

## Strategic and temporal substitution among anglers and white-water kayakers: the case of an urban regulated river

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## **Abstract**

Urban recreational landscapes, including rivers, are subject to increased pressure and more dynamic use. Recreationists apply a range of behavioral strategies to maintain as much as possible of their preferred experiences and outcomes in changing environments. While resource and activity substitution have been subject to several studies, less is known about strategic and temporal substitution. We studied how whitewater kayakers and anglers applied such strategies to cope with a highly variable river environment due to hydro-peaking, a production scheme expecting to become more common to adapt hydro power to other sources of renewable energy. A range of behavioral strategies including *ad-hoc* and planned temporal substitution, tactical and spatial substitution were identified, making recreationists better able to cope with the unpredictable river. While kayakers used mostly temporal and spatial substitution, anglers also applied tactical substitution such as changed gear and tackle, and improved their skills specifically aimed at unfavorable conditions. Future research should seek to eventually confirm and expand the identified categories of temporal and strategic substitution, for other activities and in other countries and regions.

## **Management implications**

The study highlights a range of cost-effective, yet useful mitigation alternatives that are highly relevant as many countries currently are reviewing their policies and licenses for hydro power. There is an increased focus on renewable, climate friendly energy, and the need to combine different types of renewables put special focus on hydro-peaking from impoundment facilities. Parallel to this, many countries are conducting processes of relicensing, which launch opportunities to better address multi-functional aspects of regulated rivers and reduce negative impacts of hydro-power. Increased and formalized contact between users, better information and physical modifications were all highly relevant mitigating measures that would enhance the suitability of the study area for recreation, within the existing regulation regime, several of these measures specifically improving temporal substitution.

**Key words:** River recreation; hydro power impacts; substitution; hydro peaking; mitigation; stream-flow.

## 1 Introduction

Rivers, and especially regulated rivers in urban areas, typically have multiple user interests (Marmulla, 2001). Many rivers have been subject to hydropower development, and today hydropower supply one sixth of the world's electric power. At the same time, many regulated rivers produce significant recreational benefits. Benefits from recreational use of rivers cover a wide range of activities and can be assessed from several disciplinary perspectives (see Driver, Brown & Peterson, 1991; and Parkkila et al. 2010 for overviews). Important possible benefits of river recreation include economic, psychological, physiological, social and cultural, and ecological benefits. Hydro power stations can be classified as diversion (run-of-river) and impoundment facilities. Diversion facilities typically channel all or portions of the water through an intake tunnel, down a penstock to the turbine and power station, and then release the water back into the river. Such power stations have only a small reservoir with minimum storage capacity. Impoundment facilities are normally larger hydropower systems based on one or more reservoirs which gather water from several parts of the watershed and store it in reservoirs. Such facilities can be regulated with different schemes and objectives, often with the aim of supplying electricity in seasons with low natural run-off, or in periods of high demands for electricity. Hydro power development affects the biophysical environment in a range of ways, and thereby also affects the watershed's suitability and attractiveness for different types and segments of recreational user groups (Brown, Taylor & Shelby, 1991; Brunson & Shelby, 1993; Teigland, 1999). Reduced flow, loss of whitewater stretches, reduction in fish and wildlife production, altered seasonal flow, landscape alterations, and secondary effects such as new roads, power lines, and disposal areas for tunnel material, that all can affect the landscape and the experience attributes, are some of the typical impacts. Recreationists make several tradeoffs in their choice of activities and places to perform them, including assessing impacts from hydro-power. These tradeoffs and the main alternatives have within the recreation literature typically been analyzed within the framework of substitution (Shelby & Vaske, 1991; Gentner & Sutton, 2008).

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Forecasts of climate change have increased the focus on renewable energy. Consequently, watersheds utilized for production of electricity are receiving increased pressure. Traditional practices for operation of hydropower facilities are challenged, and many regulated river systems may be exposed to more dynamic discharge patterns (Knutzen & Ruud, 2011). Important drivers are for instance the wish to increase production or maximum load (effect), to adapt production to demands or to gain synergies from coupling hydro power with other sources of renewable energy, especially wind power. The consequence might be a more unpredictable river, in terms of discharge variability, often referred to as hydro-peaking or power-peaking operation. Hydro-peaking is defined as short-term variations in production due to variations in demand and pricing. Typically, the powerplant is utilized at a maximum during daytime and on weekdays, while water is stored in the reservoir during the night and weekends when demand is less. What are the consequences of such changes for recreational use? How do recreationists understand and cope with such changes through processes of substitution? In this paper, we aim to explore these questions in a Norwegian river subject to hydro-peaking.

