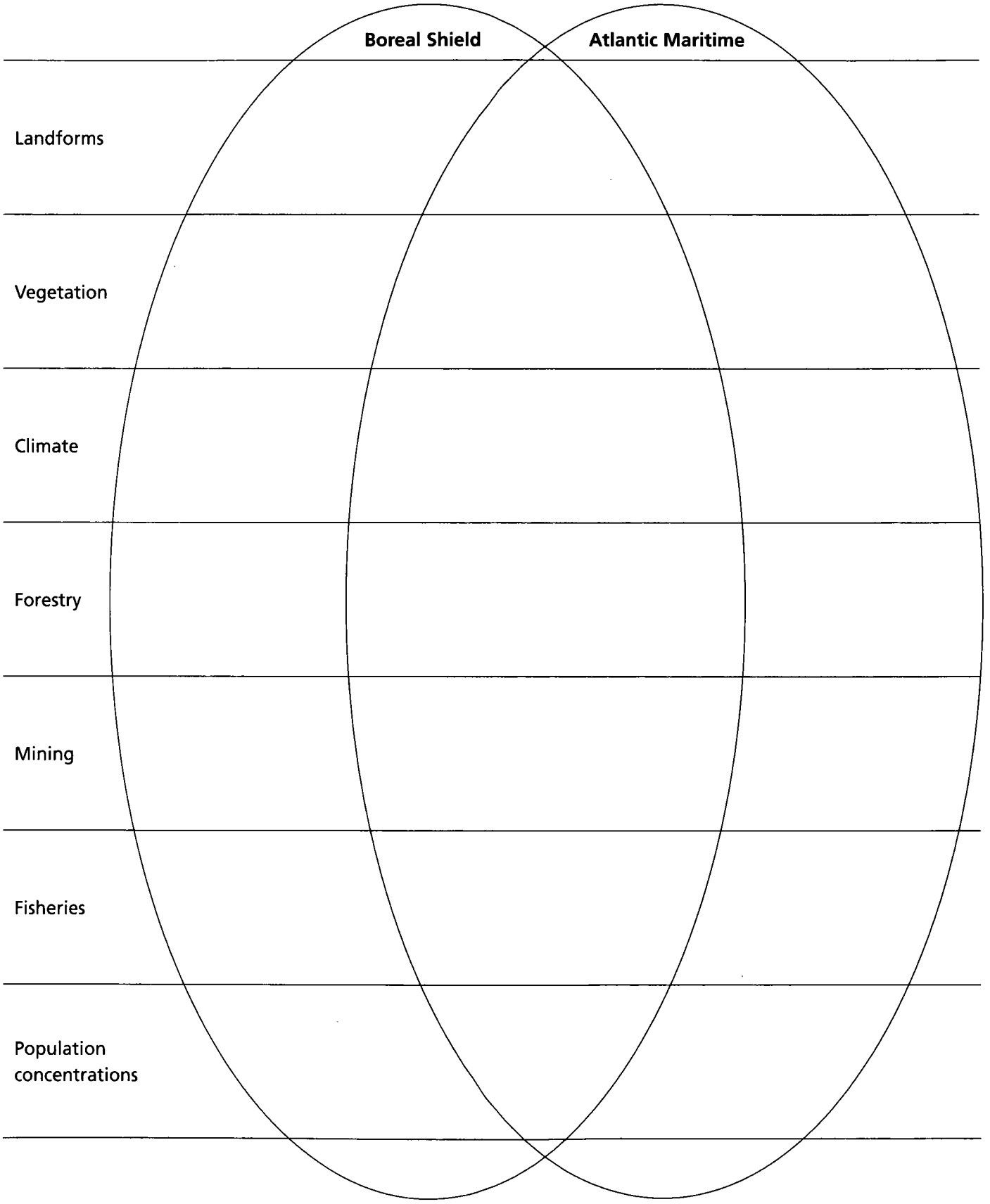
Characteristics of the Atlantic Maritime

- The landform region is the worn down Appalachian Mountains.
- The vegetation region is a mixture of deciduous and coniferous trees.
- The climate region is characterized by cool winters (-5°C average), warm summers (+15°C), and high precipitation (1400 mm).
- Mining activity is focused on offshore oil.
- Forestry is dominated by private woodlots and pulp and paper production.
- Fishing is important, with shellfish replacing cod after the collapse of the cod fishery as the number one product.

