REGULATED RIVERS: RESEARCH & MANAGEMENT, VOL. 9, 93–102 (1994)

EFFECT OF A CHANGED TEMPERATURE REGIME ON THE BENTHOS OF A NORWEGIAN REGULATED RIVER

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ABSTRACT

The lowermost 20 km of the River Surna, north-western Norway receives cool water during summer from a hypolimnetic release mountain reservoir. The benthic fauna is completely dominated by insects. Benthic densities immediately below the power station are much lower than at all other localities. Although benthic densities increase downstream of the power station, they never exceed the densities above. The dominant insect group, chironomids, can be divided into four categories according to their abundance and distribution above and below the power station: (1) rare or absent above, but common or abundant below; (2) abundant or common above but rare or absent below; (3) slightly less abundant below; (4) unchanged abundance. No major differences in the species composition were recorded for stonefilies, mayflies and caddisflies.

KEY WORDS River regulation Temperature Chironomids Stoneflies Mayflies Caddisflies Density Species composition

INTRODUCTION

High altitude storage reservoirs, constructed by damming natural lakes which then feed valley power stations, are the most common type of river regulation scheme in Norway. Most of the impact assessment studies have been carried out on the storage reservoirs, although recently more attention has been given to the effects on rivers. However, there are still few studies on the benthos compared with the fish fauna. Through the 'Weir project' (Bækken *et al.*, 1984; Fjellheim *et al.*, 1993) and other Norwegian studies in regulated rivers (Brittain *et al.*, 1984; Lillehammer and Saltveit, 1984), more information has been obtained.

Thermal changes are pronounced below deep release dams or power stations receiving water from stratified reservoirs (Ward, 1976). Generally, water released from the hypolimnion of reservoirs leads to decreased river temperatures during summer and increased temperatures during winter, compared with unregulated conditions. Most of the studies on hypolimnetic release and the effect of temperature have been carried out in North America (Ward and Stanford, 1979), where major faunal changes have been recorded.

Very little information on this problem exists from Norway. According to Raddum (1985) and Fjellheim *et al.* (1993) a reduced summer temperature of about 3°C and an increased winter temperature of 1–2°C in Aurlandselva, western Norway, gave rise to an increase in numbers, but a reduction in biomass of the benthic fauna. This was a result of smaller individual size.

The River Surna in the northern part of western Norway receives water from a high mountain reservoir. Owing to transfer of water to the reservoirs in the mountains, the river flow is reduced above the power station throughout the year. Below the power station, the Surna has increased winter flows and reduced summer flows (April–August) and peaking often occurs. Furthermore, deep releases from the reservoir lead to colder water from May to August/September, which is the growth period of the two most important fish species, Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*). In contrast, the water is warmer in the winter below the power station (Roen, 1980). Large differences in fish growth were found above and below the power station, fish being significantly smaller below the power station (Saltveit, 1990).

No benthic studies were carried out before regulation. However, as temperature conditions were virtually unchanged above the power station, the effect of changes in temperature can be studied by comparing the fauna above and below the power station.

