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# Seeding Green Power: Community Pilot Project To Develop an International Green Standard For Small-Scale Hydropower

## Final Report

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# Table of Contents

**Acknowledgements** - 1 -

**1. The Green Hydro Working Group** - 2 -

1.1. Introduction - 2 -

1.2. Working group - 4 -

1.3. Methodology - 5 -

***1.3.1. Project dossiers*** - 5 -
***1.3.2. Variants*** - 7 -
***1.3.3. Scoring system*** - 7 -
***1.3.4. Review process*** - 8 -
***1.3.5. Confidentiality*** - 8 -

**2. The projects — Overview** - 9 -

**3. "Green" projects** - 10 -

3.1. Falls Creek (Oregon) - 11 -

***3.1.1. Project description*** - 11 -
***3.1.2. Score and comments*** - 11 -
***3.1.3. Variants*** - 12 -
***3.1.4. Summary*** - 12 -

3.2. Akolkolex - 13 -

***3.2.1. Description*** - 13 -
***3.2.2. Score and comments*** - 14 -
***3.2.3. Variants*** - 14 -
***3.2.4. Summary*** - 14 -

3.3. Comments - 15 -

**4. Projects with "green" variants** - 15 -

4.1. Hat Creek - 15 -

***4.1.1. Description*** - 15 -
***4.1.2. Score, variants and comments*** - 16 -
***4.1.3. Summary*** - 17 -

4.2. Way/ Michigamme - 18 -

***4.2.1. Description*** - 18 -
***4.2.2. Score and comments*** - 18 -
***4.2.3. Summary*** - 20 -

**5. Other projects of interest** - 20 -

5.1. Les chutes de la Chaudière - 20 -

***5.1.1. Description*** - 20 -
***5.1.2. Score and comments*** - 21 -
***5.1.3. Variants*** - 22 -
***5.1.4. Summary*** - 23 -

5.2. Clowhom - 23 -
*5.2.1. Description* - 23 -
*5.2.2. Score and comments* - 24 -
*5.2.3. Variants* - 25 -
5.3. Parishville/Allens Falls - 27 -
*5.3.1. Description* - 27 -
*5.3.2. Results* - 27 -
5.4. Cannelton - 27 -
*5.4.1. Description* - 27 -
*5.4.2. Results* - 28 -

**6. Key Issues - 28 -**
6.1. Flow modification - 29 -
6.2. Minimum flow (bypassed reach) - 30 -
6.3. Proposed vs. existing - 31 -
6.4. Scenic qualities and recreation - 31 -
6.5. Cumulative impacts - 32 -

**7. Conclusions - 34 -**
7.1. Summary - 34 -
7.2. Towards a "green" standard - 35 -
7.3. Future steps - 36 -

**Appendix A: Biographical notes**

## Acknowledgements

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We are also extremely grateful for the tremendous contribution of time and effort made by the members of the Working Group. Finally, we would like to mention the contribution of Lydia Grimm, former Executive Director of LIHI, without whose efforts this project would not have taken place.

# 1. The Green Hydro Working Group

## 1.1. Introduction

Hydropower presents a dilemma for emerging green power markets in North America. Although it does not burn fossil fuels, it can have negative impacts on the fish, wildlife, and human communities that depend on healthy rivers. Furthermore, there can be great disparities in these impacts from one project to another. For concerned energy consumers to be confident that only environmentally preferable facilities are included in certified green power products, certifying organizations must apply a clear and credible standard. Establishing such a standard that can be used to apply to the enormous variety of hydropower projects is a difficult and complex task. In the United States, this has often resulted in capacity-based standards that are easy to apply, but which cannot distinguish projects based on their actual environmental impacts. Thus, in many jurisdictions, facilities with installed capacity lower than a specified cutoff value are currently deemed to be environmentally preferable, or at least sufficiently benign to be accorded the same status as other renewables such as solar and wind power. This cutoff value ranges from 5 to 100 MW, with 30 MW being the most commonly used figure.

However, over the last decade it has become very clear that installed capacity is a poor indicator of the environmental impacts of a hydropower dam, particularly when it is the sole criterion. Small facilities that de-water river reaches and block fish passage may be more environmentally destructive than larger facilities designed and operated to reduce environmental impacts. Such capacity based standards could also provoke trade challenges under NAFTA and the WTO from owners of large hydropower projects.[1]

LIHI's impact-based certification program has garnered significant support in the United States, but the program is not readily transferable to other countries because of its reliance on U.S. regulatory processes. Also, some operators of small-scale hydro facilities choose not to apply to the LIHI program because they find it too complex or burdensome. In Canada, hydropower projects may be certified as low-impact by the government-sanctioned EcoLogo program, which recently released draft guidelines. However, EcoLogo is not recognized by independent certifying organizations in the U.S. and, due to its lack of transparency, is unlikely to be so recognized unless there are major modifications to the program.

A number of other green hydropower standards have also been developed, notably one by B.C. Hydro, which it has used in a "green power procurement process" that has resulted in the

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[1] Concerns about potential NAFTA and WTO issues raised by the treatment of hydropower in an RPS were examined in detail by the North American Commission for Environmental Cooperation in its report, *Environmental Challenges and Opportunities of the Evolving North American Electricity Market* (June 2002), available at http://www.cec.org/files/PDF//Electr-Vaughan_en.pdf) and in *NAFTA Provisions and the Electricity Sector* (http://www.cec.org/files/PDF//nfta5-final-e2.pdf). In 1999, the Canadian government advised U.S. legislators that provisions that might have the effect of excluding Canadian hydropower from an RPS "would affect conditions of competition and … would be inconsistent with NAFTA and WTO national treatment obligations." (quoted in P. Raphals, *Restructured Rivers* (2001), p. 92 (http://www.centrehelios.org/downloads/reports/2001_EN_IRN_Restructured_Rivers.pdf).

purchase of some 1.8 GWh per year of new power.[2] It should be noted, however, that this standard is also unlikely to gain international recognition because it has not been widely reviewed. In addition, although a variety of criteria are included to diminish impacts, an unsupported written statement by a "reputable scientist" is sufficient to demonstrate compliance with several aspects of the standard.

Without an internationally recognized impact-based standard, the cross-border market for low-impact hydropower will be limited at best, because there will be no means of assuring consumers that adequate environmental protections are in place. By starting at the grassroots level, and focusing on small-scale facilities where there is a greater likelihood of agreement as to acceptable impacts, the goal of this project was to lay the groundwork for an objective standard that could be applied to small-scale facilities in Canada and the U.S. The additional difficulties posed by larger, more complex facilities were not addressed in this pilot project, but the experience generated here would clearly benefit reviews for larger projects.

However, the attempt to define a green standard for hydropower raises some thorny questions. Hydropower differs in a number of ways from the other renewable resources commonly thought of as "green." These differences flow largely from the fact that, unlike other renewables:

- hydropower development generally has substantial environmental consequences, some of which follow inevitably from the initial development and others that vary according to how the project is operated,
- there exists a large stock of existing hydropower generation, much of which was built, and in many cases still operates, under authorizations issued many years ago when environmental standards were far lower than they are today,
- current standards for hydropower licensing vary greatly from one jurisdiction to another,
- hydro projects vary enormously from one to another, and the factors that determine the degree of their environmental impacts are complex and subtle.

Because of these differences, any attempt to define a single green standard is fraught with difficulties. Furthermore, it is important to note that the notion of "green power" varies depending on the context in which it is used. The objective of this study is to answer the question, "Under what conditions should energy produced by hydropower facilities be eligible for inclusion in a 'green power' product offered to retail consumers?" While the answer to this question will of course be relevant to any inquiry into the eligibility of hydropower in a Renewables Portfolio Standard (RPS), or to the basis for comparing it with other generating sources in assembling a long-term utility resource portfolio, each of these questions must be addressed separately.

One challenge that merits particular attention is the need to deal appropriately both with new and existing facilities. Except in situations where dam removal is a realistic alternative, the construction-related environmental impacts of existing hydropower facilities are in essence "sunk" – i.e., the environmental costs have already been incurred. While some mitigation options exist for such sunk costs, there are also significant gains that can be made through

[2] The BC Hydro current green power standards can be found at http://www.bchydro.com/ rx_files/info/info4793.pdf.

operational changes at existing facilities. In this situation, any reduction in operational impacts that can be achieved by modifying the plant's operating regime are of course highly desirable, and there is considerable interest in using the "carrot" of the green power market to leverage such modifications.

On the other hand, for projects which have not been constructed, and where the plant's impacts are thus entirely avoidable, a standard that would encourage the development of new projects with substantial environmental impacts would put at risk the credibility of the green power market as a whole, the survival of which ultimately depends on consumers' confidence that generating stations certified as "green" really are environmentally preferable.

To date, efforts to establish a green standard for hydropower have for the most part been oriented toward objectives based on predetermined environmental criteria. While there is a strong degree of consensus as to the type of impacts to be addressed, it is difficult to justify a precise threshold on strictly scientific grounds.

The approach used in this project was to a certain extent inspired by the Delphi process, a methodology developed by the Rand Corporation in the 1950s to bring expert judgement to bear on questions that are too complex for conventional analysis. Specifically, we began from the hypothesis that the informed judgement of individuals with considerable experience with respect to the environmental implications of hydropower would constitute an invaluable basis for developing a standard for small-scale "green" hydropower facilities that could be used to identify environmentally preferable facilities in both Canada and the United States.

In broad terms, our approach consisted of:

- constituting an expert working group made up of individuals with extensive experience related to the environmental impacts of hydropower projects,
- asking them to review a limited number of existing or planned hydropower projects, based on technical dossiers prepared by the facilitators, and to rank the project from an environmental perspective, using a numerical scale, and
- asking them as well to rank a number of variants of each project, designed to elicit a greater understanding of the reasoning underlying their judgements.

It was recognized from the outset that, due to the limited resources and timeframe, it would not be possible to obtain definitive conclusions or standards from this pilot project. It was intended rather to validate the approach, to provide some preliminary indications as to the nature of such a standard and to point the way for further research.

## 1.2. Working group

In forming our working group, we sought balance and diversity across a number of parameters:

**Nationality.** We sought to obtain roughly equal representation from Canada and the U.S. Our group included 10 Canadians and 9 Americans (including the representatives of LIHI and Helios).

**Regional diversity.** Within each country, we sought members from several regions, especially those with considerable hydropower resources. On the Canadian side, our members came from six provinces (3 from Quebec and British Columbia, 1 each from Ontario, Alberta, Nova Scotia and New Brunswick). On the US side, members came from three regions (4 each from the West and the Northeast, and 1 from the Midwest) and from seven states (Oregon, California, Tennessee, Connecticut, Maine, New Hampshire and New York).

**Expertise.** We sought a high level of experience and expertise with respect to hydropower and its environmental and social implications, as well as diversity with respect to the many relevant disciplines. Our group includes 6 specialists in hydropower regulation and management, 5 fish biologists, two ecologists, two energy analysts, two owner-operators, an engineer and an anthropologist. All of these professionals have considerable experience in evaluating the environmental attributes of hydro projects and many are recognized leaders in their fields.

**Employers.** We also sought diversity in the interests represented by our members in their professional activities. Our group includes eight professionals working for NGOs, six consultants, two government scientists, two dam owners and one academic.

We are honoured to have had the opportunity to work with such an extraordinary group. Their biographical notes are presented in Appendix A.

## 1.3. Methodology

The working group reviewed in detail twelve (12) small-scale hydropower projects in Canada and the United States representing a range of types and settings of existing and proposed hydropower projects in each country. The term “small-scale” was not defined in advance; in the end, the group agreed to review projects as large as 80 MW. Proposed projects were only included if they had already been through the applicable regulatory/authorization process, in order to ensure that sufficient information would be available. The projects were reviewed in three groups of four, together with hypothetical variants of each one, as described below.

### *1.3.1. Project dossiers*

Projects were suggested for review by group members, and were chosen based on a number of criteria:

- **availability of information.** For projects licensed or relicensed by FERC over the last decade, there is usually an abundant paper trail. However, availability of information was an important constraint for Canadian projects, where documents related to the authorization process are not routinely made public, and for older U.S. projects which have not be relicensed. As a result, we were limited in our choice of Canadian projects to those which have undergone a public environmental assessment process or other public process. A number of project operators were contacted, but most declined to provide access to documents;
- **geographic diversity,** both between countries and regions;
- **type of project.** The first round was limited to “simple” projects (one dam, one powerhouse, one bypassed reach, no other dams upstream or downstream). The later rounds also included

projects raising more complex issues such as multi-use facilities or cumulative impacts resulting from several dams; and

- **project vintage,** including projects built long ago, those constructed in recent years and projects that are planned but not yet built. However, planned projects which have not yet gained regulatory approvals were excluded, due to the lack of reliable information concerning their environmental impacts.

The project leaders prepared a dossier on each project, providing summary information about the project's characteristics, setting, and impacts. Information was gathered from public documents; when required, additional information was requested from the dam operators.[3] These dossiers, together with supporting documents, were posted in a private area of the Helios Centre website, for easy access by the working group. Working group members were asked to review and rank each project in terms of environmental preferability, based on the information presented in the dossiers, and taking into account each member's knowledge base and perspective.

The project dossiers, which usually ranged from 6 to 10 pages, generally included the following types of information:

- **regulatory information :** dates of construction, licensing and relicensing, information regarding compliance with license conditions, a description of the approval process that was applied to the project, mention of collaborative efforts with stakeholders, and a description of the scope, complexity and level of detail of license conditions;
- **physical details:** including dam length and height, headpond or reservoir size, length of the bypassed reach or reaches, installed capacity, average annual energy production and capacity factor. To put the generation figures in context, a comparison was also provided with the number of large modern wind turbines that would be required to generate the same amount of energy, as well as the $CO_2$ emissions that would result if the energy were generated by gas-fired combustion turbines;[4]
- **environmental context and impacts,** including (when available) details of the size and types of terrain included in the catchment basin, the stream's hydrological characteristics, the project's flow regime, pre- and post-project fish populations, fish passage facilities, monitoring programs, water quality issues, and project impacts on native species, recreation, aesthetics and indigenous populations; and
- **maps and photos,** as available and useful.