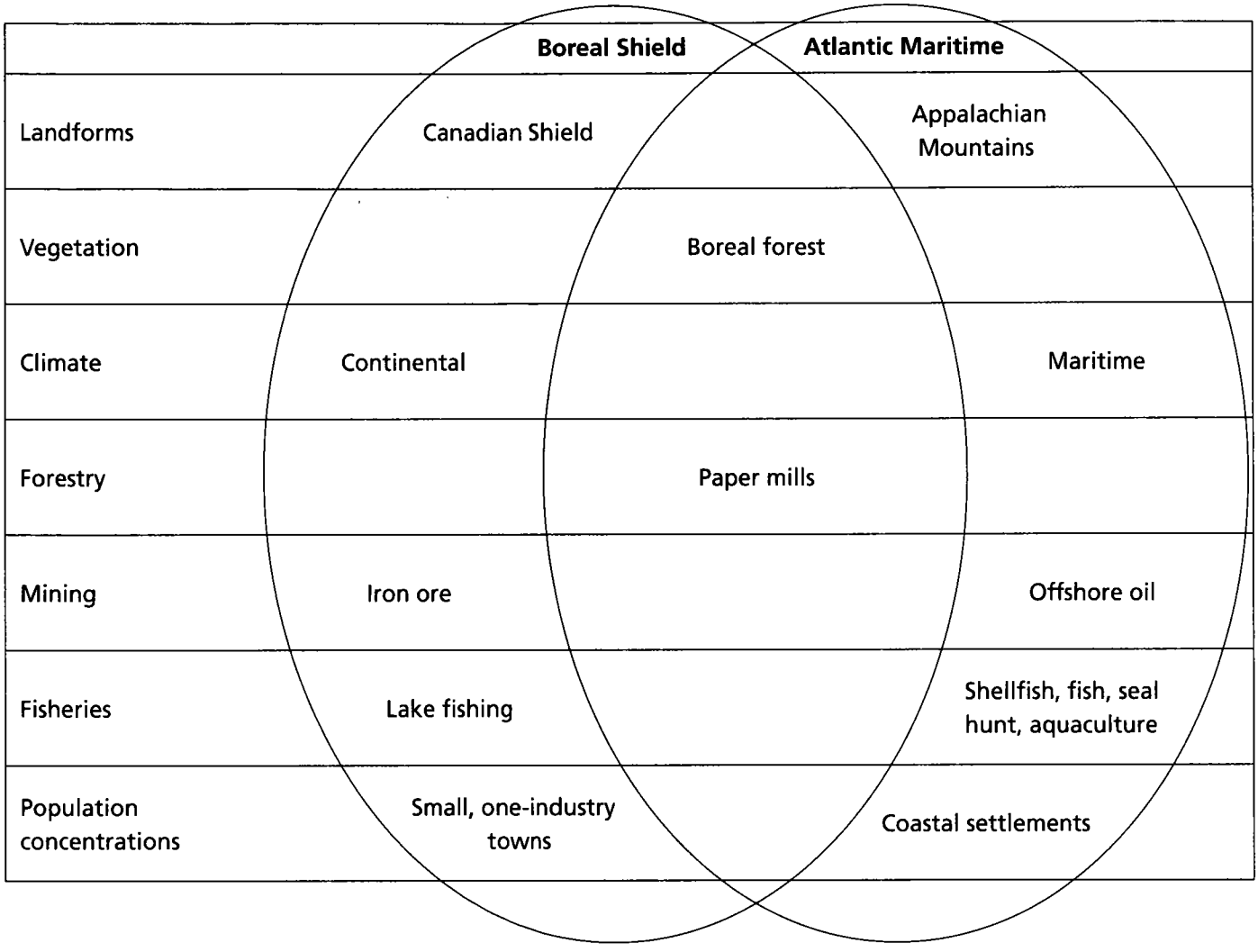
Characteristics of the island of Newfoundland

