



Climate Change and Water Users in British Columbia

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November 2007**

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Summary

Consultations with a number of water-using groups in BC in the summer of 2006 showed considerable but not universal acquaintance with signals of changing climate. Public sector managers responsible for long-term resource management and infrastructure investments displayed the greatest concern. All sectors looked to government, and specifically the province, for leadership in coping with what most saw as inevitable change. Reliable, research-based information was seen as a critical input to rational action.

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1. Introduction

In the summer of 2006, researchersⁱ from the Pacific Climate Impacts Consortium (PCIC) undertook structured interviews with a wide range of BC water users and stakeholders to:

- assess their awareness of climate change impacts on water resources,
- identify stakeholder interests, needs and priorities to adapt to climate change,
- identify a contact person to convey project results and identify additional expertise, resources and potential partnerships and
- guide the development of PCIC's plans for water related projects.

This non-random but representative list of 65 stakeholders was chosen to sample opinion on as wide a geographic and sectoral basis as possible with the time and resources available. We did not interview BC Hydro in this round, as their extensive interests will be the subject of later work. Support for the work was provided by the BC Ministry of Environment and by BC Hydro.

This note summarizes what we heard and appends, in the final two sections, interpretations and observations derived from the interviews. Sometimes stakeholders digressed from matters directly related to climate change. These comments, where reported, are intended to preserve the broader context within which stakeholders operate.

In general, there was almost universal belief in the private sector that BC's climate was changing, but that adaptation efforts should be led by someone else. Personal, corporate or sectoral action would in many cases depend on better information, both in the form of more reliable climate forecasts and in terms of readily comprehensible scenarios that would help people find adaptations appropriate to their local geography and economic interests. Public sector infrastructure managers were most likely to be planning actions now for the medium- and long-term future.

This paper is based on detailed notes of the interviews. In general, one researcher led the conversation while a second focussed on taking notes. Interviewees were promised anonymity in order to encourage frankness. Accordingly, we followed the Chatham House Ruleⁱⁱ, and the author is solely responsible for errors in reporting and interpretation.

2. Critical importance of fixed investment

Basic economic theory indicates that people who have long-term fixed investments ought to be more concerned about long-term factors that could affect their value than those whose investments allow greater flexibility. Thus, for example, organizations responsible for long-lived infrastructure, such as dams, storm drainage, sewage and water treatment plants, dikes and bridges might be expected to have a greater degree of awareness and likelihood of having taken defensive or adaptive measures than those whose asset mix is readily changeable on an annual basis. Indeed, that was broadly what we found. Agricultural spokespersons, in general, were not much concerned about climate change. Their crop or livestock choices could be changed from year to year if need be, and interannual variability tended to be more important than long-term secular change. Water availability, even in already dry areas of the province, was not seen as a clear and present danger, though some thought that was because agricultural demand would trump those of other users if push came to shove. Some noted adaptive measures such as drip

ⁱ Clint Abbott, Katrina Bennett, Jasmine Birk, Ben Kangasniemi, Michele-Lee Moore, Trevor Murdock, Dave Rodenhuis, Emma Sharkey, and Harry Swain. Emma Sharkey took charge of logistics for the group and prepared an initial draft. PCIC is a consortium of researchers and research users concerned with adaptation to climate variability and change in BC and the broader Pacific Northwest. Pacific Climate Impacts Consortium, Centre for Global Studies, University of Victoria, PO Box 1700 STN CSC, Victoria, BC, V8W 2Y2, Canada

ⁱⁱ "Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed." (1927, 1992, 2002; www.chathamhouse.org.uk)

irrigation in vineyards: it might have been undertaken for grape quality reasons, but the conservation impact was notable.