As noted in more detail below, the dossiers were for the most part prepared on the basis of public documents, as most operators contacted declined to provide us with additional data. As a result, much important information was unavailable including data concerning hydrology, geomorphology, detailed biological sampling, etc.

The twelve project dossiers are available for consultation upon request.

[3] In only a few cases did operators agree to provide additional documentary information.

[4] As total annual generation is just one characteristic of a generating station, these comparisons in no way suggest equivalence between these diverse systems. Other important characteristics include, among others, dispatchability and availability at system peak.

### *1.3.2. Variants*

In addition to the existing or proposed projects described in the project dossiers, the working group was also asked to reflect on a number of hypothetical variants to each one. These variants were carefully chosen based on the actual characteristics of each project, in order to better understand the way that different aspects of each project contributed to each member's overall judgement. Thus, instead of single judgments, the group was asked to reflect on many discrete aspects of the project, in order to better understand clarify their views as to their relative importance.

For example, after reviewing a given project, the group might also be asked to give its views on the same project, assuming:

- ♦ different operating regime (e.g., higher or lower minimum flow in the bypassed reach),
- ♦ different facility design (e.g., a larger headpond, used to store water for peaking operations, or a shorter bypassed reach),
- ♦ different environmental or social context (e.g. the bypassed reach had previously been used for tourism or recreation), or
- ♦ an existing project had been proposed but not yet constructed, or a proposed project had been built long ago.

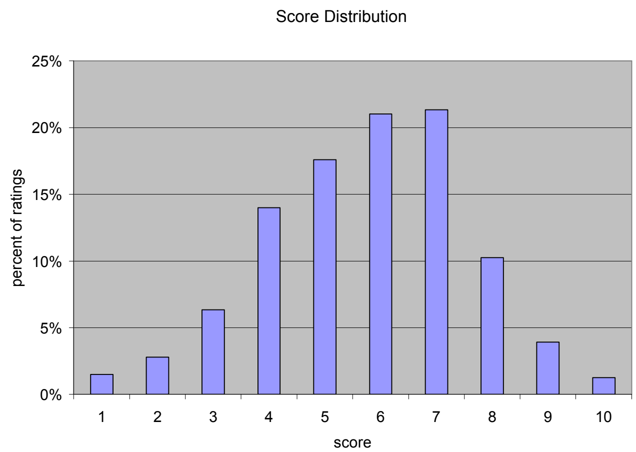
### *1.3.3. Scoring system*

After consulting the group, it was decided to score projects on a scale of 1 to 10, with a "1" the worst and a "10" the best. This scale was meant to refer not just to the set of projects submitted for review, but to the universe of hydropower projects. Members were asked to give a score of "7" or better to those projects that, in their view, should be considered "green" for the purposes of retail power or green tag markets.

It is important to note that this threshold is an artificial one, used for purposes of this working group only. There was no expectation that the projects reviewed would span the range from 1 to 10, or that they will fall in some kind of normal distribution. Nor was there any suggestion that the cutoff for "greenness" is 7/10 of the way between the worst and best, or that 30% of hydro projects are green. Rather, the intent was to provide a vocabulary that would allow members to make nuanced judgments and to share them with each other.

To give this scale a mathematical representation, it is best to think of it as a reverse logarithmic scale, where the difference from one score to the next increases exponentially as you go down the scale. Thus, the world's worst (most environmentally negative) hydro projects would all be rated between 1 and 2, with enormous improvements required to get up to a 2 or a 3. Projects that are judged to be better but still not "green" would get scores of 4-6. Those that a member thought to e just barely "green" should get a 7; those solidly "green" should get an 8, and the "greenest" most exemplary projects should get a 9 or a 10. Because it is a logarithmic scale, the difference between a 9 and a 10 is much smaller than the difference between a 1 and a 2, in order to allow the greatest sensitivity in the part of the scale of most interest.

While this system is somewhat awkward to describe, in practice we found it to be straightforward and user-friendly. Across all projects and variants, scores followed a roughly normal distribution, with a mean of 5.8. The extreme scores of 1 and 10 accounted for about 1% (each), and scores of 6 and 7 (green) accounted for 21% each, as shown in the following chart.




For the purposes of this report, we have presented the mean scores for each variant as well as the distribution of responses above and below the "green" threshold of 7. However, the reader should keep in mind that these parameters provide only an incomplete view of the group's collective rating of a given project or variant, as they fail to represent outlier effects.

### *1.3.4. Review process*

After each round of dossiers were distributed, group members were asked to submit their numerical scores and comments on the projects and their variants within about 3 weeks. Results were compiled and distributed, and a conference call was held to discuss the projects. Members were invited to revise their scorings at any time if their view of the project changed as a result of discussions or in light of other projects reviewed later, though such modifications were infrequent.

### *1.3.5. Confidentiality*

In order to ensure a climate of free and open exchanges, a commitment was made to group members that their individual scorings and comments would not be made public.

At the same time, it was agreed that both the project dossiers and the aggregate scores and comments would be divulged. As expected, this condition unfortunately led many of the project operators contacted to decline to collaborate with the project.[5] As a result, sources for the project dossiers were for the most part limited to public documents. This is the primary reason for the inability to provide certain types of technical information, as mentioned above.

[5] B. C. Hydro was a notable exception.

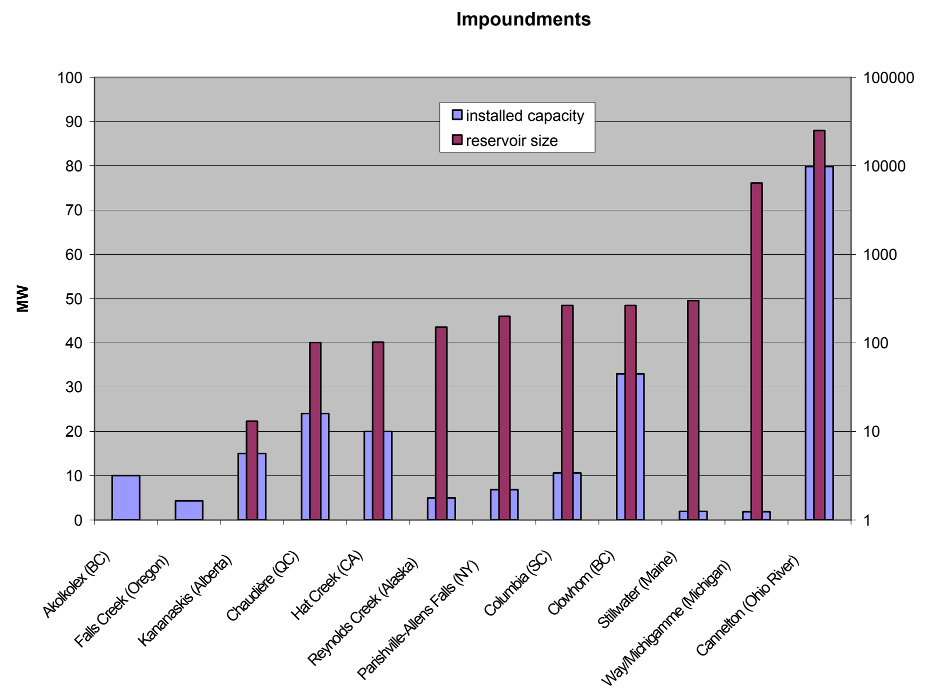
## 2. The projects — Overview

Twelve (12) projects were reviewed, in three groups. While our original intention was to divide the projects evenly between the U.S. and Canada, difficulties in obtaining sufficient information about Canadian projects led us to increase the proportion of U.S. projects.

Of the twelve projects, four were in Canada, including two in B.C., one in Alberta and one in Quebec. The eight U.S. projects were divided among five regions. Some key features of each project are summarized below.

| location | project | MW | impoundment (acres) | type | date built | mean score | best variant |
|---|---|---|---|---|---|---|---|
| **Canada** | | | | | | | |
| B.C. | Akolkolex | 10 | 0.1 | run-of-river | 1995 | 7.6 | 7.6 |
| | Clowhom | 33 | 265 | peaking/ storage | 1958; Water Use Plan in 2003 | 4.2 | 6.2 |
| Alberta | Kananaskis | 15 | 13 | peaking | 1955 | 3.4 | 6.0 |
| Quebec | Chutes de la Chaudière | 24 | 101 | run-of-river | 1998 | 5.6 | 6.5 |
| **U.S.** | | | | | | | |
| **Alaska** | Reynolds Creek | 5 | 150 | peaking | proposed | 5.9 | 6.7 |
| **West** | | | | | | | |
| Oregon | Falls Creek | 4.3 | 1 | run-of-river | 1985 | 8.1 | 8.3 |
| California | Hat Creek | 20 | 102 | run-of-river | 1921 | 5.6 | 7.2 |
| **Northeast** | | | | | | | |
| Maine | Stillwater | 1.95 | 300 | run-of-river | 1902 | 6.0 | 6.0 |
| New York | Parishville-Allens Falls | 2.4 + 4.4 | 200 | daily peaking | 1920 | 6.7 | 6.7 |
| **Southeast** | | | | | | | |
| South Carolina | Columbia | 10.6 | 265 | run-of-river | 1896 | 6.0 | 6.6 |
| **Midwest** | | | | | | | |
| Ohio | Cannelton | 80 | 25,000 (est.) | run-of-river | proposed; dam built 1974 | 5.8 | 6.7 |
| Michigan | Way/ Michigamme | 1.8 | 6.4 | peaking/ storage | 1946 (relicensed 2001) | 5.8 | 7.1 |

As this table indicates, the projects ranged in size from 1.8 to 80 MW (installed capacity). Seven of the twelve projects are true run-of-river plants (or "run-of-reservoir", when flows are controlled by another plant upstream), while five use their impoundments to vary flows from one time period to another. The size of the impoundments varied greatly, both in absolute terms and in relation to installed capacity, as seen in the following chart.




The second-to-last column, "score," indicates the mean score given by the group for the project as it exists today (or, in the case of projects that have not yet been constructed, as it is described in its license). The final column, "best variant," indicates the highest score given by the group to the project *or any of the variants studied.* In some cases, the two scores are the same, indicating that no variant resulted in a net improvement over the existing project. When the "best variant" score is higher than the project score, however, it means that one or more of the variants was seen by the group to constitute an improvement over the existing situation.

## 3. "Green" projects

Among the most interesting and useful results are those where the existing project score is under the "green" threshold of 7 and the "best variant" score is above it. In that case, the variant in effect describes changes that might be made to the "non-green" project to make it "green." This is the case for the Hat Creek and Way projects. In addition, most of the other projects have variants which would bring them up to the "borderline" range from 6.5 to 7. Our analysis will focus in particular on these variants.

The Working Group attributed mean scores that were unambiguously "green" to just two projects, the 4.3 MW Falls Creek project in Oregon and the 10 MW Akolkolex project in British Columbia. The two projects present a number of similarities. Both are run-of-the-river projects of relatively recent construction, located in steep terrain with little or no impoundment. The projects, and the Working Group's analysis of them, are described in the following sections.

## 3.1. Falls Creek (Oregon)

### *3.1.1. Project description*

This is a high-head, run-of-river facility built in 1985, located on Falls Creek in the Willamette National Forest on the western side of the Cascade Mountain Range in Oregon, northeast of Eugene.

The dam is 5 feet (1.5 m) high, and creates a pond of less than 1 acre (2.5 hectares) in size. The project creates a bypassed reach of 2.3 miles (3.8 km). The penstock is buried. The creek is too steep in the facility area for anadromous fish.

The project is located in a heavily forested area. The area of the diversion lies upstream of a steep gradient where the creek drops off, including several falls. There is no trail along the bypassed portion of the creek, and access is poor due to heavy vegetation and forestation. The area upstream of the diversion is undeveloped. The powerhouse is located along the South Santiam River, across from the Highway and a campground.

The project was issued an exemption by FERC in 1983, after consultation with state agencies, each of which can require mitigation measures for the project.[6]

Native rainbow and cutthroat trout inhabit the plunge pool habitat of the facility area, as well as upstream of the project. Anadromous species do not access the facility area due to the steep gradient and falls, although they inhabit the lower section of the Creek and the South Santiam River, into which the project discharges.

### *3.1.2. Score and comments*

As noted in the table above, the Working Group's mean score for the Falls Creek project was 8.1, well above the "green" threshold. Some 85% of the Group rated the project green. To quote a few comments:

> With no significant negative effects on any substantial quantity of wildlife habitat, or other human uses of the area, this project appears to be quite a good one. (9)[7]
>
> This appears to be an exceptional project. It is well placed to minimize watershed/aquatic impacts. They [FERC] followed the agency recommendations.(9)
>
> I would consider it green, but impacts to long bypass reach, some aesthetic impact, and tailwater in anadromous zone, keep me from going higher. (7)

A member with personal experience of the licensing process in the State of Oregon commented:

> Any project licensed in Oregon in recent times has to be green. (10)

[6] A FERC "exemption" is an exemption from the full-blown licensing process, not an exemption from regulations, available to certain facilities of 5 MW or less.

[7] The figure following each citation represents the score given by the commenter to the project or variant in question.