- Landform or physiographic region: part of the Appalachian Mountains.
- Forest or vegetation region: northern coniferous forest and barrens.
- Climate region: characterized by cool winters, warm summers, and high precipitation.
- West coast (-7°C to +17°C) 1200 mm; east coast (-5°C to +15°C) 1500 mm; interior (-8°C to +17°C) 1100 mm.
- Geographically similar regions: Atlantic region includes island of Newfoundland.
- Forestry: paper mills are located at Cornerbrook on the west coast and at Grand Falls in the interior.
- Mining: offshore oil provided 15% of the GDP in 2006.
- Fishing: shellfish value in 2006—$316M; fish value in 2006—$130M; seal hunt—$55M; aquaculture—$50M. The valuable cod fishery was closed in 2003 due to overfishing by local and foreign ships. This created considerable hardship for thousands of fishermen in small outport settlements.
- Population concentrations: 500,000 total population on the island with 1/3 on the Avalon Peninsula (St. John and metro—150,000). Much of the rest of the population is in small coastal villages. Very small population of about 25,000 total in the Gander/Grand Falls area of the interior along the Trans-Canada highway.

Comparing two regions



Comparing two regions: Suggested answers



	Boreal Shield	Atlantic Maritime
Landforms	Canadian Shield	Appalachian Mountains
Vegetation	Boreal forest	
Climate	Continental	Maritime
Forestry	Paper mills	
Mining	Iron ore	Offshore oil
Fisheries	Lake fishing	Shellfish, fish, seal hunt, aquaculture
Population concentrations	Small, one-industry towns	Coastal settlements

Activity in the St. Lawrence Lowlands

Agriculture

- 37% of Canadian agricultural production occurs in this region.
- Fertile soil, hot summers, and an abundant water supply (Great Lakes and groundwater) encourage farming.
- Land cover in the region is 38% cropland; 33% forest; and 19% other farmland.
- Top three categories of fertile land: over 50% of class 1 land in Canada is located here, and even more Class 2 and Class 3 land.
- Over 25% of all farm revenue from Canada is from this region.
- This region has an increasing number of large automated farms and large-scale livestock farms.

Industry

- Canada's industrial powerhouse and heartland is located in this region.
- A large labour force and consumer market, proximity to a large population base in the United States, and an abundant supply of raw materials are factors for industry.
- The Ontario part of this region produces 40% of Canada's goods, while the Quebec portion produces 22%.

Transportation

- This region has superior rail, road, and water transport.
- The rail system is part of the Trans-Canada Network and connects to rail in the U.S.
- The road system centres on the 401 freeway that traverses the region from Windsor to Montreal, with up to 12 lanes in the Toronto area.

- The water transport system centres on the Great Lakes Waterway and the Seaway.
- The Great Lakes contain 20% of the world's fresh water (world's largest).
- There is only a 200 m elevation change from west to east.
- Six canals with 19 locks allow ocean-going vessels to travel 3800 km to the head of Lake Superior.
- There are over 200 million tons of cargo moved each year, made up of 29% iron ore, 21% wheat, 17% other agricultural products, 14% mine products, and 12% iron and steel.

Population

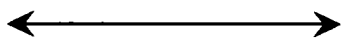
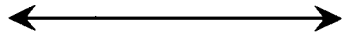
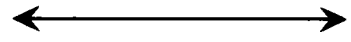
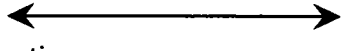
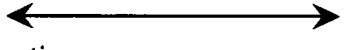
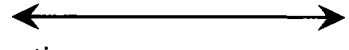
- Ontario population statistics: 1981—8.6 million; 1991—10.1 million; 2001—11.4 million; 2006—12.2 million. Toronto city—2.5 million; Toronto metro—5.1 million (2006).
- Quebec population statistics: 1981—6.4 million; 1991—6.9 million; 2001—7.2 million; 2006—7.5 million. Montreal city—1.6 million; Quebec City—0.5 million.