The interesting exception was with respect to forestry. One might have thought that firms owning land outright would be more concerned about what they were replanting than those who only held timber licenses from the Crown. In fact, at least on the basis of the relatively few interviews we undertook in this sector and in forest-dependent communities, land tenure did not appear to affect the general disregard for the far future. For both kinds of firm, the net present value of a tree that might be harvested in 60 or 80 years was near zero, and reforestation was simply seen as one of those unavoidable costs of doing business, like taxes and employee benefits, where the only obligation was to obey instructions from the Ministry of Forests and Range. At the time of our survey, some months before the resolution of the softwood lumber dispute with the US, the overwhelming preoccupation of the industry seemed to be the rapid harvest of the mountain pine beetle-affected lodgepole pine, before it rotted. Companies, indeed whole towns and interior valleys, were working two and three shifts, seven days a week, “hurling down the pine.”

Interviewees most concerned with water-related climate change phenomena tended to be public servants employed by both the provincial and local levels of government. The provincial Ministry of Forests and Range had become seized of the issue, publishing a far-reaching statement just as we were preparing to begin the fieldwork.ⁱⁱⁱ The Ministry is aware that much of the beetle-killed forest, if replanted to lodgepole pine, will likely not reach maturity because of a lack of summer moisture. The severity of the mountain pine beetle outbreak itself appears to be related to a paucity of cold winters, which has led the Ministry and their Canadian Forest Service colleagues to a new awareness of the threat of other pathogens. The Ministry is now giving thought to replanting regimes which might offer greater resilience against climate change.

Reflecting across the wide range of interviews prompts two further generalizations. First is that people seem to be universally aware of the climate change thesis. Even some who deny that anything is taking place, manmade or not, will often in the next breath say something about the winters being warmer, or storms more frequent. But second, awareness is a long way from action. Climate change is seen as uncertain, distant, someone else’s problem, or beyond the scope of individual, even regional or national, action. It was not uncommon to hear people remark that it will take some kind of disaster to prompt real action.

ⁱⁱⁱ British Columbia, Ministry of Forests and Range, *Preparing for Climate Change: Adapting to Impacts on British Columbia’s Forests and Range Resources*, Victoria, 18 May 2006

I. What we heard

3. Agriculture and forestry

These two sectors were united by their extensive use of land, their dependence on precipitation, and by the fact that rural labour tended to work in both sectors on a seasonal basis. In both cases, secondary processing uses a lot of water.

Respondents with agricultural and grazing interests were aware of signals of a changing climate but were not overly concerned. Indeed, farmers in the Peace River region were expected to welcome a moderation of the severe winters and short growing seasons which, as the principal extensive grain and canola-growing region of the province, they had long suffered. Drainage, not irrigation, tended to be the chief water concern there. Elsewhere, not much impact was being seen in terms of waterborne pests, although a new alga was causing some difficulty in the Kamloops area. Some cattlemen took the view that the mountain pine beetle was on the whole beneficial, as it was opening a lot of formerly forested Crown land for grazing. There was a mild preference for cool temperatures, as this kept viruses down and weight gain up. Graziers seemed unaware that the practice of sending beef east to Alberta for grain finishing might be affected by a marked expansion of Palliser's Triangle, the dry region in southern Alberta and Saskatchewan.

Crops outside the Peace River region tended to be more specialized, higher value, and both more water-dependent and, within the limits of a generally hard-pressed sector, economically capable of supporting investment in water management infrastructure. The demand for irrigation was expected to increase with higher-value, more water-intensive crops. Currently, 83 percent of British Columbia irrigation water is supplied from surface sources, but almost all new irrigation developments are groundwater based. About 2,000 dams and barrages in the province store water for agricultural and grazing purposes, but they tend not to be where the rain is – an observation made more acute by climate change.

There is a problem in many irrigation districts, which typically supply both irrigation and drinking water, in that full treatment to drinking water quality standards is expensively undertaken for both uses, even when irrigation accounts for 95 percent of the use. Dual systems seem to some to be a wave of the future, although in regions where crop washing is necessary, ultraviolet treatment would be preferred to anything involving chlorination, given its effects on aquatic ecosystems. Irrigation districts were also criticized for not taking into account the impact of forestry on water quantity and quality, and for their pricing policies, which were based on fees poorly if at all related to consumption and thus gave no incentive to economize. Seasonal pricing was suggested as one route to more efficient use. Price levels varied widely across the province and bore little relation to the inherent value of irrigation water. Investment in storage, which needed serious attention, was far from optimal.