The Working Group was nevertheless concerned about the length of the bypassed reach and whether the flows in it were sufficient for trout habitat. For instance, one fish biologist commented:

> … I am relying heavily on the fact that this project has been reviewed already, and especially that the environmental recommendations (e.g., min bypass flow) for the project have been reassessed recently. Concerns: a. intuitively I find the min flow to be low (may be ok for maintaining the pools, but not for riffles, which may have consequences for insects [i.e., fish food]) b. can fish migrate freely upstream and downstream at the appropriate times of year? would movement away from a flat line min flow achieve benefits? c. unclear the extent to which the final decisions represent trade-offs (e.g., between power and fish), and if so how the trade-offs were characterized. (8)

### *3.1.3. Variants*

The variant with the lowest mean score was described as follows:

(a) The project includes a larger head pond and is operated so as to increase generation during peak periods, resulting in increased fluctuations downstream, limiting the salmon habitat in the lower stream reach.

For this variant, the Working Group's mean score dropped to 5.6, and less than a third of the members still considered the project green.

Also of interest is the following variant:

(e) No design change, but suppose that the bypassed reach had previously been visible from hiking trails (including views of a scenic waterfall that is now partly dewatered) and used for fishing; assume that both hiking and fishing have substantially diminished as a result of project operations.

Here, the mean fell to 6.5 (still borderline, but well below the 8.1 given to the actual project), and votes were almost evenly divided. For several members, the recreational issues are important:

> I generally think that recreation and aesthetics should be considered (both positive and negative impacts). Here, assuming in the variant that this was a well known and well used area, that loss of human use is to me an important factor--there's not enough energy produced to lose that. (6)

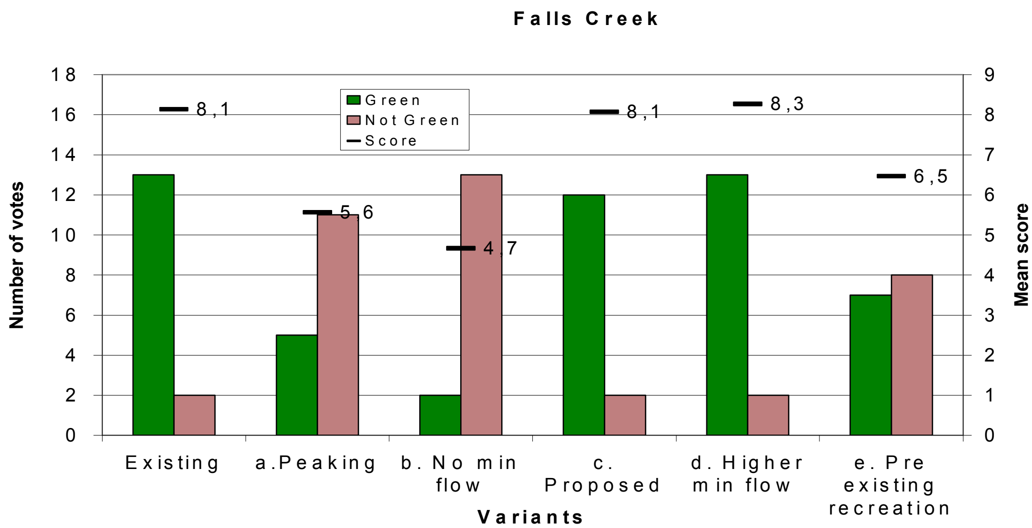
Others, however, felt strongly that they are irrelevant to a green standard:

> I am not convinced that aesthetics and recreation are valid green factors. Although they clearly have value for many people, they are human values not ecological values. I would thus not lower the rating relative to the existing project. (8)

This issue represents a significant exception to the group's generally strong degree of consensus.

### *3.1.4. Summary*

The following table shows the tally as well as the mean score for each variant:




## 3.2. Akolkolex

### *3.2.1. Description*

The Akolkolex River hydro project is a new 10 MW facility located on the Akolkolex River in Southeastern British Columbia, about 25 km south of Revelstoke. It was commissioned in 1995, without public hearings.

Located near Revelstoke National Park, the Akolkolex watershed is in a remote area that has been heavily clear cut, primarily along the mainstem valley bottom and lower reaches of the main tributaries. The project area is very remote and apparently is not regularly visited or used for recreational purposes.

The project has no impoundment, but has a low rubber inflatable weir across the rock banks to provide adequate depth for intake during low flow periods. The transmission lines that connect it to the grid run underground for 0.8 mile and overhead for 1.5 miles.

The bypassed reach includes a sequence of falls dropping 98 m (320 ft) over a half-mile stretch. The tailrace empties directly into the Upper Arrow Lakes Reservoir, one of the large storage reservoirs on the mainstem Columbia River.

The long-term mean annual runoff of the Akolkolex River at the project site is 18.8 cms (645 cfs). The project's rated flow is 10.5 cms (360 cfs), and turbine operation requires a minimum of 2 cms (cfs). Its licence requires a reserved flow of 1.25 cms (43 cfs).

A 1976 government survey reported Dolly Varden (bull trout), kokanee (a plankton-eating, landlocked form of sockeye salmon) and rainbow trout in the channel below the canyon, and good populations of westslope cutthroat trout above the barrier.

### *3.2.2. Score and comments*

The average score for the Akolkolex project was 7.6, well above the "green" threshold. In the words of one member who had direct familiarity with the project:

> I would definitely call it a green project because the net environmental impact on the watershed is minimal and extensive efforts have been made to prevent fish passage down the project. Obviously, the natural barrier would have prevented passage upstream from below the project. Also, the DFO [Canadian Department of Fisheries and Oceans] requirement to monitor gases contributes toward the project's environmental program. A potential negative is whether there is loss of Dolly Varden below the canyon. (8)

Another commenter wrote :

> This project has many positive aspects, including: run-of-river operation, limited transmission infrastructure, minimal effects on fish habitat (though the effects on the pools between falls are unclear). A collaborative consultation process may have unearthed more negative or controversial issues, so I hesitate to rank this project any higher. This appears to be a green project. (8)

On the downside, some members drew attention to the lack of public involvement in the approval process:

> Minimal instream flow—maybe is okay given canyon habitat and lack of recreation, but with lack of public review/oversight, hard to know what impacts from that. (5.5)

### *3.2.3. Variants*

The first variant inquired into the significance of the site itself in the high score.

> a) What if the bypassed reach did not include a waterfall, allowing the lower reach to serve as fish habitat and allowing passage between the upper reaches of the river and the Arrow Reservoir?

Under this variant, the bypassed reach would be of considerably greater biological significance. The Working Group gave it a score that is substantially lower (6.7), but still within the borderline green zone.

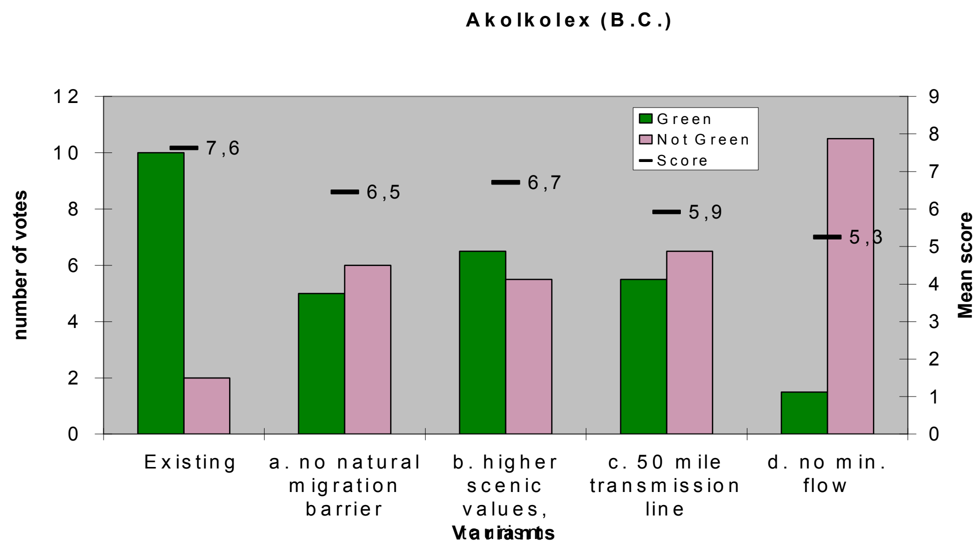
Another variant was meant to isolate the significance of the site's isolation:

> b) What if the lower reach of the river was highly valued for its scenic characteristics and frequently visited?

The score, 7.2, demonstrates that, for the Group, the lack of tourism did indeed contribute to its perception that the project is extremely low-impact. However, the relatively small reduction in the score also suggests that this issue is of limited significance.

### *3.2.4. Summary*

The following table shows the "vote" tally as well as the average score for each variant:




### 3.3. Comments

It is no coincidence that the only two projects that achieved an enthusiastic "green" consensus are uncomplicated run-of-the-river projects. These projects are also characterized by the near absence of ecological or social impact. While, as we shall see below, the Working Group did give "green" mean scores to certain peaking variants of older projects, it did so only under very particular circumstances. For the Working Group, the Falls Creek and Akolkolex projects seem to represent the closest thing to their paradigm of green hydropower.

However, it should also be noted that, in its comments and discussion, the group expressed considerable concern that green power certification might result in accelerated development of undisturbed river systems.

## 4. Projects with "green" variants

In this section, we look in detail at those projects that have a variant that was determined by the Working Group to reach (or almost reach) the "green" threshold.

### 4.1. Hat Creek

The Hat Creek project was chosen as an example of the common situation where two dams, each with its own powerhouse, are built and operated as a single unit.

#### *4.1.1. Description*

The Hat Creek project is an existing facility consisting of two 10 MW run-of-river developments on Hat Creek in northeastern California. Hat Creek No. 1, the upstream development, with 13-acre reservoir, discharges into Baum Lake, an 89-acre reservoir that is the forebay for the Hat

Creek No. 2 development. Each project has a bypassed reach of about 1 mile. The Hat Creek projects were built in 1921, and were relicensed in 2002.

The projects are located in a sparsely populated corner of the state where grazing, farming, timber harvesting, and recreational tourism are the primary occupations. Hat Creek downstream of the Hat 2 powerhouse is designated by the state as a "Wild Trout Area" primarily for rainbow trout. It is one of the most productive and popular wild trout fly fishing streams in the state.

Hat Creek is a major tributary of the Sacramento River system in the Pit River Basin. The projects lie about four miles above the confluence of Hat Creek and the Pit River. Three other projects are located downstream, on the Pit and McCloud Rivers, and range from 143 MW to 340 MW. These projects are all peaking plants.

Prior to relicensing, PG&E released a minimum instream flow of 2 cfs into the Hat Creek No. 1 bypass reach and 8 cfs as a minimum flow below Hat Creek No. 2 dam. This was augmented by other inflows, providing an instream flow of about 40 cfs in the Hat Creek 2 bypassed reach. Below the No. 2 powerhouse, Hat Creek generally carries about 480-500 cfs during non-flood flows.

During relicensing, the U.S. Fish and Wildlife Service recommended that the minimum flow in the Hat Creek No. 1 bypassed reach be increased to 80 cfs to maximize habitat for adult trout and provide enough depth for fish passage, habitat, and other aquatic needs. After this was rejected as too expensive by FERC staff, the FWS proposed a variable flow schedule, of 40 cfs December through February, 36 cfs from March through May, and 33 cfs for the rest of the year.

In the Hat Creek 2 bypassed reach, the FWS recommended that PG&E release 50 cfs from November 1 through March 31 and 80 cfs from April 1 through October 31 for trout rearing and adults. After this recommendation was rejected, the FWS proposed 80 cfs in October through March, and 50 cfs the rest of the year.

Ultimately, FERC rejected all of the FWS' proposals as too expensive—the foregone energy benefits (4,000 to 12,000 MWh for Hat Creek 1 and 2,700-6,500 MWh for Hat Creek 2) were too high. FERC concluded that the 8 cfs in Hat Creek 1 would provide 68-80 percent of the maximum habitat for all stages of trout and maintain necessary temperatures. While this level of flow would not provide for continuous flow in the reach, FERC concluded this was not necessary, as the upper portion of the reach would not be suitable for trout regardless of the flow released. Similarly, FERC concluded that the 43 cfs flow for Hat Creek 2 was sufficient to protect and enhance existing resources and that the benefits of the higher recommended flows for spawning and adult habitat were too uncertain relative to the high cost.

### *4.1.2. Score, variants and comments*

The group's average score for the Hat Creek projects was 5.6, due in large part to the wide divergence the between the license conditions set by FERC and the ecological flows deemed necessary by the Fish and Wildlife Service. Not surprisingly, the group gave a much higher score (7.2) to the first variant, in which the required flows in the bypassed reaches were set at the levels proposed by FWS after its initial recommendations had been rejected.

Variant d), in which the project was proposed but not yet constructed, resulted in a significantly lower score (4.6). Comments included:

> This is an already overburdened area in terms of hydro, and these projects would be too large scale for new projects. I'd be more likely to support new much smaller run of river projects with smaller bypassed reaches. (4)
>
> This would be a highly valuable natural area, with unusually (in CA anyway) stable flows, great fishing, great scenery. It would change the landscape dramatically, and for not very much power at all. (2)

However, one member commented that this was:

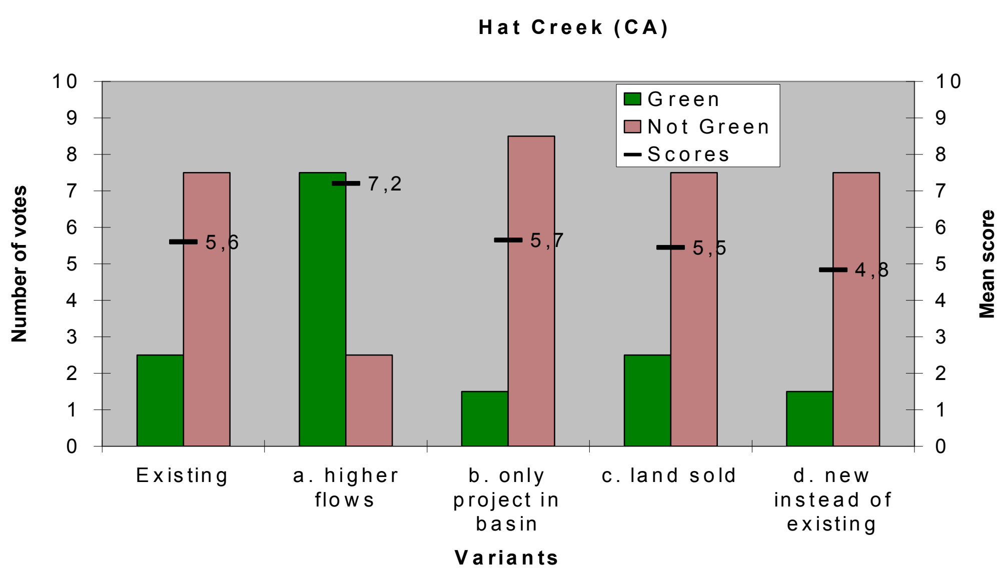
> Not a fair question. Given the high head and small dam size, it's likely that a modern design would be configured differently. It appears that the impoundment could be much smaller without a large loss in power production. (no score)

Variants b (in which these are the only projects in the water basin, but with Shasta dam still downstream preventing anadromous fish from reaching the project) and c (what if PG&E sold off its lands adjoining the project area) resulted in no net change in mean scores. However, the comments on variant b) were nonetheless interesting.