## 2 Study Area

The River Nidelva in Trondheim, Central Norway, has its sources in the mountains bordering to Sweden. Several rivers enter into the Lake Selbusjøen (58 km<sup>2</sup>), and the lake drains out in the River Nidelva, which has a total length of 30 km down to the sea (Figure 1). The average annual discharge is approximately 102 m<sup>3</sup>/s (3600 ft<sup>3</sup>/s). The watershed's history regarding hydro power production dates back to the early 1900s. Today, the regulation is based on the head from the lake Selbusjøen (157 m a.s.l.) and down to the outlets at the Leirfossen waterfall (13 m a.s.l.). Power production is partly based on run-of-river power plants and partly on the Bratsberg powerplant which is based on an impoundment reservoir in the lake Selbusjøen. The Bratsberg powerplant is run with significant variations in production discharge on a daily, weekly and seasonal basis, in line with the definition for hydro-peaking. Consequently, the discharge in the study area of River Nidelva below Leirfossen may

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change from more than 100 m<sup>3</sup> to the legally set minimum discharge of 30 m<sup>3</sup>/s within a timespan of less than an hour. However, schemes might differ from day to day, and the changes in discharge are often unpredictable.

### **Figure 1 approximately here!**

Our study area consisted of the lower 8 km section of the River Nidelva, from the Leirfoss waterfall down to the tide-influenced lower section. This part of the river is running through the town of Trondheim, the largest city of Central Norway with a population of approximately 175 000, and is surrounded by roads, industry, living areas and parks. A narrow riparian zone with forests, walkways and a mix of undeveloped areas and park-like areas frame the river, being important areas for recreation. Of specific importance are the two water-based activities angling and white-water kayaking. The study area is equal to the anadromous section of the river, which is popular for Atlantic salmon (*Salmo salar* L.) angling. Annually, the salmon catch in the river varies between 3 000 kg (appr 6600 lb) and 8 000 kg ([www.tofa.no](http://www.tofa.no)). The fishing season runs from 1 June to 31 August. Annually, some 150 - 200 different anglers are in the license register for the river. Most of the salmon fishing is administered by Trondheim Fishery Administration (TOFA), a private-public governance body. There is restricted access to specific beats (each fishing license on this river is limited to a fishing section, termed "beat"), and access is decided through a lottery. Rapids on the same section are also popular among whitewater kayakers. This section is in river classification terms categorized as an "easy category 2" (Personal communication Dan Östling, [www.americanwhitewater.org/content/Wiki/safety:start#vi.\\_international\\_scale\\_of\\_river\\_difficulty](http://www.americanwhitewater.org/content/Wiki/safety:start#vi._international_scale_of_river_difficulty)). Kayaking can be done the whole year, but most of the kayaking activity takes place from the beginning of April to the end of October, depending on weather and temperature conditions. Two local kayak clubs have approximately 100 active members. While salmon angling has a long history on the river with roots in the 1830s, kayaking is a more recent phenomenon emerging in the 1980s. Unlike angling, kayaking can be done freely as part of the common right of access. The anglers

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consider Nidelva interesting for several reasons. Some beats are well suited for fly fishing and others for bait or spoon fishing or fishing from a boat. Being a deep and sometimes fast-flowing river, it poses angling challenges making it less suitable for beginners, according to our informants. For kayaking, the river is appropriate for beginners as well as having challenging areas suitable for more experienced paddlers. Especially, some standing waves on the lower rapids offer sufficient challenges even for the more experienced.

### **3 Theory: Substitution as behavioral responses to regulation and hydropeaking**

Whitewater kayakers and salmon anglers are recreationists that often demand very specific setting attributes of the rivers they use for their activities (Brown, Taylor & Shelby, 1991; Brunson & Shelby, 1993; Whittaker & Shelby, 2002; Whittaker, Shelby & Abrams, 2006). In addition, they might also establish more affective bonds to rivers they actively use, labeled place attachment (Bricker & Kerstetter, 2000; Vorkinn & Riese, 2001). The concept of recreation substitution has been used to understand how recreationists make choices and try to adapt or cope when they are faced with changes in their recreational landscape, including hydro power development (Shelby & Vaske, 1991; Gentner & Sutton, 2008). Recreationists might experience changes that influence their activities and the benefits they are seeking. The concept of substitution has been applied within frames of socio-psychological or economic theories suggesting that when recreationists experience constraints or changes that affect their outcome, they will look for alternative strategies that will enable them to resemble as much as possible of the outcomes they seek (Brunson & Shelby, 1993; Gentner & Sutton, 2008). Typically, one river locality for kayaking might be substituted with another, or fishing for one species might be replaced by fishing for a different one.

The research tradition on substitution is based on the original framework of Hendee & Burdge (1974). They defined substitution as “interchangeability among activities in satisfying participant’s motives, needs and preferences”. Brunson & Shelby (1993) expanded this to the interchangeability of recreational experiences “such that acceptably equivalent outcomes can be achieved by varying the

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timing, means of access, setting, resource or activity". Substitution is obviously a multidimensional concept, which Shelby & Vaske (1991) illustrated in a simple two-by-two typology of activity and resource substitutive alternatives (Figure 2).