CCC 0886–9375/94/020093–10

Received 17 January 1994
Accepted 12 April 1994

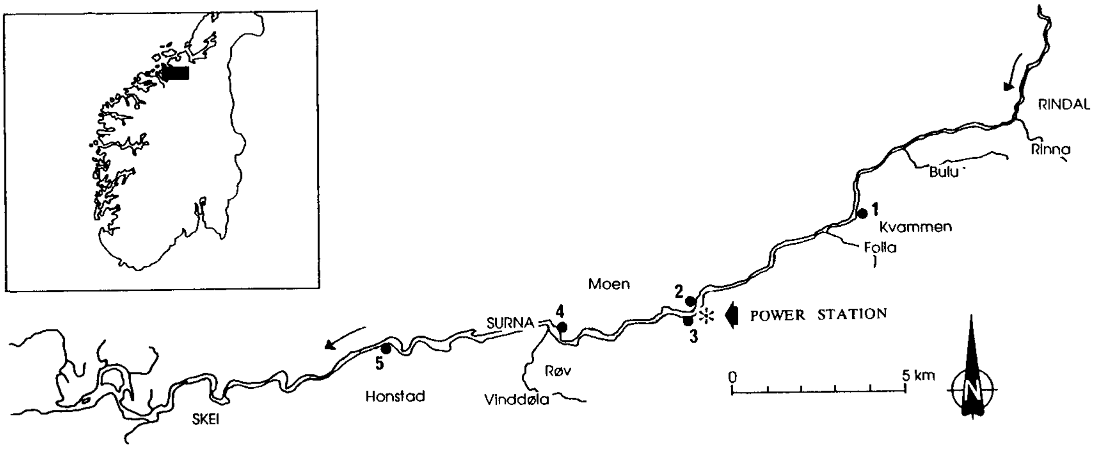

Figure 1. Map of the River Surna with sampling localities indicated

STUDY AREA

The River Surna, situated in the northern part of Western Norway is 30 km long and flows into the sea at Surnadalsfjorden (Figure 1). The river was regulated in 1968. The power station, situated close to the river, is about 20 km from the sea. The natural salmon-producing reach is about 40 km, as fish also enter the tributaries. The dominant fish species are Atlantic salmon and brown trout, with three-spined stickleback (*Gasterosteus aculeatus*) and flounder (*Platichthys flesus*) being occasionally recorded in the lower reaches.

Temperature data in the river during the study period consist of daily mean temperatures in the discharge from the power station and weekly measurements at the gauging station (Honstad) about 10 km below the power station. Temperatures in the river above the power station were simulated, based on discharge and available temperature records (Roen, personal communication). Temperature data from 1984 and 1985 are given in Figure 2. The discharge water from the power station reached maximum temperatures between late August and mid-October, although temperatures never exceeded 11°C. In June, temperatures were below 7°C, compared with the normal July temperatures of 8–9°C. In 1984 the power station ceased operation from April to August. The river temperature at Honstad is affected by unregulated discharge, the discharge from the power station and also to a limited extent by air temperatures. However, temperatures remain fairly low and are seldom above 10–11°C (Figure 2). From 1987 onwards, automatic temperature recording was in operation for three localities in the Surna, two above and one below the power station (Saltveit, 1990). These confirm the temperature pattern seen in 1984–5.

MATERIALS AND METHODS

Benthic samples were collected from five localities in the river, two above the power station and three below (Figure 1), using the kick method over a time of one minute (Hynes, 1961; Frost *et al.*, 1971). Three replicate samples were taken from each locality on each occasion. The net opening was 30 × 30 cm and the mesh size was 0·25 mm. The samples were fixed in ethanol and sorted in the laboratory. Samples were taken in October 1984 and in April, June and July 1985.

Although the samples are not quantitative, it is possible to compare abundance between localities. On the basis of total numbers collected each month, species were classified as absent, rare (< 10), common (10–50) or abundant (> 50).