> I lowered the score because without dams this would be a less developed area, although far from pristine with Shasta Dam downstream. I think areas unaffected by humans today should be held to a higher standard — but in continental US there isn't much of that now. (6, underlining added)
>
> The fact that anadromous fish can't reach the project is a big factor for me, so the absence of other projects would not change my score. (5)

### *4.1.3. Summary*

The following table shows the "vote" tally as well as the average score for each variant:



## 4.2. Way/ Michigamme

This project was chosen as an example of a situation where a relatively large storage reservoir provides regulation for a number of relatively small hydropower facilities.

### *4.2.1. Description*

The Way Dam and Michigamme Reservoir project is a 1.8 MW facility located on the Michigamme River in Michigan's Upper Peninsula, west of Marquette, MI. It was built prior to 1946, and was relicensed in 2001.

Lake Michigamme is a natural lake that was greatly expanded with the construction of the Way dam and the subsequent inundation of surrounding areas, and now totals 6,400 acres. Lake Michigamme serves as the major seasonal water storage facility for seven hydroelectric projects downstream, all within the Upper Menominee River Basin. The project is operated to maintain a certain lake elevation during specified seasons; daily peaking operations are prohibited. Wisconsin Electric (now known as We Energy) owns and operates the facility.

Prior to relicensing, Lake Michigamme was drawn down 25 feet each winter between November and February, and 5 feet in the summer between June and September. The winter drawdown was used to capture and store snow melt and spring rain for release into the river during the summer months to augment lower summer flows. The project also provided a minimum flow of 125 cfs into the river below the dam.

The Way Dam and Michigamme Reservoir project were relicensed in 2001 based on comprehensive collaboratively developed settlement agreement known as the Wilderness Shores Agreement, addressing all eight operating facilities in the Basin. Under the new license, the maximum winter drawdown of the Michigamme Reservoir is reduced from 25 to 15 feet; the summer draw down remains 5 feet. Increased, seasonally adjusted minimum instream flows are also required.

### *4.2.2. Score and comments*

The mean score for the existing project was 5.8, but there was a considerable range of opinions about this project. Among the "green" ratings:

> Relicensing addressed, and reduced, impacts on the river. (7)
>
> The new version of this project offers many positive aspects including: prohibition of peaking, seasonal reservoir stabilization, decreased reservoir drawdown, increased minimum flows, efforts to incease dissolved oxygen, collaborative decision-making, a land-use management plan and provisions for fishway installation. Areas for improvement may include implementation of run-of-river management or further decreased reservoir drawdown. On balance, this project could be considered green. (7)

Others saw attractive features to the project, but not enough to call it "green":

> The new conditions of operation under the review process make the project more environmentally attractive in many ways – from increased wetting of habitat to DO enhancement to fish passage to funding monitoring. However, the project is fundamentally a

> storage hydro project – and I see impoundment as a fundamental disqualifier for green power unless the project is adding generation to an existing dam. (6)

> Although the relicensing produced a new license with significant mitigation measures in a collaborative manner, the existing project is still one that produced an unnaturally large storage reservoir. I, therefore, rank it slightly below the green "bar". (6)

Others, however, were quite negative:

> Fundamental alteration of natural flow regimes and water conditions (DO) has occurred. Absence of salmonids is curious and may be related to the reservoir having predators like walleye. There is a risk of thermal shock to fauna downstream of dam due to alteration of discharges between upper vs lower levels of the reservoir. Project is a relatively small component of the "complex". Some evidence is presented of the proponent setting in place processes to mitigate for some impacts (woody debris passage, research), but benefits are temporally distant. It is not clear how the effectiveness of the monitoring will be evaluated. Reservoir is probably stable for greenhouse gases. (3)

> We're looking only at the 1.8 MW Way facility, not at the 61 MW complex (all 9 projects taken together). As such, the impacts resulting from the creation and operation of the 6400 acre reservoir are enormous. True, there have been great improvements under relicensing, but even so, the 15 ft. winter drawdowns presumably reduce the surface area of the reservoir at least by half. (15% for 5 ft drawdown; 80% for 25 ft). Not surprising that overall fish population is sparse. (4)

Nevertheless, variant c), under which the project would be operated in run-of-the-river mode with annual generation reduced by 25%, resulted in an unambiguous "green" score of 7.1, with "green" votes prevailing by a ratio of 3:1. Still, the rationales varied significantly:

> This would make a "greener" hydro project, but for the environment overall the loss of renewable power would be bad policy. (8)

> This has the potential of making the project green power provided that fish passage was installed and monitoring funded. It would return parts of the watershed to their pre-development state. (7)

> From an environmental perspective, this would result in a gross improvement over the long-term. However, impacts/MWh could possibly go up. I actually doubt that the effects would be as significant as suggested, but if they were, this would be a cost of about $3,810,000 per year. This is a large cost. It seems more likely that the losses would be on the order of 10%, or $1,524,000. This would definitely be worth considering, depending on the overall environmental benefits. (8)

> A major improvement, since the reservoir would come to resemble a natural lake. Implications for timing of generation probably more important than the mere increase in total kWh; significant loss of value for operator. If that's the case, and Michigamme is no longer used as a storage reservoir, there would probably be no justification for the massive inundation that increased it to 6400 acres. Shouldn't it then be "decomissioned" back to its original size? If not, project still bears responsibility for this flooding, hence my sub-green rating. (6)

Finally, it is worth noting that variant d), under which the project would have been proposed but not built, was unanimously "not green," with a mean score of just 4.7.

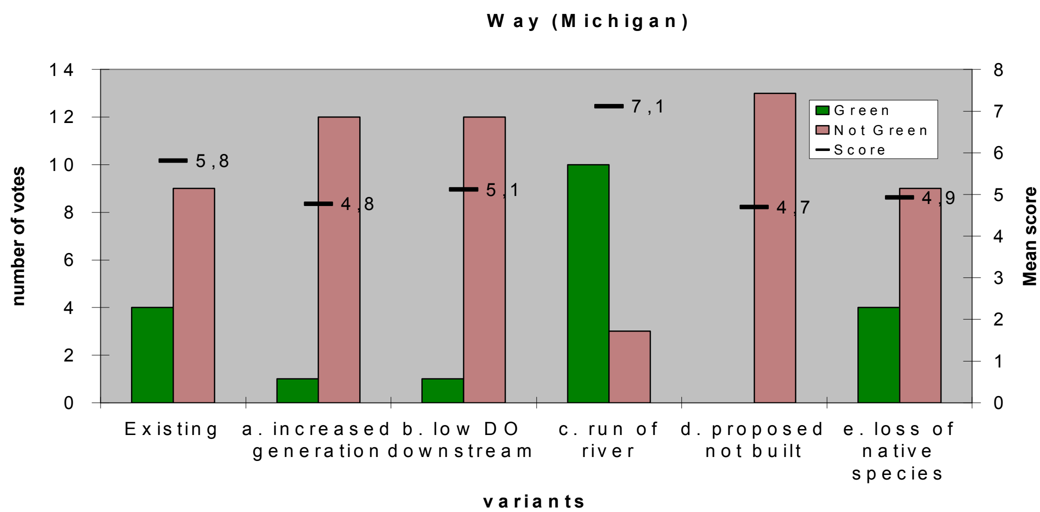
> Too big a reservoir, too little power production, even considering downstream benefits. (3)

Assuming that we are talking about the entire complex being not yet built, I would lower the score, since all of the impacts could be avoided. In other words, I increase the existing project's score slightly because the impacts are "sunk". (3)

The large impoundment and changes to flow regime would be difficult to accept by today's standards, although remoteness of the area would make it less of a problem. (5)

### *4.2.3. Summary*

The following table shows the "vote" tally as well as the average score for each variant:




## 5. Other projects of interest

### 5.1. Les chutes de la Chaudière

This project was chosen as an example of a facility, built on a site which had been developed long ago, which is operated as a run-of-the-river project but which nevertheless resulted in substantial flooding. Because the site in question is an easily accessible and frequently visited waterfall, it also made it possible to look at the questions surrounding aesthetic impacts and tourism.

#### *5.1.1. Description*

This is a 24-MW facility located near the mouth of the Chaudière River, just before it empties into the St. Lawrence a few miles upstream from Québec City. The average annual flow is 130 $m^3s$ (4,462 cfs).

The project is located at a waterfall in a provincial park, the Parc de la Chute de la Chaudière, which is visited by several hundred thousand people each year. It is easily accessible from Quebec City, and is visible from the highway (Route 20) between Quebec City and Montreal.

In 1899, a dam was built on the site (just upstream from the new dam), which produced 3.5 MW to run electric tramways in neighboring communities. A 1970 flood breached the dam, which was never repaired. The old powerhouse was demolished in 1976.

The new facility was authorized in 1997, following hearings before the Quebec Environmental Hearings Board. The dam is 7 m (23 ft) high, and 212 m (689 ft) long. The headpond is approximately 410,000 $m^2$ (101 acres). Its annual energy production is about 118 GWh. It is operation is strictly run-of-the-river, with outflows equal to inflows on an instantaneous basis.

The bypassed reach is about 200 m (650 ft). The 1997 authorization called for a minimum flow for ecological purposes of 12.5 $m^3$s (429 cfs) and an aesthetic flow ranging between 25 and 37 $m^3$s (858 and 1270 cfs) during daytime hours from April 1 to October 31. In July 2000, however, the government modified the authorization to reduce the minimum ecological flow to 4 $m^3$s (137 cfs). Neither the documents provided by the project owner to justify this reduction nor their analysis by the Quebec Environment Ministry are available to the public.

The water quality at the site is very poor, due to agricultural and residential runoff. Twelve species of fish are found, including four below the falls and three in the wetlands that were flooded to raise the headpond.

Since the project is run-of-river, there are no downstream impacts. However, the new tailrace resulted in the loss of spawning grounds of the brook stickleback. Also, the flooding of wetlands were expected to result in:

- declining populations of fish,
- declining populations of the northern dusky salamander (potentially endangered),
- Loss of 20-25% of nesting areas for waterfowl, and
- Loss of fish habitat in bypassed reach.

### *5.1.2. Score and comments*

The Working Group's average score for the Chaudière project was 5.6, well below the green threshold. On the positive side, participants pointed out that:

- the project operations are strictly run-of-the-river,
- the wetlands damaged by the project have only existed since the dam was breached in 1976 (though they presumably existed before the initial dam was built as well),
- the downstream reach is very short, as the Chaudière empties into the St. Lawrence just below the dam,
- the project went through a full, public environmental assessment process, and
- it produces significant amounts of energy, given its limited biological impacts.

However, on the downside:

- The project contributes to cumulative effects on the watershed combined with urban and agricultural development,

- The project significantly reduced the scenic qualities of an easily accessible and highly visited site,
- The ecological flow in the bypassed reach, especially after it was reduced from 12.5 cms to 4 cms, results in significant reduction in scenic qualities and in fish habitat,
- Even with the aesthetic flow, there is significant degradation of a highly visited and appreciated natural site, and
- The aesthetic flow, meant to mitigate the harm to a scenic resource, results in aggravating the biological harm, since it mimics a peaking regime.

Furthermore, the fact that the ecological flow was reduced by 68% without any public process and without making public any of the studies on which that decision was based was cited by several members as highly significant:

> Not green power, although it is a relatively low-impact hydroproject taking advantage of a short, steep fall. The proponent had an opportunity to adopt ecological flows recommended by BAPE. They have not provided documentation to justify the drastic reduction from 12.5 to 4. They have broken the public trust by doing that. (5)

> The unexplained (publicly) reduction in the recommended minimum flows is a killer here. Based on the dossier, the drop from the recommended ecological flow of 12.5 m3s to 4m3s would dewater over half the rapids and a loss of 16 percent or more of the fish habitat. Without better monitoring of impacts and demonstration of minimal effects, this project can't be green. (5)

As a result, the average score for the existing project was just 5.6, with “not green” outvoting “green” by a margin of two to one.

#### *5.1.3. Variants*

The variant a), in which the project was built with a larger headpond and is used for peaking, not surprisingly received an even lower score (4.9).

Variant b), which assumed that there had never been a dam on the site and that water quality was excellent, resulted in an even lower score (4.1). It was observed that, while such projects were routinely built in the past, building such a project today on a virgin site with a healthy fishery would be unacceptable, especially from a “green power” point of view.