**Figure 2 appr. here.**

Most of the substitution research within the social-psychological perspective has focused on activity and resource substitution (Figure 2). Generally, resource substitution seems to be preferred over activity substitution (Brunson & Shelby, 1993), for instance that river anglers would chose to move to another river over changing the activity to something different. However, research on activity substitution also document that different outdoor activities can replace each other, for instance that fishing can be replaced with hunting (i.e. Manfredo & Anderson, 1987; Sutton & Ditton, 2005). Within angling, species substitution is another issue that has been studied, being a highly relevant response in multi-species fisheries, when for instance an attractive species is protected or strictly regulated while others are not. Fishing for Atlantic salmon is in general a single species fishery with the exception of the possibility to combine with fishing for anadromous brown trout (*Salmon trutta* L. - sea trout). However, in the River Nidelva species substitution is not a relevant strategy because sea-trout is protected.

However, a key finding is that the willingness to apply activity or resource substitution are lower among those who are highly specialized (cfr Bryan, 1977), involved or committed (cfr. Havitz & Dimanche, 1997; Iwazaki & Havitz, 1998; Bricker & Kerstetter, 2000; Gentner & Sutton, 2008). Shelby & Vaske (1991), who studied salmon anglers in New Zealand, found that few salmon anglers were willing to substitute their preferred river with other nearby rivers with similar attributes, a finding that partly echo a place-dimension going beyond a "rational" consideration of attributes, motives, satisfaction and outcomes. Some anglers associate fishing with certain resources, places and attributes, and therefore do not perceive other sites as relevant substitutes even though other sites might share apparently similar characteristics. In close-to-home settings, which are the case for most

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of the users in this study, place-attachment comes in a special context. While place attachment might vary significantly among the users of close-to-home settings, situational factors (for instance available time, transportation) might make strategic and temporal substitution (upper left box in Figure 2) the only relevant adaptations.

In sum, the existing literature on substitution among anglers clearly suggests that response in terms of resource and activity substitution is suboptimal and might involve reduced outcomes. Temporal and strategic substitution might hold more interesting potential in terms of mitigating changes to recreational settings. Brunson & Shelby (1993) argued that substitute experiences that maintain as many features as possible of the original experience are most often preferred (over resource and activity substitution) suggesting strategic and temporal substitution as superior to the other substitution alternatives. They also discussed how place attachment poses special challenges to substitution, and suggested more research on strategies chosen by those with a strong attachment to a specific location. However, the substitution literature does not elaborate much on temporal and strategic substitution it contains few examples of these types of adaptation. Temporal substitution is rather self-explanatory; recreationists use the same setting but at different times than originally planned for or preferred (Brunson & Shelby, 1993). Strategic substitution is more vaguely explained in the literature. Brunson & Shelby (*ibid.*, p.71) states that "Strategic substitutes generally occur at the original time [and setting] but may involve other adjustments". An example of strategic substitution is then mentioned, where river runners who are denied permits to restricted rivers join with parties who got access (McCool & Utter, 1982, cited in Brunson & Shelby, 1993).

The aim of this study is to gain more insight into temporal and strategic substitution, by studying how recreationists adapt to a highly variable recreation environment. Our research questions were:

1. How do river recreationists apply temporal and strategic substitution in a dynamic, near-home river that is subject to multiple uses, and where discharge changes in an unpredictable manner?



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2. What subcategories of temporal and strategic substitution can be identified?
3. What types of mitigating actions and measures are seen as important to enhance recreationists' ability to conduct temporal and strategic substitution?

### **4 Method and materials**

Data were gathered by focus group interviews (Kitzinger, 1995; Hesse-Biber & Leavy, 2011). This method is considered especially useful to gain insight into the way particular issues are discussed in relatively homogenous groups, and also has the advantage of being of social nature which might provide better information compared with personal interviews (Krueger, 1988). Focus group interviews are gradually more used besides personal interviews in academic studies (see for instance Witmer, Boccato & Henderson, 2011 for a recent example from the recreation literature). The method is considered suitable for exploring user's thoughts, feelings and opinion on specific topics. We recruited participants from two user groups; salmon anglers and whitewater kayakers, to a total of four groups, each consisting of three to five representatives for the two activities (Conradson, 2005). Potential participants in the focus groups were recruited through discussions with the administrative employee of TOFA, and the board members for the two kayak clubs responsible for the whitewater activities. Each participant was granted a small remuneration of NOK 500 (Euro 60) for participation in a focus group. Our original aim was to establish groups with beginners and experienced from each of the two categories of use, to compose rather homogenous groups (Hesse-Biber & Leavy, 2011). However, it became evident that there were few inexperienced anglers among the regular users, and thus we ended up with one generalist angler group and one specialist group instead (Bryan, 1977). For whitewater kayakers, we succeeded in constructing one group with inexperienced and one with experienced users. Basic characteristics of the participants are presented in Table 1.

**Table 1 appr. here!**

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We developed an interview guide with open ended questions centering around the following themes; participant background (as anglers/kayakers in general and their experience history on the River Nidelva more specifically); pros and cons of the River Nidelva as a place for angling/kayaking and important attributes of the River Nidelva; knowledge about the regulation and the hydro peaking schemes on the river; if and how recreationists eventually adapt to hydro peaking and, finally, their thoughts on potential mitigating actions to improve their activity opportunities on the river. Focus groups are considered a method where the moderator (researcher) can influence the direction of the debate, for instance the way information is presented beforehand, structuring and composing the groups, and in the outline and formulation of the interview topics (Stewart et al., 2007). These limitations apply equally to individual interviews and should be considered in every qualitative study. We were careful not to provide specific information about hydro-peaking beforehand, and the invitation focused mostly on a general interest in learning about and discussing the informant's recreational experiences on the River Nidelva.