Farmers were said to be interested in tradable water rights, but it was noted that widespread use could vitiate the principles of the Agricultural Land Reserve program.

The forest industry was generally unconcerned about such effects of climate change as a shrinking land base to support trees, noting that reforestation designs were up to the Ministry and were already beginning to shift in the direction of warmer temperatures. Instead, their concerns were in the here and now: availability of water for manufacturing uses; roads, bridges and drainage structures and the standards to which they need to be built; and fire suppression regimes that increase the probability of catastrophic loss through more intense, duff-fuelled fires. No particular hydrological signals of climate change had been noted, but there was a concern about water availability and about a seeming increase in the frequency of extreme weather. From an infrastructural perspective, the industry would welcome better forecasts of the timing of the freshet and of flood return periods.

At the level of the firm, planning for reforestation does not seem technologically advanced. One firm ran 250-year models – principally to forecast fuel build-up for fire management – without any consideration of climate change. Private sector foresters working in the field expressed concern about future ecosystems which might be radically different from the present, but said that their mandate was to do what management wanted, which was what Victoria wanted. People working in the Ministry of Forests and Range and the Canadian Forest Service were greatly concerned about the long term future: see below.

4. Local governments

We talked to more local governments – municipalities, regional districts, First Nations organizations and diking societies – than any other group. From the smallest to the largest, they are keenly aware of public opinion as reflected through the elected officials with whom they work closely. The broad generalization that emerged from these interviews was that climate change is farther down the list of local government priorities than officials wish. Most cite observations from local experience: not less snowpack as such, but warmer summers, more frequent extreme precipitation events, or the advent of the mountain pine beetle outbreak and the threat of other forest pests. These tend to be seen by the voters they serve and their elected representatives as distant matters, not necessarily man-made, and highly uncertain; spending lots of money in the here and now to cope with hypothetical events was seen as a non-starter. On the other hand, there were several comments to the effect that the people were ahead of their leaders on these issues.

A common complaint was that climate forecasts were unreliable, the information was not presented in understandable ways, and that the provincial government, rather than improving the flow of information, had cut back on important advisory work. Statements like the 200-year flood was coming every 20 years or so, or that there had been three 50-year floods in the last decade, were common. These were often mentioned in the same breath as a perceived lack of guidance from Forestry on what to plant, Highways on what standards should be used for roads, bridges and drainage, or Environment on what long-term shifts in (especially) precipitation should be expected. There was an almost universal wish for more local hydrological and hydrogeological research, especially if it could be connected to research on climate change. What was currently used was memorably described as “witchcraft” by one respondent. Local governments often had data but no resources for analysis. Aquifers, ice-jams, water levels, groundwater quality, the effects of climate- and industry-induced vegetation change were all matters of intense concern, made all the more so by perceived pressures from regional health authorities and the province to invest to upgrade water quality. At least this was true for communities reliant on streams and groundwater. Those who drew from lakes or large rivers were less concerned about understanding the regional hydrogeology. A quite general concern, however, was with respect to the possibility of spills from trucks or trains into surface water sources.

Several local government officials indicated that groundwater sources were becoming increasingly attractive for drinking water sources given the decreasing reliability of surface supplies due to climate change impacts. Groundwater is also seen as offering better water quality where surface water is readily affected by multiple land uses.