Variant c), in which the ecological flow in bypassed reach is doubled from its original level to 25 cms, was the variant with the highest score (6.5). Comments include:

> This would alleviate most of my concerns, since the magnitude of “peaking” would be reduced. I assume that there might be some fluctuations up to 37 cms but that flows are likely to be closer to 25 cms most of the time. (7)

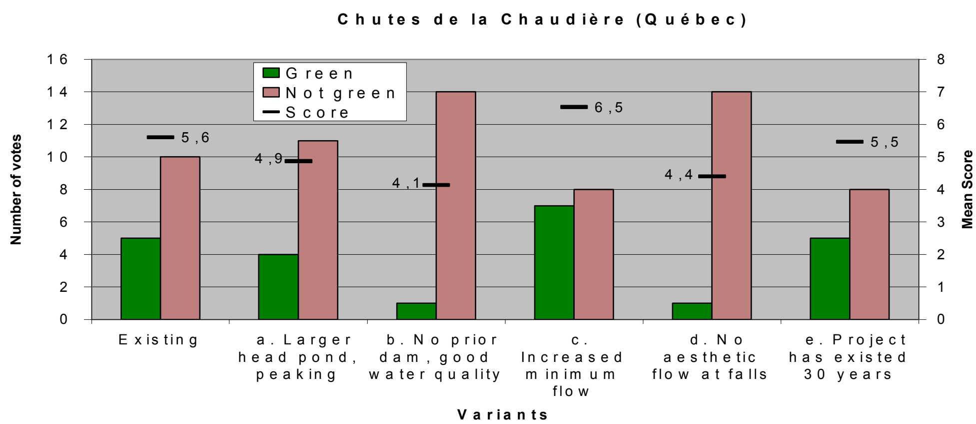
> The bypassed reach is quite small. However, a larger minimum flow would help to preserve more habitat below the falls and lessen the daily fluctuations in flows in that reach in the summer months. It would, however, also significantly reduce or halt energy production during average years five months of the year. (5)

> This sounds like it would help with my concerns, but not entirely clear if this would solve the probable fisheries impacts. It's still a pretty low percentage of the annual flow. Lack of

publicly available information and environmental analysis, which apparently is common in Canada, is very frustrating and quite different than in the US. (6)

### 5.1.4. Summary

The following table shows the "vote" tally as well as the average score for each variant:




## 5.2. Clowhom

This project was selected as an example of a single facility with a substantial reservoir used for peaking. Variants were chosen in order to examine the importance of the operating restrictions for such a project.

### 5.2.1. Description

The Clowhom River hydro project is a 33 MW facility located on the built in the 1950s on the Clowhom River on British Columbia's "Sunshine Coast," about 55 km northwest of Vancouver. It is one of 11 hydro projects owned by B.C. Hydro in the Bridge-Coastal region, stretching north from the US border to Prince Rupert and from the Pacific Coast far into the coastal mountains.

The Clowhom project consists of a dam that impounds Lower Clowhom Lake (1840 acres), with a 350 metres bypassed reach. The powerhouse empties directly into the salt-water Salmon Inlet of the Sechelt Inlet, which empties into the Georgia Straight separating Vancouver Island from the mainland. Before impoundment, the Clowhom River emptied into a chain of two lakes (Upper and Lower Clowhom Lakes) and a small pond, before flowing over the Clowhom Falls into the Salmon Inlet.

The project resulted in the loss of 350 m (1137 ft) of mainstem channel. Impoundment resulted in the flooding of these three lakes and 315 hectares (778 acres) of terrestrial habitat, as well as 78 hectares of channel and riparian habitat on the mainstem and a tributary. Flooding also resulted in the loss of 17 km of lake shoreline and 6 km of the mainstem channel, as well as 3 km of channel of a tributary.

The Clowhom plant is used for peaking on the B.C. Hydro system, and thus supports both domestic requirements and export sales. It generally operates in "on-or-off" mode, alternating between 0 and about 30 MW output once or twice a day. However, since it empties directly into the Salmon Inlet, there is no downstream riverine environment that is affected by these flow variations. There is no flow in the bypassed reach.

Prior to impoundment, there was an extensive sport fishery for rainbow and cutthroat trout in the Clowhom Lakes. It is not known what other species were present. There is no evidence of substantial anadromous fish in the Clowhom basin prior to impoundment, but a small side channel (flooded by the initial impoundment) reportedly did allow coho salmon and steelhead to ascend the falls, and may have provided some spawning and rearing functions. Salmon are not currently found in the Salmon Inlet, though the name suggests that they may have been in the past.

Limited fish studies of the Clowhom reservoir have recently demonstrated the presence, in addition to rainbow and cutthroat trout, of kokanee, three-spined stickleback, prickly sculpin and western brook lamprey. Juvenile Dolly Varden trout were also found, but it is not known whether or not they successfully rear to maturity in the reservoir.

The studies also showed the cutthroat trout populations to be in poor condition, relative to pre-impoundment studies, suggesting a lack of suitable prey. Rainbow trout were in better condition, but since impoundment the average size has declined substantially and the number of older fish were very limited. This may be due to the shortage of large insect prey and their inability to compete with cutthroat trout.

Water chemistry studies show the reservoir to be oligotrophic (low in nutrients) and thus not very productive. The reservoir stratifies during summer, with substantial mixing during fall, spring and probably winter.

Clowhom is currently in the Water Use Planning (WUP) process, which was first announced by the BC government in 1996 in order "to revisit provincial water management in light of changing public values and environmental needs." The WUP process is meant to optimize project operations and water management. It thus makes a clear distinction between "footprint" impacts, related to the project's existence and its physical installations, and operational impacts related to project management. For instance, fish passage and the loss of riverine habitat due to dead storage in the reservoir (independent of reservoir operations) are footprint issues that cannot be addressed in the WUP. A separate B.C. Hydro program, the Bridge-Coastal Fish and Wildlife Restoration Program, is meant to address footprint impacts on fish and wildlife for facilities in this region.

### *5.2.2. Score and comments*

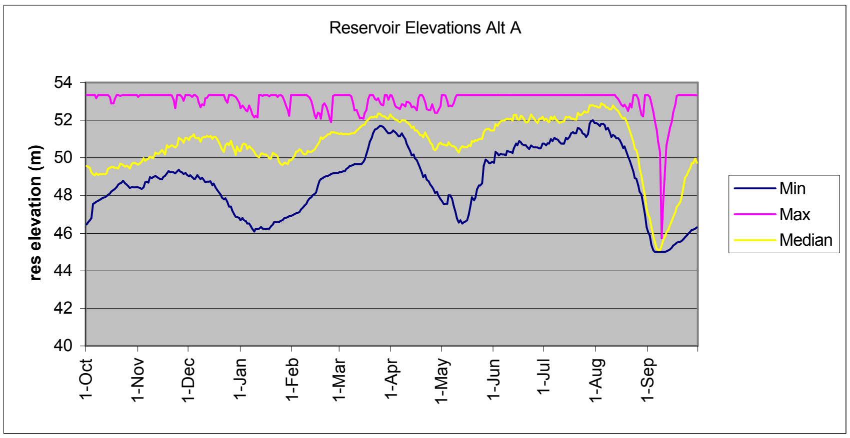
The Working Group's mean score for the Clowhom project as currently operated was 4.2, and not a single member gave it a "green" score. Comments on the project included the following:

> They severely affected an apparently productive lake system and a nice little fishery. The scale of the project is nevertheless fairly small and there are no downstream effects, so I have moved away from the very low end of the scoring system. (4)

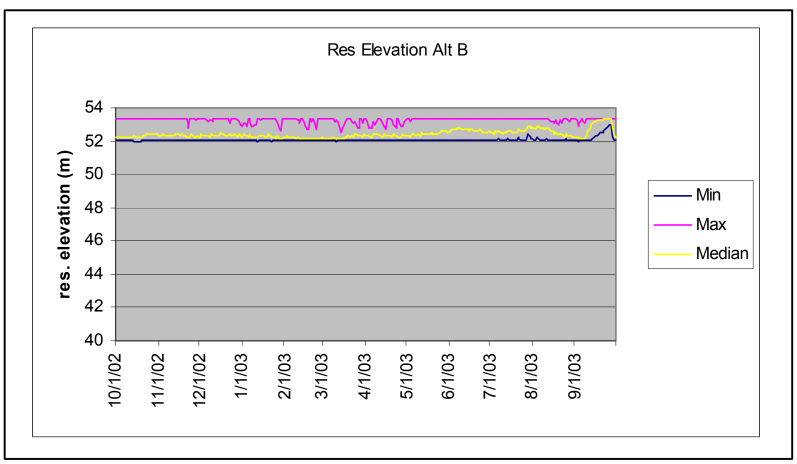
The existing project does not seem to have much going for it. Negative aspects of the project include: loss of main stem channel and bypassed reach, riparian habitat loss due to flooding, peaking operation, significant and rapid drawdown, recreational losses, fish population decreases, and no effective littoral zone. Operational changes could go a long way in improving this project. (3)

### *5.2.3. Variants*[8]

In the WUP process, several alternate operating regimes were developed and evaluated in relation to economic and environmental criteria. Under current operating criteria, the reservoir levels in typical wet, medium and dry years are those shown in the following graph :

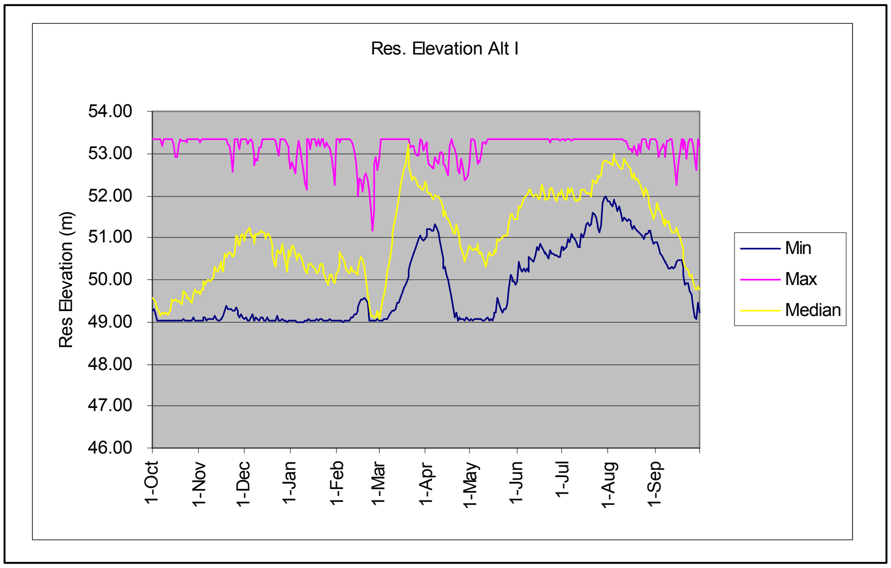



Two of the alternate operating regimes were of particular interest to the Working Group. Alternate B is intended to closely mimic the behaviour of a natural lake. This alternative provides an Effective Littoral Zone as large as that of the pre-impoundment lakes, and is best for recreation. However, it involves frequent small spills, with resulting economic loss and fish entrainment, and very greatly reduces operational flexibility. The simulation results for this alternative, identified as variant a) in our process, are shown below :




[8] Due to ambiguity in its drafting, variant d) has been excluded from our analysis.

Alternate I, like the current operating regime, allows considerable operational flexibility. However, limits are imposed which nevertheless allow for the formation of an Effective Littoral Zone. It sets a minimum level of 49 m year round. (The current license allows drawdown to 42 m, though drawdowns below 45 m are rare.) It also includes increasing the turbine discharge limit, and shifting annual maintenance to March. The simulation results for this alternative, identified as variant b) in our process, are shown below :




The mean score for variant a) was 6.2, and that for variant b) was 6.1. However, the perceptions of the two variants were very different for several Working Group members. Thus, for variant a), comments included:

> This would almost return it to a natural system, eliminating most impacts of development other than the flooding itself (which would become without purpose, except for increasing head). While I find the method used by BC Hydro overstates the system consequences of loss of storage, they would nonetheless be quite substantial. Surprisingly, the loss of value resulting from loss of peaking ability is not very great ($6.70 to $6.54 M, or 2.5%). (7)

> Restores some of the natural flow regimes, but probably not enough to improve impacts on spawning areas. The approach is theoretical. No evidence is given that restoring an Effective Littoral Zone actually improves fish production. The projects, in improving access to fish populations that may already be stressed, could actually have major new negative impacts upon them. (4)

Both of these commenters gave lower scores to variant b). However, others were very concerned about the loss of operational flexibility in variant a):

> The tradeoffs here would be a bad idea. Water levels may mimic a natural lake, but its not, so there are still other impacts and the operational losses aren't worth it. (5)

This commenter increased his score to 7 for variant b).

## 5.3. Parishville/Allens Falls

Parishville/Allens Falls was selected as an example of a two-facility peaking project in which the operating regime has been greatly modified as a result of a collaborative process.

### *5.3.1. Description*

Parishville and Allens Falls are two separate existing hydropower developments, built in the 1920s, operated as a unit and licensed together as one project. The project is owned and operated by Reliant Energy, and was relicensed via a collaborative process in 2002. The facilities are located on the West Branch of the St. Regis River in northern New York about ten miles east/southeast of the Village of Potsdam.

The area around the project is predominantly rural. There are no other water developments or hydropower projects in the West Branch St. Regis basin. The watershed itself includes small towns and farms, with agriculture and recreation uses (e.g., fishing, canoeing, camping) predominant.

Both facilities include a reservoir, dam, penstock, bypassed reach, and powerhouse. The Parishville development (2.4 MW) is the furthest upstream and discharges into the Allens Falls impoundment (4.4 MW). Parishville has a bypass reach of 4,175 feet (1.3 km); Allens Falls has a 13,700-foot (4.2 km) bypass reach. The facilities are operated for power generation in a "pulsing" mode with daily impoundment fluctuations of less than 1 foot (0.3 meters); minimum instream flows in the bypassed reaches are now required, but were not prior to relicensing.