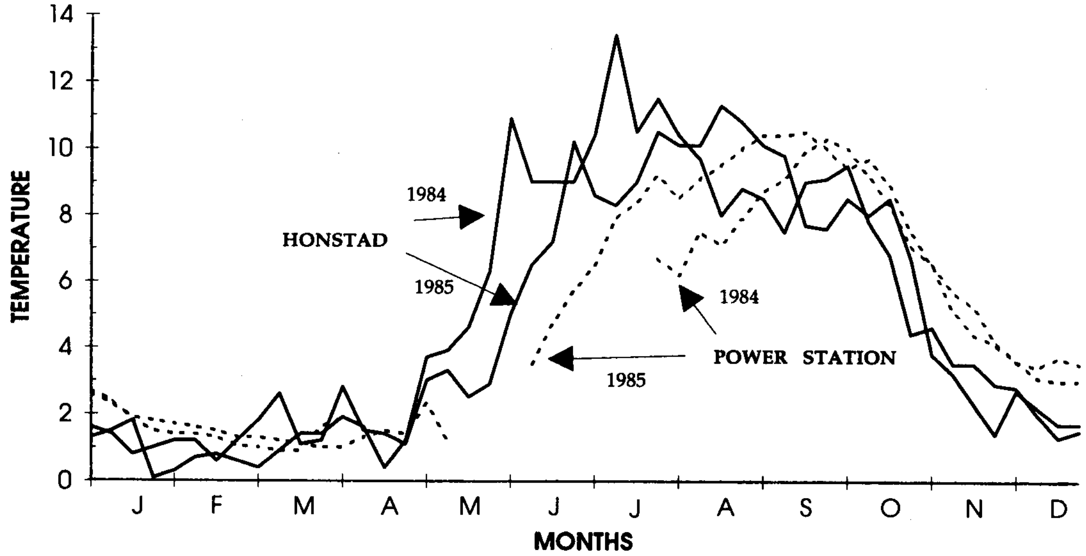

Figure 2. Weekly mean water temperatures in 1984 and 1985 at the power station and at Honstad below the power station in the River Surna, based on daily readings

RESULTS

The benthic fauna was completely dominated by insects, mainly chironomids, mayflies, caddisflies and stoneflies. Oligochaetes were the only non-insect taxa recorded. The highest benthic densities were recorded in June, whereas July had the lowest densities (Figure 3). Benthic densities were similar in all months, except for June at the locality immediately below the power station (station 3). Densities here were also much lower than at all other sampling stations. An increase in abundance was observed downstream, except in July. However, densities downstream never exceeded densities above the power station.

Chironomidae

The chironomids were the dominant insect group. They were the most numerous group at all localities in all months except October, when both stoneflies and mayflies were more abundant at certain localities (Figure 3).

The chironomid fauna consisted of 47 species. Of these, a total of 35 species were recorded above the power station, whereas 33 were recorded below (Figure 4). The least number of species was found in April. The 19 most abundant species were divided into four categories according to their abundance and distribution in the river (Table I). The first group consisted of species rare or absent above the power station, but common or abundant below. This group contained five species (group 1, Table I). For seven other species, the situation was the opposite, being either abundant or common above the power station, whereas they were rare or absent below (group 3, Table I). Four species decreased slightly in abundance below the power station (group 2, Table I). The final group consisted of three species whose abundance was unchanged throughout the river (group 4, Table I).

Plecoptera

A total of 16 stonefly species were recorded in the river (Table II). Of these, 15 were found below, whereas 12 were present above the power station (Figure 4). The least number of species was found in July. The fauna was dominated by four species, *Amphinemura sulcicollis*, *Capnia atra*, *Leuctra fusca* and *Leuctra hippopus*, which were abundant both above and below the power station. For most of the remaining species no major differences in distribution were found above and below the power station (Table II). Although a few more species occurred below the power station, these species were rare in samples.