Municipal public servants and their engineering advisors worry about the robustness of their existing stock of infrastructure and the adequacy of their designs for storm drainage, roads and bridges in light of what they see as more frequent and more intense storm events. Water infrastructure is planned with lifetimes of 50 to 100 years, and early obsolescence because of climate change could have serious financial consequences. More than one respondent expressed a desire for more guidance from the provincial government on just what they should be planning for in terms of the frequency of extreme rainfall events. Better legislation that would allow real control over extraction, source water protection and water use was mentioned more than once: the

sense was that this was a sleepy sector not commanding much attention from legislators. Water quantity and quality monitoring had fallen victim to provincial and federal spending cutbacks. Opportunities for integrated power and water planning were lost because of Victoria's departmental silos.

Better cooperation from federal authorities was frequently mentioned in the context of water resources. Provision for First Nations was spotty and cooperation with neighbouring jurisdictions difficult – not because of any unwillingness on the part of neighbours but because the federal Department of Fisheries and Oceans adopted a rigid and inexplicable stance. DFO officials were seen as distant, not open to argument, and often uncomprehending of local circumstances – including the nature of threats to fish.

Finally on the cooperation front, there were occasional expressions of interest in better cooperation among industrial users, governments and neighbouring jurisdictions on a watershed basis.

Approaches to municipal water use ranged from up-to-date, with metering, increasing block rate structures, impressive demand-side management, and high quality treatment both of drinking water and of sewage all the way to essentially 19th-century standards. In one town the biggest water user was the grocery store, which used 30,000 g/d for cooling. Treatment in many places lags well behind the federal-provincial drinking water guidelines, and sewage treatment may be especially primitive. Attitudes about the abundance of nature seem to dictate the pattern rather than simple economics, although there are many small systems whose customers are not well to do.

Where public education and other demand reduction measures are used, community responsiveness appears to be considerable, even in the absence of metering and pricing. On the other hand, property owners and development interests in some places were said to suppress bad news about water quality, and to resist research and reporting, on the grounds that property values could be threatened.

Many signals of changing climate were mentioned: wetter winters, drier, windier and hotter summers, storms coming from highly unusual directions, forest pests, invasive species in lakes, greater frequency of extreme weather, ice jams, higher snowlines, and longer growing seasons were all mentioned. For winter resort communities, wide variations in snow conditions were thought to be natural variations, although there was not agreement on the point. But what was wanted from climate forecasts was the kind of certainty and reliability that people were accustomed to in one- or two-day weather forecasts. Expressions of probability were not easily grasped by engineers and town councillors, some claimed. Information needed to be presented in simple, graphic scenarios: no one knew what a rise of 2°C in average annual temperature meant.

5. Professional organizations

All of the representatives of professional organizations to whom we spoke were observing the impacts of climate change in their domains and all felt that government and society in general was slow in reacting. Increased frequency of extreme precipitation events, later freeze-up leading to short seasons for ice-road dependent resource extraction, a locally urgent need to dredge and dike, the impact of mountain pine beetle on runoff, streamflow, turbidity and groundwater, earlier freshets, algal blooms in both fresh and salt water and shorter flood-return periods were all cited. One observer commented that a formal market in water rights would better serve the underlying values and spur adaptation.

The Interior Health Authority was seen as nudging communities to think more carefully about water quality, which was stimulating a good deal of planning and even investment. This would be a particularly helpful time to insert considerations arising from climate change. Most changes in infrastructure planning by localities are regulation-driven, and there was a felt need to

reconsider flood-return periods and extreme events. If the province were to require this, along with full-cost accounting, there could be a fruitful revolution in water planning and management all across the province.

6. Environmental and other non-governmental organizations

To one degree or another all these groups shared a greater urgency about conservation than their resources, or the attention they could garner from governments, allowed them to pursue. There was a quality of frustrated earnestness running through all these conversations, but also energy and commitment. All saw signals of climate change in the work of their organizations. Warmer waters meant less dissolved oxygen, with wide impact on aquatic communities. Shallow wetlands, with their rich production of the invertebrates necessary for fish and birds, were under attack both from development and from seasonally more extreme water flows. New species were appearing, including dire ones like avian botulism, and some species were behaving differently. Swans, for example, were observed wintering over in open Interior waters. Vultures and wild turkeys were being seen for the first time. The conflict between wetlands and human health, long dormant, was being revived with the prospect of mosquito-borne West Nile virus becoming endemic in BC, with the result that broadly destructive pesticides were increasing in use. Some places were now getting a third (irrigated) hay crop in a growing season. Earlier freshets, receding glaciers, lower late-summer flows and changes in the quantity and quality of groundwater were widely mentioned. More woods closures during fire season were clashing with desires for outdoor recreation; some tree species were becoming less common through failure to regenerate.