Energy sources

- Electrical generation by fuel for Ontario: nuclear—35% (down from 57% in 1999); hydro—30%; coal—25% (declining); natural gas—10% (rising).
- Electrical generation by fuel for Quebec: hydro—94%; coal and nuclear—6%.

Assessing importance

Rank order the factors using the following scale: 5 = significant influence 1 = limited influence

	Agriculture	**Industry**	**Transportation**
Magnitude of influence. How deeply felt or profound is (or will be) its influence?	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:
Scope of influence. How widespread is (or will be) its influence?	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:
Duration of influence. How long-lasting are (or will be) the effects?	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:	5 4 3 2 1  Explanation:

Considering future challenges

What will be required by each component of the economy in order for it to keep pace with the demands of the growing population in this region?

	Agriculture	Industry	Transportation
Land use needs	- *more land may be required to grow sufficient crops* - *existing farmland may be lost to residential and industrial development*	- *more land needed for expansion of industry and housing for workers*	- *some current infrastructure may be sufficient (railways, seaways, airways)* - *more land needed to build highways to accommodate growing population commuting from the suburbs*
Resource needs			
Energy needs			

Competing climate change myths

Paired myth # 1

MYTH according to affirmers: CO_2 levels rose after the start of warm periods, so CO_2 does not cause global warming.	**MYTH according to skeptics: Human-produced carbon dioxide has increased over the last 100 years, adding to the greenhouse effect, thus warming the earth.**
We know CO_2 is a greenhouse gas because it absorbs and emits infrared. Fairly basic physics explains how such gases trap heat radiating from the earth. The planet would be a lot colder if this did not happen. So why, over the past million years or so, has the earth repeatedly switched between ice ages and warmer periods? The long-held theory is that this is due to variations in the earth's orbit—known as Milankovitch cycles—that change the amount and location of solar energy reaching the earth. These cycles correspond with most climate transitions. However, their direct heating or cooling effect is small and does not fully explain the temperature switches. This suggests that some kind of feedback effect amplified the initial changes in temperature. The ice itself is one contender. As the vast ice sheets started to shrink, less of the sun's energy would have been reflected back into space, accelerating the warming. The possibility that CO_2 plays a role was suggested more than a century ago. The ice cores show a remarkable correlation between CO_2 levels and temperature over the past half-million years. The extra CO_2 was released from warmer seas, as the gas is less soluble in warmer water.	Carbon dioxide levels have indeed changed for various reasons, human and otherwise, just as they have throughout geologic time. Since the beginning of the industrial revolution, the CO_2 content of the atmosphere has increased. The rate of growth during this period has also increased from about 0.2% per year to the present rate of about 0.4% per year; that growth rate has now been constant for the past 25 years. However, there is no proof that CO_2 is the main driver of global warming. As measured in ice cores dated over many thousands of years, CO_2 levels move up and down after the temperature has done so, and thus are the result of, not the cause of, warming. Geological fieldwork in recent sediments confirms this causal relationship. There is solid evidence that as temperatures move up and down naturally and cyclically due to solar radiation and orbital and galactic influences, the warming surface layers of the earth's oceans expel more CO_2 as a result.

Paired myth # 2

MYTH according to affirmers: Cosmic rays are the cause of global warming, creating clouds that hold heat in the atmosphere.	**MYTH according to skeptics: Global warming is caused by CO_2, it is not the result of cosmic rays.**
The atmosphere already has many of cloud condensation nuclei because we have added a lot of pollution to the atmosphere, in the form of CO_2, by burning fossil fuels.	The ionization of air by cosmic rays imparts an electric charge to aerosols that encourage them to clump together. These clumps become large enough to trigger the condensation of water, and hence, form clouds.