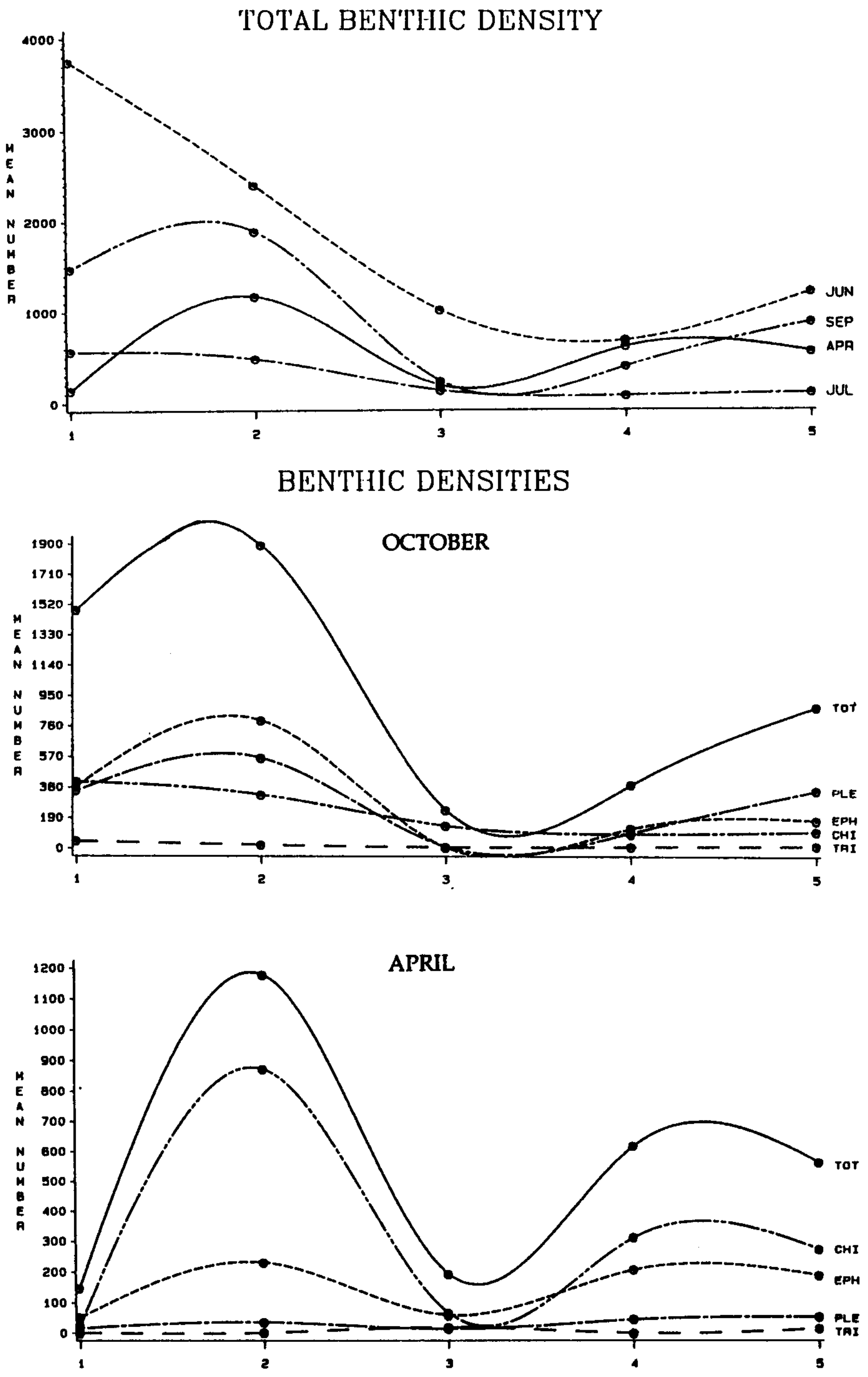

Figure 3. Total benthic densities and densities of different taxa (mean number per one minute kick sample) above (1 and 2) and below the power station (3, 4 and 5) on the River Surna

Ephemeroptera

The mayfly fauna was dominated by two species, *Baetis rhodani* and *Ameletus inopinatus*, which were abundant both above and below the power station (Table II). Another fairly common species, *Ephemerella aurivillii*, also occurred in similar numbers above and below the power station. As for the stoneflies, species