Fisheries-oriented groups were especially conscious of water temperatures, especially extremes in late summer, which had large consequences for fish mortality. Groundwater temperatures in hatchery supplies had risen about one degree in recent years, and two of the five main hatcheries were experiencing seriously diminished flows, affecting fry production. Fish are exceptionally sensitive to water chemistry, acidity, temperature, dissolved oxygen levels, timing of freshet, and low summer flows. On the other hand, lessened ice cover improved winter survival.

Some cited the incoherence of federal and provincial water laws as a matter that needed attention. Protecting BC water from external demand, in part through better licensing and pricing, was seen as something the provincial government should attend to. Governments were also taken to task for depleting the inventory of hydrometeorological stations, thus impoverishing the data base for all management and adaptation. Most interviewees stressed, in one way or another, the need for data-rich, empirical, bottom-up research.

Organizations focussed on working with local governments on management and development issues cited the usual exasperations but in general were willing to persist because they saw some changing of minds in the process of mutual engagement. Some places slated for dramatic growth were beginning to experience resource conflicts of a quite novel sort, for which history had ill prepared them. Substantial investments in drinking water quality were foreseen in communities which hitherto had consumed it straight from nature, and returned it without treatment.

Observed adaptations included ski resorts moving to higher elevations. Desirable ones included full cost pricing and user-pay schemes for water, an attack on the myth of abundance, and the re-use of gray water (or the separation of drinking water and irrigation networks).

Organizations making long-term commitments to acquiring lands for conservation purposes or making capital improvements on easements worried whether they might be investing in the right places, given the probable course of climate change. Micro hydro producers are

strongly dependent on future streamflows. Scenarios that painted easily understood pictures for the general public would be most helpful.

7. Independent power producers and mining companies

Both specialist firms and some mines produce hydroelectric power. For the mines, excess power is a minor incident in their revenues. The pure independent power producers tend to see themselves as risk-free small entities enclosed within the BC Hydro system, without very much independence of thought or operation. Neither group was aware of signals of climate change, and all thought they were well insulated from any possible impacts – either by being minor and non-consumptive users of large rivers, or by being well down the hydroelectric food chain, protected from climatic vicissitudes by water entitlements and good contracts. None of those interviewed used anything but routine historical data for planning or investment purposes. Climate change was “not on the radar” for them, though there was some speculation about greater frequency of extreme events. This was seen as affecting the reliability of transmission rather than the design of generating infrastructure. There was a sense that it would take some kind of disaster, some strong external event, to change things.

The small hydroelectric companies saw themselves as non-consumptive users of water and therefore deserving of a light regulatory hand. The mining companies, conscious of the relatively large amounts of water they used in production, including dust control, or diverted through excavation and construction, were more conscious of the need to be a good steward and to reclaim lands and waters after mining operations had ceased. Mines at higher altitudes sought local streams or groundwater as sources, causing some concern among downslope users who saw their ‘first-in-time’ rights threatened, and when high-altitude flows failed, might have to pump water from river valleys at considerable expense.

8. Tourism and recreation

This large sector had fairly concentrated interests in water and climate change: snow, its quantity, time of arrival and melt, and the elevations at which it could be considered reliable, was part of every conversation. Receding glaciers, and temperatures too warm for snow to fill crevasses, were limiting late-season skiing. Trees were seeding themselves farther up the expensively groomed mountainsides. Even the fish-oriented enterprises worried about snowpack and the timing of the freshet.