The focus group meetings were organized by a facilitator and an assistant. By using two researchers we ensured that all topics in the guide were covered, that adequate follow-up questions were presented and that all informants were given the opportunity to present their knowledge, views and opinions. All four focus group interviews were video recorded after getting the approval of the participants. Video filming has the advantage over audio tape recording in that it is easy to identify the speaker within the group, and it also makes it much easier to assess for instance irony and gesticulations used to underline oral messages. The four interviews were planned to last no more than two hours, and lasted between 93 and 118 minutes. Each focus group ended with a summary by the facilitator, where we briefly recollected the discussion and asked for corrections or additions to our summary from the participants. All four interviews were transcribed word for word.

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The analysis was based on a qualitative case study approach (Creswell 2007). The goal of the sampling plan was not to represent the full populations of salmon anglers and kayakers, but rather to gain an in-depth understanding of how these recreationists use, understand and adapt to their recreational environment subject to hydro-peaking. A main goal for the analysis was by direct interpretation to identify patterns of temporal and strategic substitution by looking for correspondence between the anglers and kayakers. The considerable quantity of written information was first coded, then thematically organized and condensed, and key patterns and themes were identified and conceptualized (Creswell, 2007) with reference to the existing framework of substitution. Both researchers cooperated during the analysis.

Focus group discussions, transcriptions and analyses were all conducted using Norwegian language. Translation of analyses and citations into English was done at the stage of article writing. Translation to English was done carefully with the assistance of a trained translator, with the goal of not changing the content and meanings during the translation stage.

The kayakers were generally younger and with a shorter user history, probably also with less place attachment to the study area than the anglers (Table 1), some with only temporal residency in the city. All the anglers had their permanent residency in Trondheim and had lived in Trondheim for a relatively long time, while several of the kayakers were students who lived in Trondheim temporarily. The experienced kayakers had typically been kayaking for five to six years, whereas the inexperienced had one to three years of practice. All anglers had been fishing in Nidelva for at least 15 years, with the most experienced having used the river regularly for more than 50 years. All anglers used the river quite extensively during the three-month season with between 20 and 60 trips per year. Kayakers had a significantly longer season. Quite a few of the kayakers were students and therefore away during the summer, with few were present in July. While the angler informants were men only, four out of ten kayakers were women. It was not possible to recruit any female anglers to our groups,

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reflecting the general salmon angler profile in Norway, with only approximately 5 % being female anglers (Tangeland, Aas, Andersen & Fiske, 2010).

## 5 Results

### General image of the river

The user's experiences of River Nidelva and the key recreational attributes of the river are complex and multifaceted, and did not resemble simple stereotype images of an urban or regulated river only. Its proximity to the city center, within short travel distance for many users, is an imbedded part of how the informants assess the river for recreation, and a main reason why temporal and strategic substitution is more favorable than resource substitution. Despite the fact that both the anglers and the kayakers have alternative, and more "famous" rivers for their activities within an hour's drive from Trondheim, the extreme nearness to home is a key quality of the River Nidelva. Even if the river is regulated, and affected by its location within the city borders, the anglers see it as a living, dynamic, rather secluded and mighty river. They are also well aware that having such a river in the midst of their city within short distance from home is rather unique.

### Behavioral adaptations to hydro-peaking: Temporal and strategic substitution

The anglers had extensive knowledge of the hydro power regulation on the river, both regarding its effect on the fish population as well as its direct impacts on the fishing. All the anglers were also very well aware of the hydro-peaking scheme. This way of maneuvering the river has existed since the power plant Bratsberg was established in 1976. The long history has contributed to the anglers constructing their own term for how the river behaves in periods of much hydro peaking:

*Well, we call it **yo-yo river**, that's the word we use among us salmon anglers when she (the river) is like that (Angler 3).*

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All the anglers had in-depth, shared knowledge of different water levels and how it affects the suitability of fishing and the attractiveness of the different beats. In discussing the regulation, they explicitly referred to for instance how a change from 40 m<sup>3</sup> to 30 m<sup>3</sup> alters fishing opportunities on every beat. The kayakers, mostly the experienced group, were also quite well aware of the varying water levels, and understood that it has to do with the hydropower regulation. But the kayakers are all unfamiliar with the term “hydro-peaking”. The experienced kayakers differ from the beginners in that they have a much clearer understanding of how and why the river changes and at what runoff levels different parts of the rapids are suitable for kayaking. The experienced kayakers are therefore rather similar to the anglers in how they make references to water levels in m<sup>3</sup> when discussing and assessing the river. The beginners lack knowledge to make references to specific discharge levels. Nevertheless, among both anglers and kayakers there was obviously an ongoing exchange of knowledge, experiences and opinions about flow levels and suitability for recreation.