### *5.3.2. Results*

This project was chosen to highlight the significance of a collaborative settlement for an older project. The average score of 6.7 for the existing project, despite the fact that it is used for (daily) peaking, demonstrates that the Working Group gave considerable weight to the reduction in environmental impacts resulting from the recent collaborative relicensing agreement. This is demonstrated by the the "proposed but not built" variant, where the score declined precipitously to 4.9. As discussed below, this variant provides a strong indication that, in the minds of the Working Group members, new facilities must be held to a much stricter standard than existing projects.

## 5.4. Cannelton

Cannelton represents a type of "incremental" hydropower project which has aroused considerable interest in recent years, which adds generating equipment to an existing dam built for other purposes. In this case, turbines are added to one of the many navigational locks on the Ohio River, one of the most heavily developed rivers in North America.

### *5.4.1. Description*

The proposed Cannelton Hydropower project is a proposed installation of a grid enclosing 140 small turbines ("hydromatrix" technology) to the tainter gate bays of an Army Corps of Engineers Lock and Dam on the Ohio River, built in 1974. There will be 5 modules placed in as many gate bays, each of which contains 28 turbines with a capacity of 570 kW each, for a total installed capacity of 79.8 MW.

The existing Army Corps Dam is one of 60 dams, and lock and dam facilities in the Ohio River Basin constructed to provide navigation along the mainstem Ohio (including water control dams on tributaries in the basin's watersheds). There are 20 dams on the mainstem Ohio for navigation.

The pool created by the Cannelton dam is 117 miles long, and there is no bypassed reach.

The project is expected to result in some mortality of drum and shad, but the amounts are not expected to be significant, given the size of the populations present.

### *5.4.2. Results*

This project produced a wide variety of scores, depending above on the degree to which the participant was willing to divorce the score for the "incremental" generation from the impacts of the existing dam, without which that generation would be impossible. The following represent the range of views expressed:

> The project evaluation should include the existing dam that allows it. The low score reflects the scale of that dam relative to the power that will be achieved as well as the irreversible impacts that were caused. The score would be a 2 if there was seasonal storage. (3)
>
> Although the net impact on the environment is minimal because it is operating in run-of-reservoir mode without storage, the dam has historical impacts which could have been partly mitigated. For example, the project does not permit fish passage. Also, there is no environmental enhancement or new habitat created in the overall design. Also, the transmission line does have a net impact. The project is not green. To be green an enhancement program would be needed. (5)
>
> Actual (marginal) impacts of project are very low compared to significant power production (entrainment and impingement of populous species, new 8-mile transmission line that creates no new habitat fragmentation). True, the damming of the Ohio has created huge impacts, but there is no link to the power development. (7)

The mean score of 5.8 in fact was composed of two blocs, one ranging from 2 to 5 (mean 3.7) and the other ranging from 7 to 9 (mean 7.3). This divergence with respect to cumulative impacts is discussed in section 6.5, below.

## 6. Key Issues

It is clear from the review of the projects and the variants described above that there are many elements that contribute to the Working Group's judgements, whether on an individual or collective basis, as to the environmental qualities of a given hydropower project. In this section, we will focus on the most important of these features.

## 6.1. Flow modification

One of the most important conclusions to emerge from this process is that the extent to which a project modifies a stream's natural flows played a critical role in the Working Group's judgments. Run-of-the-river projects (those in which inflows are equal to outflows on an instantaneous basis) do not affect streamflows downstream of the facility, nor do they affect water levels in any reservoir or headpond upstream of the facility. All the projects and project variants that were deemed "green" by the Working Group were run-of-the-river, based on this strict definition.[9]

That said, it is also worth noting that some peaking projects or variants did achieve near-green scores. For example, the Parishville-Allens Falls project in New York State was rated 6.7, even though it is operated as a daily peaking plant.[10] However, this project is noteworthy in that its operating regime was fixed as the result of a multi-party collaboratively developed settlement agreement.[11] Under this agreement, reservoir drawdown is limited to 6 inches, except when necessary to maintain minimum flows in the bypassed reach.

Five of the projects studied included variants related to peaking. For the run-of-river Falls Creek plant, the highest scoring project in the study, the score for a variant with a larger headpond to allow peaking operations fell to 5.6. from 8.1. A similar variant reduced the score of the Chaudière project to 4.9 from 5.6.

There were also two peaking projects (Reynolds Creek and Kananaskis) with variants that eliminated or substantially reduced the peaking-related flow fluctuations. In both cases, the mean score improved substantially, as shown in the table below.

An interesting example in this regard is the Columbia project in South Carolina, at the confluence of the Broad and Saluda Rivers is one of 15 projects on these two rivers, some of which are quite large. Thus, while Columbia is a run-of-river project, its flows are controlled by other projects upstream. (It would thus be more appropriate to refer to it as a "run-of-reservoir" project.) Variant b), which presupposes modifications in the operations of an upstream facility that would result in steadier, more predictable flows downstream of the Columbia project, increased the mean score by 0.6.

9 In other contexts, the term "run-of-the-river" is sometimes used to refer to projects with very limited storage capacity.

10 The project is operated in a "pulsing" mode, with daily impoundment fluctuations.

11 The parties included the project owner (Reliant), state and federal resource agencies, the St. Regis Mohawk Tribe, the local county and town, and several environmental organizations, including the Adirondack Mountain Club, American Rivers, American Whitewater, and Trout Unlimited.

| | | score change | |
|---|---|---|---|
| | **variant** | **RoR to peaking** | **peaking to RoR** |
| Falls Creek | (a) Larger headpond, peaking | -2.5 | |
| Parishville/ Allens Falls | (c) higher capacity, more reservoir fluctuation, lower min flows | -1.6 | |
| Chaudière | (a) Larger headpond, peaking | -0.7 | |
| Columbia | b) less flow variation from upstream facility | | 0.6 |
| Reynolds Creek | (d) Run of river | | 0.8 |
| Kananaskis | (c) reservoir stabilized, weekly block loading | | 2.6 |

The substantial variation in scores for variants that affect the degree of flow modification demonstrate the critical importance of this issue for the Working Group.

## 6.2. Minimum flow (bypassed reach)

Another issue that clearly contributed significantly to the group's judgements is the required flows in the bypassed reach(es). Seven projects had variants related to these flows.

| | **increased flow** | **decreased flow** |
|---|---|---|
| Falls Creek | 0.2 | -3.4 |
| Chaudière | 0.9 | -1.2 |
| Parishville | -0.1 | -2.6 |
| Reynolds Creek | 0.5 | -2.8 |
| Hat Creek | 1.6 | |
| Columbia | 0.6 | |
| Akolkolex | | -2.3 |

It is interesting to note that, while increased flows had a significant impact on the score for Hat Creek and Chaudière, they had little effect on the other projects. A closer look reveals, however, that in these two cases the Working Group had significant concerns regarding the flows in the underlying projects. It is thus not surprising that improvements in this regard would result in significantly higher scores. This demonstrates once again the danger of mechanically applying a flow standard that doesn't take into account the particular characteristics of the project in question.

Similarly, variants with decreased flows in the bypassed reach generally had quite significant repercussions on the Group's overall perception of the "greenness" of the project, with scores falling by up to 3.4 points. The exception was, again, Chaudière, where the score for the existing project already reflected the Working Group's judgment as to the adequacy of the flows provided.

## 6.3. Proposed vs. existing

The Working Group's score for the "proposed but not yet built" variant were inmost cases substantially lower than for the underlying project. The following table shows the score differentials for these variants :

| project | score differential "proposed" variant |
|---|---|
| Parishville/Allens Falls | -1,8 |
| Way/Michigamme | -1,1 |
| Hat Creek | -0,8 |
| Clowhom | -0,6 |
| Columbia | -0,5 |
| Chaudière | -0,1 |
| Falls Creek | 0,0 |

These results imply that some of an existing project's impacts are "forgiven" because they have already been incurred. Or, viewed from the other side, that new projects have a higher threshold to meet, since all of their impacts (and not just those related to project operations) can be avoided.

A clear implication of this finding is that different standards are needed for new and for existing projects. There was strong support for the notion that it is appropriate to give credit through the green power market for modifications to the operations of existing projects that result in reduced environmental impacts. It is less clear, however, how the "footprint" impacts resulting from the initial development should be taken into account.

## 6.4. Scenic qualities and recreation

Only three variants addressed questions related to scenic qualities and recreation. In each case, variants which increased the impact on these factors resulted in lower mean scores, as seen below. (Each of these variants is discussed in detail in section 4, above.)

| | | |
|---|---|---|
| Falls Creek | (e) pre-existing recreation/aesthetics | -1.6 |
| Chaudière | (d) no aesthetic flow | -1.2 |
| Akolkolex | (b) highly valued for scenic qualities and heavily visited | -0.9 |

It is important to note, however, the Working Group was clearly divided on this issue. As noted above, some members feel strongly that, important as these issues might be, they have no bearing on whether or not a hydro project should be characterized as "green". Others felt that, since these qualities are valued by many people, they must inevitably be taken into account in a green standard, if that standard is to reflect the values of the consumers who will ultimately rely upon it.

## 6.5. Cumulative impacts

Most of the issues we have addressed thus far relate to the design or operation of a single project, regardless of its surroundings. In the real world, however, it is quite common to find a number of dams, with or without power generation, on the same river system. In such cases, it is not at all obvious to what extent an individual project should be "held responsible" for the environmental consequences of the development as a whole.

One Working Group member described the problem as follows:

> A general comment on facilities that are in highly regulated watersheds is that we have no way of apportioning impacts amongst projects, i.e. addressing cumulative impacts. Very often operations are very linked between different plants, which makes the economics of plant x strongly dependant upon the upstream plant y. It is therefore very difficult to just discuss the operations and impacts of a single plant in this case [Hat Creek] as well as the Stillwater project.

A number of our projects and variants were chosen to explore these issues:

- Hat Creek, where there are three other hydro projects in the vicinity, in addition to the two Hat Creek units. Variant b) examined the hypothetical situation where these additional plants did not exist, although the large Shasta plant farther downstream was still present, preventing anadromous fish from reaching Hat Creek. The mean score for the variant was almost the same as that for the base project (5.7 vs. 5.6). This was explained as follows:

  > I do not see the other project interacting with this project in a manner that affects its score.
  >
  > The fact that anadromous fish can't reach the project is a big factor for me, so the absence of other projects would not change my score.

- Variant a) of the Columbia project (South Carolina) assumes that there are no upstream facilities on the Broad River. Removing the upstream facilities would give much more importance to the facility's fish passage facilities. This variant did lead several members to vary their scores, but there was no trend, and thus no significant change in the mean score.

  > The fish passages definitely become more important in this case because they are providing access to larger areas. Currently the upstream passage only provides access to the next dam upstream. Of course, if all of the other upstream facilities already had fish passage, then it would have no difference in importance. (6)
  >
  > Assuming that the fish passage is effective and operating at full throttle (not the staged implementation of fish passage proposed) this project appears to have the makings of a decent green power project. There would continue to be issues with reservoir management that would require attention. (8)
  >
  > If this is the last barrier before fish can access upstream habitat on the Broad, then the fish passage measures become more important and this carries more of the burden of the loss of upstream access, so the score goes down. (4)

- The Stillwater project, a 1.95 MW run-of-river facility of a heavily developed river (with over 100 dams, not all of which are used for generation), had a mean score of 6.0. Variant b) involved the absence of all dams downstream of Stillwater, and variant c) involved the absence of all upstream dams. As the comments below indicate, there are no simple answers to the questions raised by these variants. Regarding variant b), members wrote:

> If no dams downstream but ones upstream exist it would raise the value of fish passage at this facility although reduce the urgency to construct at upstream plants. If this plant was actually blocking fish it would be less green. (5)
>
> The issue of cumulative effects is a difficult one, but I believe that to qualify as green a project should be green in its own right (i.e., without needing to consider other impacts). My scores are therefore consistent through these variants. (8)
>
> Depends if they installed passage for both salmon etc and sturgeon, since sturgeon should be able to reach the dam. If no passage yet I would give them a 4, if passage were installed they might get a 7, if underway but incomplete a 6.

And regarding variant c), without upstream dams, the comments included the following:

> Not Green because of cumulative effect on up and down migrating anadromous fish. I know this system fairly well and come to this conclusion because the existing upstream fish passage is generally better than what exists downstream. The downstream Orono Dam (power facilities have been retired) on the Stillwater branch has no fish passage and is clearly a barrier to up migrants and possibly delays down migrants. (6)
>
> Expected impact on water quality (first dam where the flow is regulated). Expected economic impact on Penobscot Nation community. (5)
>
> This would help improve the score to lessen the overall cumulative effects burden that should be share by all the projects, but not enough to move it into a green category, especially since fish passage is still not provided. (6)

- The Chaudière project, where variant b) assumed that there had never been a dam on the site and that water quality was excellent. In essence, this variant is addressing the cumulative impacts resulting from the dam and from the agricultural and residential development in the watershed. Under this variant, the score dropped from 5.6 to 4.1, implying that the existing project is more acceptable than the variant because river is already harmed. However, there was no unanimity on this point. It should be noted that the Quebec Public Hearing Board (BAPE) had stated that project approval should not be based on assumption that the *status quo* will persist, since water quality could and should improve. Viewed from this perspective, the environmental impacts of the existing project should be assessed as if the river were not already polluted.

These examples demonstrate that there are two different ways to look at cumulative impacts. On the one hand, the presence of other dams is seen as augmenting the impacts of the dam under study, since the actual ecological effects are greater than those that the dam would create in isolation. On the other hand, the presence of other dams can be seen as reducting the dam's responsibility for the actual impacts, since that responsibility is shared among several facilities.

The framework for thinking about cumulative impacts is particularly important with regard to "incremental" projects, where either power generation equipement is installed for the first time at existing dams (e.g. Cannelton), or where additional turbines are added to an existing hydropower project. While the Working Group did not address any projects of this latter type, there is considerable activity in this type of development.