Paired myth # 3

MYTH according to affirmers: Human CO_2 emissions are tiny compared to natural sources.	**MYTH according to skeptics: Human CO_2 emissions are large compared to natural sources.**
This is true, but natural sources are balanced by natural sinks. The breakdown of organic matter releases huge quantities of CO_2 but growing plants soak up just as much. The increase over the last 200 years is due to the burning of fossil fuels.	Volcanoes emit more CO_2 than human activities. Methane is also produced in rice paddies and when forest fires occur.

Paired myth # 4

MYTH according to affirmers: A bit of warming will be of great benefit.	**MYTH according to skeptics: Warming is not good for humans.**
Some global warming will be good. In cooler regions this may be true, but warmer regions could be adversely affected. Some wildlife may thrive and some may become extinct. Areas may turn into deserts. Coastal flooding and wildfires could occur.	Heating bills will go down and agricultural crops will be able to grow further north. Ships will be able to travel further north.

Paired myth # 5

MYTH according to affirmers: Water vapour has a greater effect than CO_2.	**MYTH according to skeptics: CO_2 is the most common greenhouse gas.**
First, there is the greenhouse effect, and then there is global warming. The greenhouse occurs because certain gases (and clouds) absorb and re-emit the infrared radiation emitted from the earth's surface. It currently keeps our planet 20°C to 30°C warmer than it would be otherwise. Global warming is the rise in temperatures caused by an increase in the amount of greenhouse gases as a result of human activity. Water vapour is by far the most important contributor to the greenhouse effect. Pinning down its precise contribution is tricky, not least of all because the absorption spectra of different greenhouse gases overlap. At some of these overlaps, the atmosphere already absorbs 100% of radiation, meaning that adding more greenhouse gases cannot increase absorption at these specific frequencies. For other frequencies, only a small proportion is currently absorbed, so higher levels of greenhouse gases do make a difference.	Greenhouse gases form about 3% of the atmosphere by volume. They consist of varying amounts (about 97%) of water vapour and clouds, with the remainder being gases like CO_2, CH_4, ozone, and N_2O, of which carbon dioxide is the largest amount. Hence, CO_2 constitutes about 0.037% of the atmosphere. While the minor gases are more effective as "greenhouse agents" than water vapour and clouds, the latter overwhelm the effect of the others by their sheer volume and, in the end, are thought to be responsible for 60% of the "greenhouse effect." Those who attribute climate change to CO_2 rarely mention this important fact.

Paired myth # 6

MYTH according to affirmers: Glaciers are not receding worldwide.	**MYTH according to skeptics: Receding glaciers and the calving of ice shelves are proof of global warming.**
Most of the world's glaciers are shrinking, a new satellite survey of over 2,000 glaciers has revealed. Concerns have been raised about melting glaciers on Mount Kilimanjaro in the Tanzanian Himalayas and in Glacier National Park in Montana (*New Scientist,* 13 May 2000, 28). Infrared and visible photographs taken by ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), a Japanese instrument on board NASA's Terra spacecraft, show the shrinkage is happening on a global scale. ASTER takes about two days to map the surface of the Earth, with a resolution of about 20 km. The instrument also has an unprecedented ability to zoom in on sites of particular interest to resolutions as high as 15 km.	Glaciers have been receding and growing cyclically for hundreds of years. Recent glacier melting is a consequence of coming out of the very cool period of the Little Ice Age. Ice shelves have been breaking off for centuries. Scientists know of at least 33 periods of glaciers growing and then retreating. A glacier's health is dependent as much on precipitation as on temperature.

Assessing climate change myths

Myth	
Main point of contention. In your own words, what exactly is the disagreement?	
Arguments offered. What examples and evidence do they offer to support their position?	
Dependable sources. Do the sources of information seem reliable?	
Relevant facts. Does the information relate to the argument for which it is being used?	
Adequate evidence. Is there enough evidence to support the conclusions offered by the scientist?	
Conflicting evidence. Is there convincing evidence to support a different conclusion than the one presented?	