Both groups found the river least attractive at minimum flows. At minimum flow (30 m<sup>3</sup>), the river is generally uninteresting for kayaking. Also, several beats lose their attractiveness for fishing, especially the bigger pools most attractive to boat anglers. The overall availability of good fishing areas was lowest at the minimum flow. The anglers favored stable conditions with medium water levels (50 – 70 m<sup>3</sup>). The kayakers generally preferred somewhat higher water levels, with 60 m<sup>3</sup> as a minimum for good kayaking on the most attractive rapids and waves. However, at higher levels (above 120 m<sup>3</sup>), some of the upper rapids became less interesting.

Unlike the kayakers, the anglers were also annoyed about periods of increasing or decreasing water flows. According to the anglers, rising or falling water reduced the fish’ inclination to bite, adding to the frustration of changing from an attractive flow to less attractive (lower or higher). In addition, rising water after longer periods of minimum water level create periods of very “dirty” water conditions, because rising water tears off dead moss and algae that has dried during the low water period, causing further nuisance and frequent interruptions in the fishing.

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An important adaption for both groups of recreationists is trying to avoid low water situations by temporal substitution (Table 2). However, an almost inherent problem is caused by the fact that periods of low flow generally correspond with people's free time. Evenings and weekends, as well as the weeks of the general staff holiday are times for recreation, and are often the same periods when the main power plant is not at work, resulting in a river on minimum flow:

*I mean, the river has reduced value for recreation just because that it is often low water at times when I have the opportunity to fish. After work, in the weekend and things like that, that's when I can go fishing and that is when the river is often at low flow. This is the worst side of the hydropeaking scheme (Angler 1).*

Nevertheless, temporal substitution was important for both groups of recreationists, and several adaptations tried to make the recreationist take advantage of general flow patterns as well as more daily/current observation of the conditions. This led to ad-hoc as well as more planned temporal substitution. It is unexpected and rapid reductions in discharge that is considered most annoying by both groups. This often happens during the evening, but the exact time for when the powerplant shuts down can vary significantly from day to day. Thus, both the anglers and the kayakers tried to get on the river as soon as possible after work or studies if they observed a good flow, hopefully enjoying a few hours of good conditions. Generally, ad-hoc adaptations were common among both groups. Anglers frequently also took breaks during periods of rising or falling water, unlike kayakers, who were not annoyed by changes per se.

In addition to work and family obligations, limited number of fishing days with fixed dates reduces the opportunity to apply temporal substitution among many of the anglers. Access to the most favorable beats may be available only for a maximum of three days during the season, on predetermined dates (through a lottery before the season starts). Therefore, many people fish independently of the conditions and try to make the best of it, by applying a variety of behavioral adaptations (Table 2). The

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first main category is what we labeled tactical<sup>1</sup> substitution. Technical adaptations involve changes between boat and bank fishing on beats where this applies, change of primary method (for instance spoon vs fly), and changes in gear/weight of sinkers/spoons/fly lines. Lighter gear and tackle as the water gets lower and heavier as the flow increases is the general rule of adaptation. Another tactic among some anglers was to improve skills (Table 2), typically by specializing in fishing at low-water trying to turn it into some kind of “competitive advantage”. They fished low water with lighter gear and at night or in bad weather, aiming to capitalize on the fact that other anglers might be home avoiding the general poor conditions, benefiting from the short periods when the fish are still possible to catch and the river is less crowded.

Another strategy is what can be labeled spatial substitution (Table 2), which is changing the key area for fishing or kayaking within the river. Which beats/rapids and what parts of the beats or rapids that perform well, depend on the water level. For anglers, this strategy can be performed within a beat or involve more than one beat, depending on what the angler has available (some might have access to more than one beat, while most will be restricted to changing spots within a beat). For kayakers, the strategy might decide what rapids the kayakers spend the most time on. If anglers can switch beats, they seek the beats dominated by glides and rapids rather than pools when the river gets low. If they cannot switch beat they focus on the spots which still have sufficiently high water velocities. However, this might also lead to crowding as anglers tend to gather on a smaller area, sometimes sparking conflicts between anglers.

**Insert table 2 appr here!**

### Mitigation

After assessing temporal and strategic substitution, we discussed mitigating measures relevant to ease or improve good angling and kayaking opportunities on the river. There were similarities and

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<sup>1</sup> Tactic is defined as “the art or skill of employing available means to accomplish an end” (Merriam – Webster)

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differences in how the representatives of the two activities approached this (Table 3). While the salmon anglers via the Fishery Administration view themselves as a relevant stakeholder group, the kayakers felt marginalized and almost non-existent in the debate about management and mitigation of the river. The salmon angling interests have a long tradition for addressing fishery and conservation concerns in the river. This also includes cooperation between TOFA and the hydro power company on producing hatchery salmon to compensate for impacts from hydro power, stock monitoring and so forth. Their perception as an inferior user group is especially well illustrated by the fact that live website information about the flow level in the river provided by the power company is only available during the angling season, and closes down as soon as the fishing season is over, despite the fact that the kayaking season is much longer. That the anglers are being treated as a more “serious” stakeholder seems to add to the feeling of insignificance among kayakers.