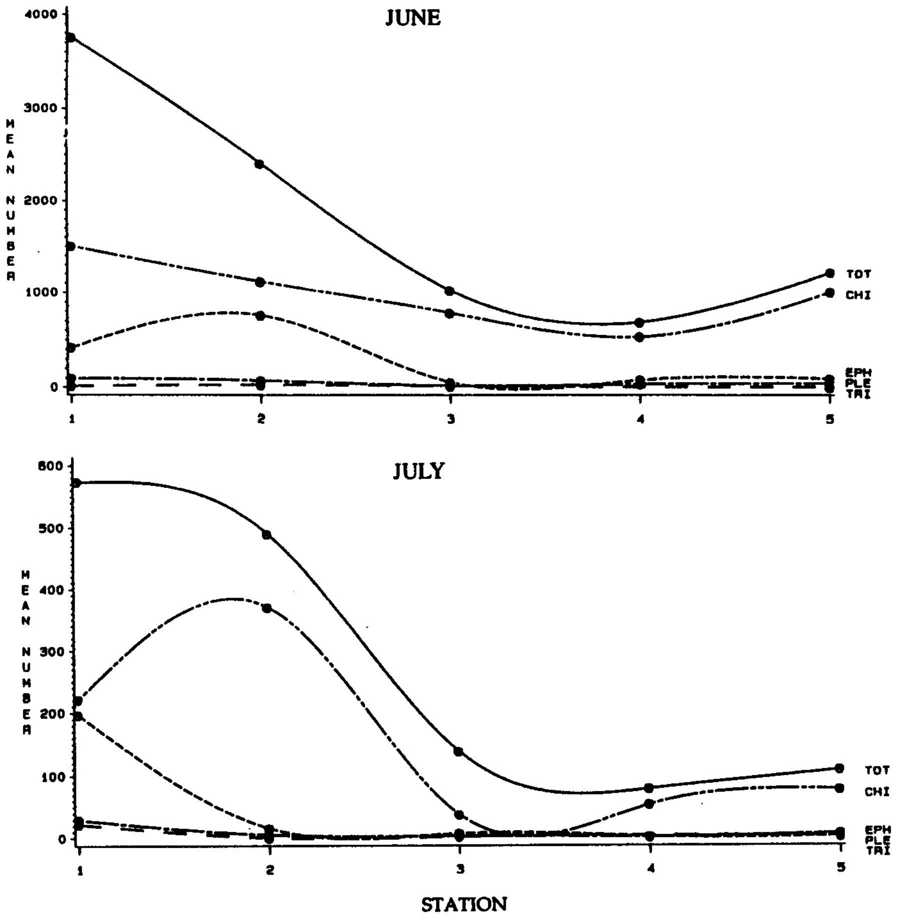

Figure 3. *Continued*

restricted to either above or below the power station were only recorded in low numbers, although slightly more species were recorded below (Figure 4).

Trichoptera

The caddisfly fauna consisted of only a few species (Table II). The three most abundant species occurred above and below the power station, and also for this group no major differences in distribution pattern were observed.

DISCUSSION

The temperature regime in regulated rivers may be modified in several ways (Ward and Stanford, 1982). Several studies from North America report major changes both in the density and species composition of mayflies, stoneflies and caddisflies. In general, temperature seems to have the greatest effect on the fauna in continental and warm temperature areas, where hypolimnion releases can produce substantial temperature changes (Saltveit *et al.*, 1987; Brittain and Saltveit, 1989).

Although the average number of mayfly taxa usually decreases below deep release reservoirs, the mean density often increases as many species commonly attain high densities below such reservoirs (Ward, 1974; Young *et al.*, 1976; Gore, 1977; 1980; Zimmermann and Ward, 1984). Stoneflies are generally