Climate change references

Skeptics

- World Climate Report: www.worldclimatereport.com
- The Marshall Institute: www.marshall.org
- Facts About Climate Change Science: www.climatechangefacts.info
- Bjorn Lomborg: www.lomborg.com
- Cold Facts on Global Warming: brneurosci.org/co2.html
- Individuals: Robert Balling, Sherwood Idso, Richard S. Lindzen, Pat Michaels, S. Fred Singer

Affirmers

- Union of Concerned Scientists: www.ucsusa.org/global_warming
- Natural Resources Defense Council: www.nrdc.org/globalwarming/
- Environmental Defense Fund: www.edf.org/page.cfm?tagID=517
- Climate Science Watch: www.climatesciencewatch.org
- SourceWatch: www.sourcewatch.org/index.php?title=Portal:Climate_Change
- Individuals: Al Gore, Ross Gelbspan, Dr. Michael MacCracken, Dr. Benjamin Santer, William Ruddiman

Canadian sites

- Environment Canada Science of Climate Change—PowerPoint and slide presentations: http://www.msc.ec.gc.ca/education/scienceofclimatechange/understanding/presentation_resources/index_e.html
- Environment Canada–Climate Change:www.ec.gc.ca/default.asp?lang=En=n=6EE576BE-1
- The WeatherMakers: www.theweathermakers.ca

The Arctic: The International Polar Year—2007–2008

- IPY: www.ipy.org
- IPY(Canada): www.ipy-api.ca/english
- IPY(Canada): www.ipycanada.ca/web/guest/home
- IPY Classic: classic.ipy.org/about
- International Polar Year: www.ipy.gov
- NOAA IPY: www.arctic.noaa.gov/aro/ipy-1/
- Arctic Global Warming: www.worldviewofglobalwarming.org/pages/arctic.html

Conditions in the Central Plains

General information

The Central Plains have a continental climate, with cold winters and warm to hot summers. Precipitation has a summer maximum and is variable, which often creates drought conditions, especially in the area of southern Alberta and southwestern Saskatchewan known as Palliser's Triangle. This area is the most affected by the Rocky Mountains, which block moisture from reaching the plains, creating a rain shadow. Because of the hot summers, evaporation can take valuable moisture out of the soil. Much of the evaporated moisture returns to the ground as the summer maximum of rain from thunderstorms, but some of it comes down as hail, which damages crops. Chinook winds in the late winter and early spring can also raise temperatures very quickly on the eastern foothills of the Rockies and cause large amounts of snow to disappear quickly through evaporation.

The glaciers in the Rockies act as a reservoir for moisture. This moisture is released slowly each summer in warmer temperatures and provides water for irrigation in the rivers flowing eastward towards Hudson Bay.

Since the 1940s, the length of the growing season has increased by up to 10 or 15 days. There has also been less snow cover to melt and replenish the soil, and spring runoff has occurred earlier. Glaciers have reduced in size by 25% over the last 100 years, reducing river flows. This has been overcome by building dams and reservoirs to capture water for irrigation. This action has helped the areas near the reservoirs, but evaporation from the reservoir surface and decreased water flows have hurt areas downstream, especially during spring runoff.

Prairie crop areas are made up of wheat—49%; barley—29%; canola—14%; alfalfa—10%; and oats—7%. Crop values: wheat—54%; canola—26%; barley—12%; flaxseed—4.5%; and oats—3.5%.

Sub-regions of the Central Plains

Boreal Plains: This sub-region is found in the northern part of the Central Plains. It is 80% Boreal forest and 7% water. The climate consists of harsh, cold winters (-20°C) and short, warm summers (+15°C). Precipitation ranges from 450 to 500 mm but the evaporation rate is very low, resulting in moister conditions than farther south. Most of the area is too cold for agriculture, but some agriculture is found in the Peace River area of Alberta and British Columbia.

Prairie Parkland: This sub-region is located south of the Boreal Plains in a narrow band of aspen and grassland extending from the Rockies to Lake Winnipeg. The winters are long and cold (-15°C) and the summers long and warm (+20°C). Precipitation varies from 500 to 550 mm, with a summer maximum, but this sub-region is affected to a greater extent by evaporation than the Boreal Plains.