Cumulative issues vary greatly from one situation to another, and do not lend themselves to any simple solutions. Considerably more study is ne eded in order to reach consensus as to the appropriate treatment of cumulative impacts.

# 7. Conclusions

## 7.1. Summary

Based on analysis of the working group's judgements for the diverse projects and variants, the following aspects emerge as the most important determinants:

- **Flow alterations.** The most important issue is clearly flow alteration, both in the bypass reach and downstream. For the bypass reach, this depends both on the length of the reach and the required flows. For the downstream reaches, it depends on how the facility is operated — whether outflows are identical to inflows on a moment-to-moment basis ("run-of-the-river"), or whether waters are stored in the headpond ("storage/peaking").
- **Impoundments.** While even true run-of-the-river facilities often require minor impoundments to stabilize turbine flows, the group was unwilling to give a "green" label to new projects with significant impoundments. It was however, less categoric with respect to existing installations, as long as the facilities were managed in such a way as to minimize the ecological consequences due to water level and flow variations. For such facilities, the group strongly favoured management regimes that closely resemble the patterns of a natural lake and that, as a minimum, allow for the formation of a healthy littoral zone ecosystem.
- **Landscape, aesthetics and recreation.** Views were divided within the working group as to the importance that should be given to these issues within the context of a "green" rating system. Some argued that landscape and aesthetic values are part of the popular conception of "the environment," and that public confidence in the green power market could be harmed if green power products included energy generated by facilities notorious for having infringed on these values. On the other hand, it was argued that these values, like power generation itself, are societal values, not ecological ones. "Green" certification, from this point of view, should rely strictly on ecological considerations.
- **Monitoring and adaptive management.** While these issues were not an explicit focus of the project reviews, several Working Group members noted the importance, for their own judgements, of a credible program to monitor ongoing project impacts, to make public the results and to modify operations based on those results.
- **Procedural transparency.** For all its flaws, the FERC regulatory process imposes a degree of transparency and of public involvement in decision-making far greater than those which are generally required in Canada.[12] This was a significant concern for many Working Group members in their assessment of the Chaudière project, where the ecological flows were reduced by almost one third without public notice or comment. It was also mentioned in regard to the Akolkolex project, where the limited public record raised the possibility of "sleeper" issues. While in this latter case the members' nevertheless found the project

[12] The Water Use Planning process in British Columbia is a significant exception.

sufficiently appealing to give it a mean score of 7.6, it is clear that limited access to technical information and limited public involvement in decision-making remain significant obstacles to the acceptability of Canadian hydropower in green power markets.

## 7.2. Towards a "green" standard

While this pilot project has moved us closer to the goal of an impact-based "green" standard for small-scale hydropower, it is not yet possible to articulate such a standard. It is clear, however, that the Working Group intends this qualifier to be applied very selectively.

Only two projects, Falls Creek and Akolkolex, were found by the Working Group to be unambiguously "green". These have the following characteristics:

- strict run-of-the-river, with no downstream flow modification;
- little or no headpond, and no operations-related fluctuations in its water levels;
- the bypassed reach is of little ecological, scenic or recreational importance, and the required flows in it are adequate for the needs of native species found there; and
- no impact on biodiversity or on threatened or endangered species.

Through the variants, a second group of projects can also identified which, for the Working Group, can be said to produce green power. These are storage projects of older vintage, in which the operating regime has been established through an open collaborative process and in which:

- downstream flow modifications and upstream water level fluctuations have been optimized to minimize their ecological implications, even if so doing reduces their value for the power system;
- required flows in any bypassed reaches are clearly adequate for the needs of native species; and
- no impact, either resulting from the impoundment or ongoing operations, on biodiversity or on threatened or endangered species.

It should nonetheless be noted that most such projects do have substantial "footprint" impacts, and that several Working Group members expressed strong reservations about describing such projects as "green," despite the consensus that the power from such projects should be eligible for sale in the green power market. To emphasize that such facilities are nevertheless the source of significant environmental impacts, it was proposed that they be described as "blue," reserving the "green" epithet for projects that are truly low impact. Such a designation would aim to encourage improvements at existing projects while at the same time maintaining a high standard for projects specifically designated as green.

Finally, it is necessary re-emphasize that, as in so many issues concerning hydropower, the devil is in the details; it is not possible, as a result of this limited pilot study, to set out precise rules to judge projects that fall in the grey zone between clearly green and clearly not.

Furthermore, as noted above, there are two issues for which the Working Group was clearly divided. These are:

- the significance of scenic, touristic and recreational values in a green standard, and
- the appropriate treatment of cumulative impacts in situations where the actual impacts result only in part from the generating equipment or dam under study.

Finally, it should be noted that the study only scratched the surface of so-called "incremental" hydropower, which covers the following two categories:

- where turbines are added to existing water control facilities which have heretofore not produced electricity (such as the Cannelton project, described in section 5.4), or
- where additional turbines are added to hydropower facilities.

As with cumulative impacts, these projects raise questions about to what extent one can separate, for the purposes of certification, facilities which on the ground are indistinguishable. As noted in section 5.4, the group's views were not convergent with respect to Cannelton. While the "marginal" environmental impact of the turbine addition project may be negligeable, the full impact of the facility as a whole are very great. The question is even more acute when turbines are being added to an existing hydropower facility, as, once construction is complete, the old and the new become a single functional unit. Certification of the incremental capacity would thus lead to regarding one part of the post-addition facility as green and the other part as not green, an approach that was unacceptable to several Working Group members.

### 7.3. Future steps

This pilot project has demonstrated both the value and the limitations of the chosen methodology. On the one hand, it has demonstrated the value of using expert judgment of real projects and hypothetical variants as a critical tool in addressing a question as complex and fact-based as the environmental impacts of hydropower. At the same time, it has demonstrated the limitations of using this approach for a process that must make value judgments and tradeoffs that, at the end of the day, must reflect the values of a much broader public.

There was a strong consensus among Working Group members with respect to the value of this approach, and the importance of in-depth case-by-case analysis to sort out the complex interplay between the many factors that contribute to the environmental profile of even a simple hydropower project.

However, several factors contributed to limit the effectiveness of this pilot project. These include:

- Inadequate information base. Several members in their comments emphasized the lack of essential information in many of the project dossiers. This is due both to limitations in the time and resources that project leaders could devote to dossier preparation, and to the lack of cooperation (with a few notable exceptions) on the part of project operators who were asked to provide supplemental information. As noted above, this problem is more acute for Canadian projects and with U.S. projects which have not been recently licensed or relicensed by FERC.
- Insufficient interaction among participants. Face-to-face meetings of the Working Group, which were impossible given the project's resource limitations, would have permitted a far

greater degree of interaction among the members. Despite the use of e-mail and web-based discussion tools, real-time discussions were limited to one conference call per round of evaluation.

- Enlarging the circle. In setting up the Working Group, our primary goal was to ensure a sufficient degree and diversity of expertise to be able to adequately address the environmental issues raised by hydropower development. (The group also included two owner-operators, to ensure that their perspective was represented.) However, as we have seen, the issues turn not only on expert analysis but also on values. In the words on one participant:

  > I believe strongly that all the components we looked at are value driven or political in nature. For example, the decision about how much we take fish and wildlife issues into consideration is very much value laden. A standard is merely a way to state what some representative body believes. It is objective only in the sense that it can be calculated or applied by everyone with the same result (e.g., like a speed limit). A green standard is an attempt to find a consistent representation of our values.

  Thus, final choices as to the standard by which it will be determined whether or not a given hydro project produces "green power" cannot be made without the participation of a broad swath of civil society, in particular of those who will market and purchase green power.

The challenge for a follow up study will thus be to create a process that involves both hydropower experts and those responsible for policy decisions in the world of green power. In practical terms, there would be considerable value in repeating the exercise with:

- more thorough and complete project dossiers;
- face-to-face meetings, to allow participants to influence and be influenced by each others' views; and
- a wider Working Group, including more members from the green power marketing community, the broader environmental community and the hydropower community.

Constituted in this way, and moving systematically from simpler to more complex projects, it should be possible ultimately to develop broad consensus around precise standards for the inclusion of hydropower in green power markets.

# APPENDIX A

## Working Group — Biographical Sketches[13]

**Fred Ayer** has been involved with FERC relicensing for over twenty-five years as both a consultant and Licensee's employee. He has worked on over 75 hydro regulatory projects. Prior to opening Fred Ayer Associates Inc., in early 2002, he was Senior Partner at Lukas & Ayer. From 1994-1997, Fred was a Partner at Long View Associates. From 1991 to 1995 he was Director of Environmental Services at Northrop Devine & Tarbell. He was with Bangor Hydro-Electric Company (BHE) from 1983 through 1990 where he was the Director of Environmental Affairs. In 1989 he testified as a National Hydropower Association witness at the Senate ECPA oversight hearings.

From 1992-2000 he was retained as Lead Regulatory Consultant by Avista Corporation, Spokane, Washington. During that time he assisted the utility in the successful collaborative relicensing of its 790 Mw Noxon Rapids and Cabinet Gorge Projects on the Clark Fork River in Montana and Idaho.

During 1998 and 1999, Fred appeared as a speaker at FERC Outreach Sessions for Alternative Licensing Processes in Maine, Oregon, Washington, Michigan, Montana, Idaho, Utah, Alaska, and California. He also made presentations on collaborative processes at the National Conservation Training Center (NCTC) Hydropower Workshops in Lacey, Washington, Clear Lake, California, and Charleston, South Carolina. In late 2001, during the Uprating and Refurbishing Hydro Projects Conference sponsored by International Waterpower and Dam Construction in Prague, Czech Republic, Fred chaired an international panel entitled "Breaking Down the Barriers."

In 2000, 2001, and 2002 he was a presenter/instructor at a dam removal course offered by the Engineering Department of the University of Wisconsin. During the first half of 2002, Fred was retained by the US Forest Service to participate, as a workshop instructor, in presenting FERC Negotiation for Forest Service Executives. Fred's clients currently include: City of Seattle, Catawba-Wateree Relicensing Coalition, Synergics Inc., Natural Resource Council of Maine, and the City of Fremont, California.

In June 2003, Fred became Executive Director of the Low Impact Hydropower Institute.

**Kerry Brewin** is a fisheries biologist based out of Calgary, Alberta. He worked for Trout Unlimited Canada for more than 12 years; first as consultant working on specific projects and then for eight years as TUC's Alberta Council Manager and Biologist. Previous to that he worked for several years studying salmonid ecology as a Research Associate at the University of Lethbridge. Kerry has a M. Sc. in Zoology from University ofAlberta.

While working for TUC, Kerry was heavily involved in a wide variety of cold water

[13] Note: some members did not participate in all phases of the project.

conservation projects and issues across Alberta, as well as nationally. His works leading TUC's conservation program in Alberta involved such things as: providing technical expertise on numerous conservation projects; representing TUC on numerous multi-stakeholder committees; raising public awareness about issues affecting coldwater resources; and working with industry and government to find cooperative solutions to problems affecting Alberta's coldwater resources. While at TUC, the conservation initiatives he developed won several provincial and national awards including: two Order of the Bighorn Awards; an Emerald Environmental Award; and a National Recreational Fisheries Award. Kerry's involvement in hydro projects range from sitting on a multi-agency committee formed to identify opportunities to mitigate the impacts of TransAlta Utilities hydro operations on Alberta's aquatic resources, to providing review comments on small hydro development proposals.

**Charlton (Chuck) Bonham** is Trout Unlimited's California Counsel, where he is responsible for Trout Unlimited's California Hydropower campaign, and for the California Water Project, which focuses on state water law reform. He has served as Chairman of the California Hydropower Reform Coalition (CHRC) since 2000. His work on the Klamath, Pit, South Fork American, Stanislaus, and San Joaquin rivers in California has been instrumental in establishing favorable conditions for productive negotiations. With Richard Roos-Collins, he represents CHRC in Pacific Gas & Elect. Company's bankruptcy proceeding and associated matters. He received his J.D. and Environmental and Natural Resources Law Certificate from Northwestern School of Law of Lewis and Clark College, in Portland, Oregon. Charlton has published articles on Section 18 of the Federal Power Act and Dam Removal, the Wild and Scenic Rivers Act, and contributed to a Public Lands Law course book. Prior to law school, Charlton spent four years with the Nantahala Outdoor Center, the nation's leading whitewater instruction school, and completed a Peace Corps service in Senegal, West Africa.

**Eric Duchemin** (PhD in Environmental Sciences) is research director of DREXenvironnement, an independent environmental research and consulting group. DREXenvironnement's expertise is focused primarily on GHG emissions from natural and perturbed environments from the energy sector, and on assessment of these gases for national inventories. Dr. Duchemin has written numerous reports and scientific papers on GHG gas emissions from hydroelectric reservoirs (Canada, US and Brazil), as well as provided expert testimony on environmental impacts of small and large hydroelectric reservoirs. He is currently involved as a lead author in the Land-Use and Land-Use Change section of the *IPCC-Good Practice Guidance for National GHG Inventories*. Dr. Duchemin also serves on the board of directors of the Union Québécoise pour la Conservation de la Nature (UQCN), the largest environmental NGO in Québec, and heads its Energy and Climatic Change committee.

**Matthew W. Foley** is the co-proprietor, Azure Mountain Power Company, St. Regis Falls, N.Y. (FERC #10442, 750 kw ), and Riverat Glass & Electric, Wadhams, N.Y. (FERC #9691, 500 kw) hydroelectric projects. He is on the Board of Directors, and is past President, Boquet River Association (www.boquetriver.org), and is a member of the Wadhams Volunteer Fire Company, Adirondack Ski Touring Council, Adirondack Mountain Club, Adirondack Nature Conservancy, and AAAS. In the 1970s, he built and operated a glassblowing studio in Plainfield, Vt., with three partners. Seeking energy self-sufficiency, he looked for a waterpower site suitable for producing the 30 kw needed for electric glass melting, and inspected dozens of abandoned mills and hydro plants in New York and New England. He purchased the defunct 1904 vintage 400 kW hydro plant in Wadhams, a small19th century mill town in the farmland between the Adirondacks and Lake Champlain, restored the smaller of the plant's two generating units (100 kW) to operation, and built a glassblowing studio in the plant.