Because of structural changes in the hydro power industry, the local power company in Trondheim has merged into the largest Norwegian hydro power company, Statkraft SF. Both groups commented on the fact that as a consequence of this, responsibility for the daily operations has been moved from Trondheim to a centralized operation station on the west coast of Norway. According to both groups, they felt somewhat estranged by this, making them hesitant about whether and how they should contact the power company. Both groups requested better and more systematic contact with the power company (Table 3).

In terms of more concrete mitigation actions there were both similarities and differences between the two groups (Table 3). Both groups generally wished for more water and higher predictability in runoff during important periods for recreation activities. However, both groups realized that it was rather unlikely that they would manage to bring about any major changes to the overall operation of the power plants on the river. Their main request was therefore for more information about the operations of the power plants, to be able to better adapt through temporal substitution. Today, data about discharge levels are provided “live” on an hourly basis on the internet during the fishing



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season, so that users can check water levels without seeing the river. However, no forecast information is provided. This is, as the informants understand it, because competitive conditions concerning electricity prices make the power company restrained. Nevertheless, in follow-up communication with Statkraft SF, the company confirmed that it would be possible to publish information during the afternoon about production schemes the following day (Vidar Fossøy, Statkraft SF, personal communication). The kayakers also strongly wanted web-based real-time discharge information available on the internet all year round. The fact that this service is only available during the fishing season at the moment becomes a kind of symbol of the low standing of the kayakers.

### **Insert table 3 appr here!**

While the ideal river for both kayakers and anglers resemble a rather natural river, none of the groups are reluctant to manipulate the river and its physical features and character if it can reduce some of the drawbacks following from hydro-peaking. Especially the anglers acknowledged the fact that hydro power regulation also provided some benefits in terms of more water than what would be natural, especially during late summer. However, in the periods of minimum water flow common in late summer, the release of short term freshets of water to bring up fish that gather in the estuary is something the anglers suggest. Both groups also raised the issue of the potential of making physical alterations in the river, to increase suitability for angling and kayaking, especially under low-water conditions. The kayakers discussed the idea of making physical alterations that might secure good waves also at low flows. They told us about people they knew who halfheartedly tried to increase the height of drops at certain locations by expanding sills with blocks of stone during low water conditions. They were familiar with so-called whitewater parks that have been constructed in several urban rivers around the world, improving whitewater kayaking conditions in general, and specifically under low flow. The anglers suggested putting out large stone-blocks to create better currents and more angling spots, again especially to improve conditions under low flow.

## **6 Discussion and Conclusion**

Researchers have called for more research on substitution to guide management, specifically on temporal and strategic substitution (Brunson & Shelby, 1993; Gentner & Sutton, 2008). This study has identified how two groups of recreationists apply different types of temporal and strategic substitution to cope with hydro-peaking dynamics in a regulated river. This category of substitution has previously not been subject to much systematic research despite that it is being considered a favorable and much used strategy (Shelby & Vaske, 1991). Especially in a changing, unpredictable everyday recreational setting, the application of temporal and strategic substitution is highly relevant. In our study, informants have displayed a range of behavioral responses to the setting, trying to gain optimal experiences. Short-term temporal substitution was the most important adaption, applied by both groups. Anglers and kayakers are extremely concerned about getting on the river when the conditions are good, especially in the evenings and afternoons, and they are less eager and tend to suspend or interrupt their activity when conditions are unfavorable. Both ad-hoc and more planned (to the extent possible) temporal adaptations were reported. Anglers were often restricted to limited and fixed times for fishing. While both kayakers and anglers had the study area as a near-to-home recreational area, they probably differed in their place attachment. The anglers generally had much longer use histories compared to the kayakers. Fixed and limited times for fishing (limited access), as well as a stronger place attachment, might explain why anglers displayed a wider range of other adaptations to cope with the impacts from the hydro-peaking compared to kayakers who operate under a free access regime. Angler substitution included a subcategory labeled tactical substitution; which included technological (gear) adaptations, and improved knowledge/skill. The final category identified was spatial substitution, a strategy that was used by both groups.

Our findings add to the existing research on substitution by bringing forward a more elaborated and specific conceptual platform for describing and analyzing temporal and strategic substitution. This platform can be important to assess how user groups make tradeoffs and decide their behavior on

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multiple-use sites, as well as in identifying and selecting mitigating actions and measures (Davenport & Anderson, 2005). Future research, in other locations and also by applying quantitative approaches, should seek to confirm, adjust and expand the typologies of temporal and strategic substitution identified here. Future research should also more cautiously address how possibly different levels of place attachment might affect selected strategies of substitution behavior. In this study, the participants probably had different levels of place attachment, but if this or differences between the two activities (for instance differences in seasons and in access for the two activities) caused some of the observed differences in substitution strategies between the two activities were not investigated further.