The snow layering and temperature conditions favouring avalanches are now well understood and may be becoming more frequent. It was pointed out that every rail and road connection between Vancouver and the rest of Canada was prone to avalanche closure.

Ski resort operators and allied firms were greatly concerned about short-term forecasts that could affect their day-to-day operations. But they were also concerned about longer-term adaptation. The larger ones were all to one degree or another attempting to spread their capital over two or three seasons rather than just one, and were locating new facilities at higher altitudes and shutting down lower ones. People planned their ski vacations a year in advance: getting a reputation for snow unreliability or for wet (warm) versus dry (cold) snow had large economic consequences. All seemed acutely conscious of climate change and interested in further precision that might become available through research. Snowline, snow quality, and inter-annual variability were at the heart of their research needs.

In contrast one fishing-oriented firm strongly denied there was anything beyond natural variation in what was being observed – and went on to describe the first-ever appearance of sunfish off the Queen Charlottes, warmer ocean currents as one of three causes of declining fish

numbers. This operator did not want forecasts, which could be bad for business and were unreliable anyway. “What you don’t know can’t hurt you.” If climate change meant that the coastal regions were becoming more like California, “Bring it on!”

9. Provincial and federal government agencies

We conclude by turning to the staff of the agencies that are supposed to think long and hard about our collective future. Interviewees were not senior officials who spoke for whole departments but rather tended to be mid-level professionals in specialized branches or agencies with a strong and well-informed commitment to the fields in which they worked. To that degree they often shared some of the impatience of private players.^{iv}

A universal concern was with respect to measurement. Not a single agency seems to believe that a sufficient investment is made in environmental measurement and observation. Several had been involved in budgetary battles of attrition over the preservation of the existing network of hydrometeorological stations. All cited examples of what seemed to them to be signals of a changing climate, including many of the phenomena mentioned above. Some specifics not elsewhere mentioned included the importance of stream velocity in freshets and thunderstorms for the scouring of fish eggs from redds, the contamination of water supplies as a consequence of more forest fire fighting, an expected increase in complaints from the US about exported pollution, the over-licensing of streams for agricultural uses, the deleterious effect of warm water on fingerling mortality, and the longer duration of low flows, which meant both warmer water and higher ultraviolet exposure. The conflict between deepening channels and destroying redds was mentioned, in part as an example of local and federal interests being in conflict. Temperature changes at altitude are little measured but in 2006 the southern Interior experienced a week of 28°C highs at 1800m, something without any precedent. Variability and extremes are of concern. An example is Okanagan Lake, which after 75 years of monitoring set a new record inflow in 1996 – followed by an inflow half again as high the next year. Only a few years later, in 2003, the lowest inflows and worst drought on record since the 1930s occurred.

There was a strong sense that public education is necessary but that it will take quite a jolt to spur people from awareness to action. One of the principal adaptations expected was increased storage, even when it increased evaporation, which would provoke the usual local land use disputes. Somewhat farther off was the possibility of water pipelines of uncommon length to deal with local shortages. Power consumption would rise and shift toward a summer peak. Provincially, a serious start on subdivision regulation with infrastructure costs and energy conservation taken into consideration was overdue. The incoherence of federal, First Nations, and provincial approaches to water takings and regulation needed attention. Altogether, though, there was a feeling that arresting events would be necessary to jolt governments and the public into action, especially when this might mean even minor increases in the price paid for water services.

Provincial departments seem widely aware of the need to provide leadership on adaptation. Much of this is presently accomplished through publishing timely flood warnings and networking with emergency services. Contingency plans for drought and support for integrated watershed management are also undertaken. The Ministry of Forests and Range has devoted great effort to its Future Forest Ecosystems Initiative, and to planning allowable cuts taking into account current lodgepole pine mortality. The need for research on which to base provincial roles in public safety, resource management, standard-setting, environmental protection and water rights allocation is evident.