Agricultural production in this area includes wheat, barley, and oats. Changes taking place to grow oilseeds with a focus on canola, which comprises 50% of world production.

Prairie Grassland: This sub-region is located in southern Alberta, Saskatchewan, and Manitoba. This area has a long, cold winter (-10°C) and hot summer (+20°C). Evaporation and the rain shadow of the Rockies are major factors that reduce the available moisture. The vegetation here is made up of short to tall grasses, depending on the amount of precipitation and evaporation that takes place. Grain farming takes place in tall grass areas where there is more precipitation. Cattle ranching is located in the short grass area where precipitation levels are lower.

Predicting the impact of climate change

	Current situation in the three regions	Anticipated changes as a result of climate change	Reasons for the predictions
Temperature and precipitation			
Vegetation			
Weather			
Glaciers			
Water supply			
Agriculture			
Population			

Environmental challenges in the Western Mountain ecozone

1. Aquaculture and sea lice in the Broughton Archipelago
2. Collapse of the salmon run
3. Moratorium on off-shore drilling in Hecate Strait
4. Sewage disposal in Victoria
5. Rising sea levels in Richmond
6. Water shortage in the Okanagan
7. Water pollution in the Fraser River
8. Building of the Site C Dam on the Peace River
9. Collapse of the forest industry
10. Pine beetle infestation
11. Logging of spotted owl habitat
12. Logging untouched watersheds in Clayoquot Sound
13. Declaring a National Park in the South Okanagan
14. Air pollution in the Lower Mainland
15. Garbage disposal in the Lower Mainland
16. Developing a ski resort on First Nations traditional lands
17. Allowing mining in Tatshenshini Provincial Park
18. Allowing trophy hunting in Spatsizi Plateau Wilderness Provincial Park
19. Allowing coal mining in the Flathead Valley

Background to the issue

	Commentary
Environmental challenge	
Cause(s)	
Historical background	
Present situation	
Main stakeholders	
Main issues	Political Economic Environmental Social

The Critical Thinking Consortium

Tools for Critical Inquiry is a project of The Critical Thinking Consortium. TC² is a non-profit partnership of schools, school districts, faculties of education, teacher professional associations, universities and other educational organizations. Its aim is to promote critical thinking from primary to post-secondary education through partner-sponsored professional development, publications and research.

SCHOOL DISTRICTS AND SCHOOLS

Balmoral Hall
Branksome Hall
Burnaby School District
Calgary Board of Education
Campbell River School District
Central Okanagan School District
Comox Valley School District
Creative Secondary School
Crofton House School
Delta School District
Foundations for the Charter Academy
Halton District School Board
Little Flower School
Mission School District
Nanaimo School District
New Westminster School District
Okanagan-Similkameen School District
Peace Wapiti School District
Peel District School Board
Southridge School
St. John's School
St. Mildred's-Lightburn School
Stratford Hall
Surrey School District
Tall Pines School
Toronto District School Board
Toronto French School
Toronto Montessori Schools
Upper Canada District School Board
Vancouver School District
York House School

EDUCATIONAL ORGANIZATIONS AND ASSOCIATIONS

BC Science Teachers' Association
BC Social Studies Teachers' Association
BC Teacher-Librarians' Association
Calgary Regional Consortium
Central Alberta Regional Consortium
Edmonton Regional Learning Consortium
English Schools Foundation
LesPlan Educational Services
Library & Archives Canada
North Eastern Ontario School Authorities
Northwest Regional Learning Consortium
Ontario Association for Geographic and Environmental Education
Ontario Geography/History, Humanities and Social Sciences Consultants' Association
Ontario History, Humanities and Social Science Teachers' Association
Provincial Intermediate Teachers' Association
Southern Alberta Professional Development Consortium
Statistics Canada

COLLEGES AND UNIVERSITIES

Antigua State College
Simon Fraser University
University of British Columbia
University of British Columbia-Okanagan

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