This study also adds to the existing knowledge on stream flow and recreation, mostly as it presents results from another context (Norway) than the jurisdiction (the United States) from which most of the existing studies originates (Brown, Taylor & Shelby, 1991; Whittaker & Shelby, 2002; Whittaker et al., 2006). This study confirmed previous findings that both activities had niches for their preferred flow (Whittaker & Shelby, 2002), with flow being an essential determinant of the possibility for having a quality recreation experience. Despite the fact that both activities preferred medium-high flows (Brown et al. 1991), we found that ideal niches varied somewhat between the two main activities, where the anglers preferred somewhat lower flows than the kayakers. There were also somewhat different niches between subgroups of anglers. Boat anglers generally preferred higher flows than bank anglers. We also found that anglers preferred stable flows and disliked periods of rapid changes, while kayakers were not concerned about changes per se. This also echoes previous findings (Whittaker et al. 2006).

The study points to a range of rather simple, low-cost mitigating measures that will increase cooperation and dialogue between the different user interests on the river and increase benefits of recreation. A regular meeting-place for all major users of the river is clearly needed, and an obligatory demand on regulated rivers in other jurisdictions. An appropriate, open and regular meeting place

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would sort out misunderstandings, and reasonable mitigating actions could be discussed in a proper way. Such a forum has, to our knowledge, not yet been facilitated on the River Nidelva. More and better information will facilitate better opportunities for recreationists to apply the identified strategies of temporal, tactical and spatial substitution. Somewhat more ambitious, but not necessarily unrealistic, were the suggestions of physical alterations to restore or replace lost recreation opportunities at low flows. Anglers asked for stone blocks to create spots for better currents, while kayakers referred to channel modifications (whitewater parks) made elsewhere to create whitewater waves that are sufficient also under low-water conditions<sup>2</sup>.

Many western countries are now facing major relicensing processes for hydro-power, often for HP constructed in the 1950 – 1970s (Knutsen & Ruud, 2011; Whittaker et al. 2005). These relicensing processes provide an excellent opportunity to improve conditions for multiple uses, including more temporal and strategic substitution as opposed to resource and activity substitution. This should be based on instigating better cooperation and mitigation programs. These processes would benefit from actively utilizing existing and new research on river recreation, which will also provide important supplements to the dominating research on economics, hydrology and watershed ecology.

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A range of technical papers and recommendations for whitewater parks are available (artificial, in side-channels or in the main river), see for instance [http://www.americanwhitewater.org/content/Wiki/stewardship:whitewater\\_parks](http://www.americanwhitewater.org/content/Wiki/stewardship:whitewater_parks). A literature search reveals no social-scientific analyses of such parks, for instance if there is differences between user groups and motivations on such parks and “natural” rivers.

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**Table 1.** Overview of key characteristics of the focus group participants from the River Nidelva.

<b>Anglers</b>		
Number		6
	Males/females	6/0
	Age	55 (mean) 39-70 (range)
Residency	Trondheim (permanent)	6
	Trondheim (temporary)	0
Occupation	Blue collar	2
	White collar	3
	University Students	0
	Retired	1
<b>Kayakers</b>		
Number		10
	Males/females	6/4
	Age	29 (mean) 22-44 (range)
Residency	Trondheim (permanent)	5
	Trondheim (temporary)	5
Occupation	Blue collar	0
	White collar	5
	University students	5
	Retired	0

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**Table 2.** Temporal and strategic substitution strategies (main and sub categories) observed among salmon anglers and whitewater kayakers in River Nidelva.

Substitution Strategy	Example citation
<b>Temporal substitution</b>	
Advance Ad-hoc	<i>If you see the river is in good shape around 4 – 5 PM, on your way home from work, you cannot have dinner before going out (Kayaker 4, experienced). - Buy a Snickers! (Kayaker 7, experienced).</i>
Pause Ad-hoc	<i>My experience is that when the flow increases and the river rises, you might as well sit down on the bank and have coffee. Because... you might see lots of fish jumping, but they never take, they never take. (Angler 4).</i>
Advance or postpone – planned	<i>Since the river often rises around 7 – 8 AM (when schools, industry start up), I generally go fishing a little bit after that time, as the river settles at this level. (Authors' comment: A bit later than the normal time for morning fishing for salmon). (Angler 3).</i>
Adapting to schemes	<i>I try to "store" the graphs for the variation in the runoff the last days in my head, so I adapt my fishing to the situation the previous days – because often they follow the same scheme for some period of time. (Angler 1).</i>
<b>Tactical substitution</b>	
<u>Technical adaptations</u>	
Changing between boat and bank	<i>But it is clear – on Kroppan (an attractive beat for boat angling) we depend on very specific water levels as you know. If it is 100 m<sup>3</sup> we can fish the middle tailout, but if it is only 30 m<sup>3</sup>, it is almost impossible to fish that spot from boat (Angler 4).</i>
Changing method	<i>I always carry two rods – one fly rod and one spinning rod for worming or spoons. (Angler 3).</i>
Changing gear/tackle weights	<i>It has become a regular habit. That - okay – here we go, river rises, so you automatically dig down in your tackle bag and change your gear to something heavier (Angler 2).</i>
<u>Skills improvement</u>	
	<i>We have started fishing with very light tackle (lines and flies) making it possible to fish from a boat also on low water conditions. It is difficult, very difficult, but if we succeed with the right rig and row correctly, we normally catch a fish. (Angler 5).</i>
<b>Spatial substitution</b>	Change location within river or beat <i>It depends on what you want to do, but at 80 m<sup>3</sup> you get a very good wave at the so called "death-drop", but if the river runs at 60m<sup>3</sup>, you need to move down to the rapids at Sluppen bridge to find a good wave. (Kayaker 7).</i>

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**Table 3.** Preferred mitigating measures and how they enhance identified substitution strategies.