^{iv} This section relies in part on a memorandum from the BC Ministry of Environment: “Submission to Pacific Climate Impacts Consortium for the Water Users’ Consultation,” June 20, 2007

In research terms, in addition to a broad push to understand the impacts climate change could have in straightforward and graphic terms, there was a need to focus on extreme events and the synoptic conditions that accompanied them. Some combinations, like rain on snow, or sea level rise coupled with seiches, could trigger serious flooding. Ice jams, likewise, were associated with specific combinations of conditions. One Ministry (Environment) summarized its research requirements as follows:

- “An understanding of future...water supplies and demand, and how that will be affected by climate change;
- Extreme event return period statistics...revised to reflect recent history [and] scenarios for future return periods for extreme events that reflect climate change;
- More extensive hydrometric monitoring;
- Sea level monitoring along coastlines vulnerable to flooding and erosion;
- Hydrological modelling tools suitable for use in developing climate change scenarios;
- More detailed regional scenarios...across the varying landscapes of the province;
- Tools...[that] water suppliers, local governments, and First Nation communities need to adapt to the impacts of climate change; [and]
- Projections of rain and coastal wind storm frequency and intensity associated with climate change which could be used to inform building codes [and] infrastructure design standards.”

II. Commentary

10. Concluding remarks

Reflecting on what we heard, a few generalizations emerge. Many people, for example, see the climate change issue as mostly about reducing emissions. Adapting to unavoidable climate change seems beyond reach. Questions about adaptation often elicited the feelings of helplessness more often associated with the need for concerted international action to deal with the global common property problem. Even within the much more local and even personal realm of adaptation, while there was almost universal awareness of threat, there was a widespread sense that governments should be offering leadership and taking action. In this respect there were many suggestions about helpful actions the provincial government could take. On the other hand, when the federal government was mentioned at all, which was rarely, it was often with a sense of a distant, uncomprehending entity whose silo mentalities conflicted with local priorities, as with DFO and local drinking water supplies. Universally, however, regardless of background, people expressed needs for research-based public information. Sometimes this was specific and categorical and at other times simply a generality, but the more the professional or economic interests of our interlocutors were affected by the potential impacts of climate change, the more heartfelt was the demand for better research, even when distinctions between what could routinely be provided and what would take heroic long-term effort were not made.

The absence of an orderly and flexible system of groundwater allocation in BC raises the concern that increased groundwater extractions for agriculture and domestic water use, as a means to adapt to climate change, may lead to greater water use conflicts in the future.

11. Key Findings

The type of information water resource stakeholders need to adapt to climate change includes:

- Hydrometeorological data
- Updated extreme event return period statistics
- Better tools for understanding local watershed hydrology
- Water temperature and other parameters affecting fish survival
- Better short term weather forecasts
- Readily understood long term climate change projections
- Information that would engage local elected officials in addressing climate impacts.

These interviews also provide a basic outline of stakeholder's expectations of government, and research institutions in helping them adapt to climate change impacts. Government's role is to provide relevant and understandable information on current and projected changes to the water resource. Government is also seen as having a critical role in helping water users resolve water use conflicts that may be aggravated by climate change. It is evident that water resource stakeholders believe they know what to do with regard to adaptation if they have enough information. Adaptation decisions are largely site and sector specific. Examples of adaptation presented during interviews bore this out.

Stakeholders did not generally distinguish the role of research institutions from the role of government. It can be inferred that government needs to collaborate with research institutions to address the needs of stakeholders.

Other observations relevant to provincial water management agencies:

- Stakeholders seek provincial leadership in supporting their efforts to adapt to climate change. The Ministry of Environment is a logical choice for this sector.
- Groundwater is seen as a means to reduce reliance on surface water sources where surface supplies may be threatened by climate change.
- Water conservation is broadly recognized as a key tool to reduce vulnerability to climate change.
- Current planning and investment to improve drinking water quality and supplies should include consideration of climate change impacts.
- There is a need for better research-based public information.
- The scattered and scarce groups and individuals in Pacific North America who are working on these problems should work in a coordinated fashion.