In subesquent years, in response to PURPA, he restored the larger 300 kW unit to operation and started selling electricity into the grid. In the course of plant restoration, he discovered that the NY Department of Environmental Conservation had begun annually stocking Salmon upstream a few years earlier. To bypass outmigrating smolts, he changed the intake to an angled bar rack, designed with the help of an environmental analyst at the NY Public Service Commission. In the 1980s, he prepared and filed a FERC Exemption from Licensing for the never-licensed plant. He added a third generating unit, 150 kW, and studied the effectiveness of fish bypass see Migration of Landlocked Atlantic Salmon Smolts and Effectiveness of a Fish Bypass Structure at a Small-Scale Hydroelectric Facility, Nettles & Gloss, North American Journal of Fisheries Management 7:562-568, 1987). He also designed and constructed a second hydro plant at an old mill dam in St. Regis Falls, NY.

Over the years, Matt has held various hydro related consulting jobs, most in the Adirondacks, some paid, some not. In 1995-96 he spent a total of about two months in the mountainous Altai Republic of southwestern Siberia, assessing small hydro resources as a volunteer for Ecologically Sustainable Development, Inc., a nonprofit land use consulting firm based in the Adirondacks. ESD, founded by former Adirondack Park Agency staffers, was under contract to the Altai government to prepare a land use plan for the Republic's vast and beautiful open spaces which, like the Adirondacks, are within a day's drive of millions of urban dwellers (Russians who no longer face domestic travel restrictions and increasingly possess automobiles). Our job in the hydro field was to help kill an environmentally destructive 180 meter high Katun River dam on which construction had actually started in the last days of the Soviet Union, and to point out the desirability of smaller alternatives which would be more affordable, have negligible environmental impact, and better accommodate the needs of the electrically underserved population. Matt has a Regents Diploma, South Glens Falls Central School, South Glens Falls, N.Y. (1966) and an A.B. (Psychology), from Hamilton College, Clinton, N.Y., 1972

**Todd Hatfield** is a consulting biologist based in Victoria, British Columbia, working in the fields of water resources planning and research. Most of my work his hydropower-related on behalf of government, First Nations, and industry. A primary focus over the last two or three years has been water use planning, a multi-objective public process to adjust operations at existing hydropower facilities in BC. More recently, he has been working with the provincial and federal governments to develop "fish-based" instream flow standards for BC streams, a project motivated primarily by hundreds of proposals for small hydropower in the province, though it will also cover consumptive water uses.

**Ken Kimball** — Director of Research for the Appalachian Mountain Club, the oldest conservation organization (1876) in the US with over 94,000 members whose mission is to promote the protection, enjoyment and wise use of the mountains, rivers and trails of the Appalachian region (Northeast US). I have a Ph.D. in limnology and am a steering committee member of the Hydropower Reform Coalition, a board member of the Low Impact Hydro Institute, and have been one of the leads on many of the hydroelectric relicensings in New England over the past decade. Because New England purchases considerable hydro power from Canada and our members also use the rivers of Canada for recreational and aesthetic purposes, our organization has an interest in seeing a more universal North American approach to defining "green hydro".

**Lydia Grimm** – Executive Director, Low Impact Hydropower Institute (through May 2003). Lydia was Executive Director of LIHI since September of 2000, and was responsible for overseeing implementation of the Low Impact Hydropower Certification Program, a voluntary certification program to identify environmentally acceptable hydropower facilities in the U.S. Prior to her work at LIHI, Lydia was an attorney for federal natural resource agencies, including the US Forest Service and the Bureau of Indian Affairs. She provided legal counsel to the agencies as they participated in hydroelectric project licensings throughout the country, helping them to assert license conditions for the protection of National Forest resources and tribal trust resources affected by hydropower projects. She has over ten years experience in hydropower licensing proceedings throughout the United States. Lydia has an environmental law degree from Northwestern School of Law at Lewis & Clark College in Portland, Oregon, and a B.A. in anthropology from the University of California at Berkeley.

**Annette Lutterman** is currently working on an interdisciplinary doctoral thesis out of the Biology department at Dalhousie University. Her research is focused on evaluating the cumulative effects of hydroelectric development on riparian habitat in the Churchill River watershed. It integrates historical and current ecological data and knowledge from different sources including botanical surveys, local environmental observations over time, and satellite imagery.

She has worked with the Innu Nation since 1998 on several contracts related to the proposed hydro developments on the lower sections of the Churchill River in Labrador. This included coordinating two sessions of community consultation in Sheshatshiu and Utshimassits, and representing the Innu Nation on an environmental task force evaluating baseline research for the proposed development.

She is familiar with many of the existing large hydro projects in Canada and other parts of the world. This includes a multidisciplinary evaluation of the environmental and social effects of a hydro/irrigation project in Indonesia during the course of her masters of environmental studies work.

**András Mák** is an anthropologist based in Quebec City. He spent most of his carrer working with first nations of Quebec and Labrador, more specifically with the Innu. His mandates led him to be closely involved in the Innu Treaty process, which involves the province of Quebec and the Canadian government, and in the follow-up of many major development activities on the territory, mostly hydroelectric and military. His interest in small scale « green » hydro projects originates from the current discussions between the Innu and the province of Quebec on future development of such facilities on Innu lands and the general debate in the province of Quebec on this matter.

**Steve McAdam** is a biologist specializing in the effects of hydroelectric dams and flow regulation on fish and riverine ecosystems. He has worked on these issues through his involvement with industry, government agencies, and university research. He is currently involved in the Water Use Planning process, a program to redress environmental impacts due the operation of BC Hydro´s dams. Some specific areas of interest include the effects of flow regulation on reproductive dynamics of fish, endangered species recovery planning, the comparison of the tropical and temperate impacts of river regulation, and the thermal effects of dams. He is senior hydroelectric impacts biologist with the British Columbia Ministry of Water, Land and Air Protection.

**Craig Orr —** Dr. Craig Orr, an ecologist and salmon conservationist, is the Associate Director of Simon Fraser University's Centre for Coastal Studies, and the Executive Director of Watershed Watch Salmon Society. Orr has worked as a naturalist, endangered species researcher, and seabird ecologist. For more than 15 years he has promoted salmon conservation in British Columbia, focusing on coho salmon, selective fishing, water, and sustainable aquaculture. Orr has written more than 200 articles on salmon, the environment, and the outdoors in some 25 magazines and newspapers, and authored numerous technical and scientific reports. He also provides technical advice to the Bridge Coastal Restoration Program (Chair), Pacific Salmon Endowment Fund (technical committee), Vancouver Foundation (environment committee), Canadian Parks and Wilderness Society (marine committee), Sierra Club (marine committee), Fisheries Advisory Team (water use planning), and the BC Aboriginal Fisheries Commission (policy analysis group).

**Andrew Pape-Salmon** was the Director of Sustainable Energy at the Pembina Institute. (He is now Senior Policy Advisor in the Alternative Energy Policy Branch of the B.C. Ministry of Energy and Mines.) He is a professional engineer and resource manager with a focus on sustainable energy policy, low-impact renewable energy technologies, business feasibility assessment and community energy planning.

Andrew has worked extensively on the implementation of low-impact renewable energy and energy efficiency at a community level with First Nations and municipal government partners in Alberta, British Columbia, the Yukon, and the Northwest Territories. The emphasis of much of this work is on low-impact hydropower.

He led Pembina Institute involvement in the certification of low-impact "green" renewable energy sources in Canada through a Pembina Institute publication in 2000 as well as its involvement in the process to develop new Eco-Logo guidelines for Canada.

Andrew was the Pembina Institute representative on the Clean Air Renewable Energy Coalition, an organization of businesses, ENGOs and municipal governments that advocate for changes in federal, provincial, and territorial energy policies to support growth in low-impact renewable energy supplies in Canada. He was a Director of the Canadian Wind Energy Association from 199-2002. During his term, he was the co-author of the "Wind Vision for Canada" and led the "Government Relations" subcommittee.

**Philip Raphals** is co-founder and director of the Helios Centre, a non-profit research centre which, since its founding in 1996, has become a leading source of independent policy analysis concerning sustainability in the energy sector. His work has focussed on a wide range of subjects related to sustainable energy policy, ranging from resource planning to green power certification, transmission policy and market design. He has devoted particular attention to the interplay between competition and regulation and to the environmental implications of trade in electricity. He has authored dozens of reports and studies and has provided expert testimony in numerous regulatory proceedings. He is currently involved in a major study for the Latin American Energy Organization (OLADE) on the lessons of electricity restructuring in the Americas.

Since the early 1990s, when he was associate scientific coordinator for the environmental assessment of the Great Whale project, his work has addressed many issues related to hydropower development. Last year, he authored a widely quoted book-length study entitled *Restructured Rivers : Hydropower in the Era of Competitive Energy Markets*. Philip chairs the Renewables Advisory Panel to the U.S.-based Low Impact Hydropower Institute (LIHI), and participated actively in the development of the new Ecologo electricity guideline.

**Richard Roos-Collins** is the Litigation Director for the Natural Heritage Institute, a non-profit natural resources consulting firm comprised of experienced conservation lawyers and scientists. Richard has extensive experience with hydropower project licensing proceedings and settlement negotiations, and is a Steering Committee member of the Hydropower Reform Coalition. Richard is an experienced trial attorney representing both public agencies and non-profit organizations in natural resources policy, energy, hazardous waste, and air quality laws. He served as attorney-adviser in the Office of General Counsel, U.S. Environmental Protection Agency for development of regulations governing smog, acid rain, and waste incineration. He was the Deputy Attorney General for the Public Rights Division, California Department of Justice, where he prosecuted cases of improper management and disposal of hazardous wastes. He served as Vice-Chairman of the Water Resources Subcommittee of the American Bar Association, and is a member of the Governor's Advisory Committee on the Central Valley Project Transfer in California. He is attorney for California Trout in the Mono Lake cases. He received his Juris Doctor degree with honors from Harvard Law School in 1986.

**Charles Rosenfield** operates several small hydro stations, one in Rhode Island, and one in Connecticut. His interest in this project is that we all consider ourselves environmentalists with the goal of promoting green power use. He would like to see a standard developed for hydro projects that works for both the various river advocacy groups and the hydro industry.

**Steve Rothert** is American Rivers' Associate Director of Dam Programs for the California Field Office, where he works on hydropower dam relicensings and dam removal efforts. Prior to this position, Steve worked for three years in Botswana, where he represented International Rivers Network on dam and other river issues throughout southern Africa. Prior to this international work, Steve worked in American Rivers' DC office as Coordinator of the Hydropower Reform Coalition. Steve received an M.S. in water resources management at the University of California, Berkeley.

**Dr. Michael J. Sale** is a Distinguished Staff Member in the Environmental Sciences Division of Oak Ridge National Laboratory (ORNL), where he has worked since 1980. He also serves as Leader of the Water Resources Group in ESD. His educational background includes a B.S. in Zoology from the University of Michigan, a M.S. in Aquatic Ecology from the University of Illinois, and a Ph.D. in Environmental Engineering and Science from the University of Illinois. He manages assessment projects at ORNL for the Federal Energy Regulatory Commission and is Principal Investigator for environmental R&D under the Department of Energy's Hydropower Program. Mike has broad experience in basic and applied research on the environmental problems of the hydropower industry. He recently served as a member of the Water Sector Assessment Team for the National Climate Change Assessment, and he is a Fellow Member of the American Water Resources Association.

**Fred Whoriskey** was born and raised in Massachusetts. He attended Newton High School, graduated from Brown University in Providence, Rhode Island in 1976, and then went to work for Woods Hole Oceanography Institution (WHOI) in Woods Hole, Massachusetts, after spending one year on an aquaculture project; he became Manager of WHOI's Matamek Research Station in Sept Iles, Quebec. This field station was concerned with Atlantic salmon biology and stream ecosystem structure and function. Fred left WHOI to do Ph.D. studies at l'Université Laval in Quebec City. He graduated in 1984 and held a NATO postdoctoral fellowship at the University College of Wales in Aberystwyth, UK. In January 1986, he was hired as an Assistant Professor at McGill University and promoted to Associate Professor in 1992. He joined the Atlantic Salmon Federation full-time in 1995 as its Natural Resource Scientist, and became V.P. Research & Environment in 1996.

Fred's research interests are in fish biology and ecology, and the impacts of exotic species on native ecosystems. He is author or co-author of 45 papers in refereed journals, as well as many technical reports and editor of two books. He has also been heavily involved in public policy issues, especially with regards to environmental impact assessments. He was appointed Deputy Scientific Coordinator of the Great Whale Scientific Support Office in 1993. There he advised the five Federal and Provincial panels and Commissions reviewing Hydro-Quebec's Environmental Impact Statement on the Great Whale project and helped analyze the conformity of the Environmental Impact Statement. He has served as a scientific advisor to the Moose River/James Bay Coalition, the Grand Council of the Cree (Quebec), and the Atlantic Salmon Federation on hydro-electric development on the Moose River, Great Whale River, and Ste. Marguerite/Moisie Rivers respectively. He has helped the International Development Research Centre with projects in Tanzania, Uganda and Kenya, and has worked extensively in public education. Presently Fred serves on the Board of AquaNet (Canada's National Centre of Excellence in Aquaculture), the Huntsman Marine Science Centre, the Atlantic Salmon Broodstock Development Program, and the St. Lawrence Valley Natural History Society. He is a frequent public speaker. Fred is married to Lise Paquin, and has three children (Sophie, Marc and Kim).