Measure	Substitution type	Example citation
Information		
Improved informal and formal contact between the central power company and recreation interests	General	<i>Previously, there was always someone we could call at the power station. We feel much more alienated towards those who operate the power plant today compared to before (Angler 1.)</i>
Live runoff data on web, year-round	Temporal, Ad-hoc	<i>There is one thing I especially would like to comment on. It is rather “amusing” that the water flow is only available on the internet in the salmon season (Kayaker 5, experienced). – Yes, because when there is no salmon fishing there is of course no one who is interested in water levels (Kayaker 7, experienced). (ironic).</i>
Publish forecast for production (runoff) the next day on web or sms	Temporal, Planned	
Physical alterations		
Rocks to create new fishing spots	Spatial substitution	<i>We have had these dreams about cooperating with the power company, the municipality or someone...Because in other cities in Europe where they have rivers in the middle of the city – they make more out of it. You can create an artificial wave by constructing the riverbottom to endure a good wave which is there all the time. (Kayaker 7, experienced).</i>
Artificial waves for kayaking		
Freshets during periods of low water	General	<i>Freshets would be very useful. I cannot imagine it represents much of a cost for the power company. (Angler 2).</i>

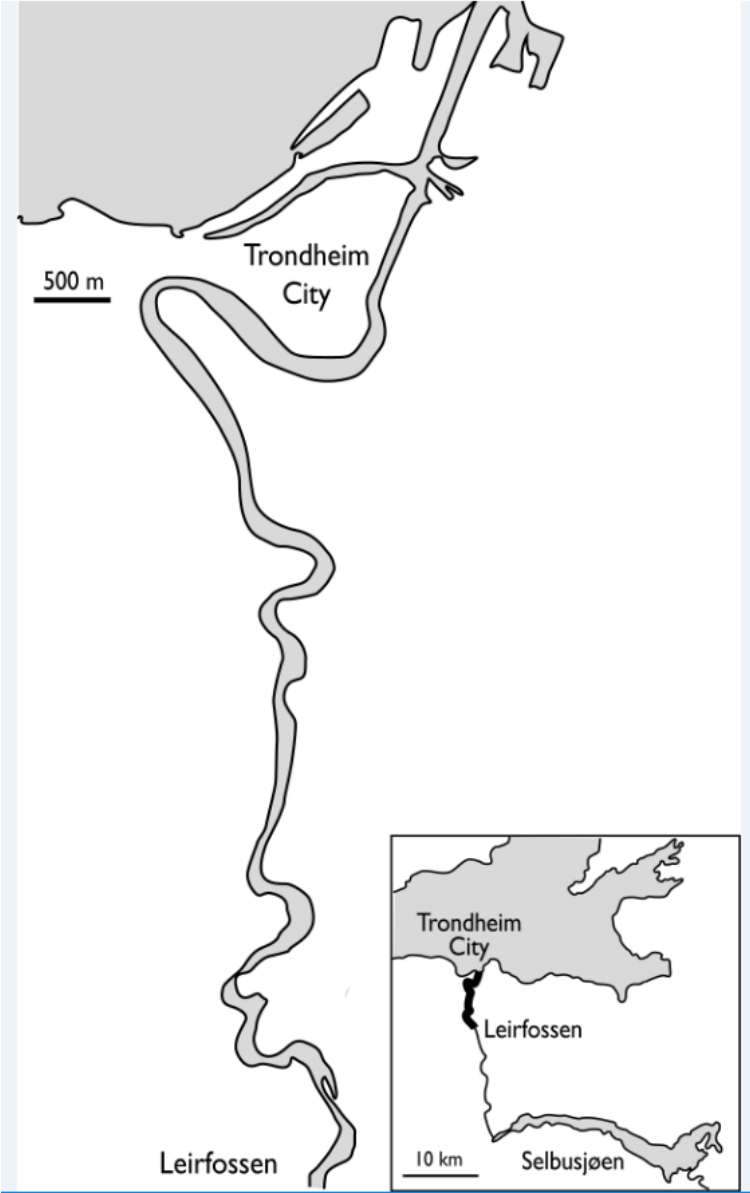


Figure 1:

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Figure 2:

		Resource	
		<i>Same</i>	<i>Different</i>
Activity	<i>Same</i>	Temporal or strategic substitution	Resource substitute: - Site - Species
	<i>Different</i>	Activity substitute	Resource and activity substitute

**Figure legend:**

**Figure 1.** *The study area in relation to the city of Trondheim, central Norway.*

**Figure 2.** *Main types of substitution alternatives in outdoor recreation (from Shelby and Vaske 1991).*