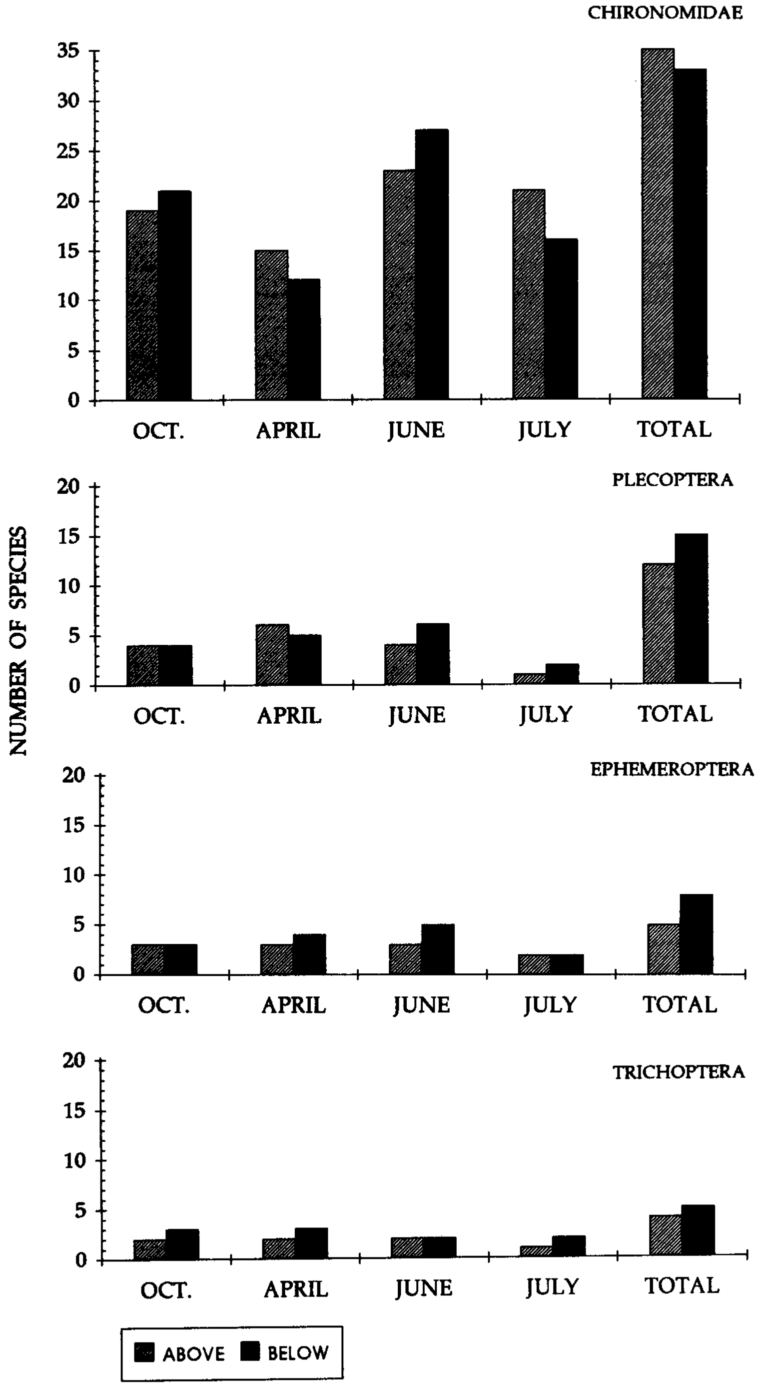

Figure 4. Number of species of chironomids, stoneflies, mayflies and caddisflies recorded above and below the power station in the River Surna in total and at different times of the year

Table I. Distribution and abundance of chironomid species above and below the power station on the River Surna, western Norway

Taxa	Above	Below
Group 1		
Macropelopia sp.	Absent	Common
Prodiamesa olivacea	Absent	Common
Heterotrissocladius marcidus	Rare	Abundant
Stictochironomus sp.	Rare	Common
Synorthocladius semivirens	Rare	Common
Group 2		
Diamesa sp.	Abundant	Common
Orthocladius sp.	Abundant	Common
Thienemaniella sp.	Abundant	Common
Micropsectra sp.	Abundant	Common
Group 3		
Diplocladius cultriger	Common	Absent
Pseudosmittia sp.	Common	Absent
Eukiefferiella gr. devonia	Abundant	Rare
Eukiefferiella gr. gracei	Abundant	Rare
Rheosmittia sp.	Abundant	Rare
Tvetenia sp.	Abundant	Rare
Cricotopus sp.	Abundant	Rare
Group 4		
Conchapelopia sp.	Abundant	Abundant
Corynoneura sp.	Abundant	Abundant
Nilotanypus sp.	Common	Common

adversely affected, either being absent or strongly reduced both in density and species diversity (Ward and Stanford, 1979; Stanford and Ward, 1984).

Ward and Stanford (1982) stressed that high species diversity among aquatic insects is usually associated with a wide annual temperature range. Moreover, Vannote and Sweeney (1980) have suggested that biotic diversity along a watercourse closely parallels that of thermal variation. Thus a reduction in both diel and annual thermal ranges in connection with river regulation will lead to a reduction in species diversity. The elimination of mayfly and stoneflies species below hypolimnion release dams has also been related to the fact that specific temperature requirements are not met (Spence and Hynes; 1971; Lehmkuhl, 1972; Stanford and Ward, 1984).

However, such effects are less marked in areas with a low species diversity such as north-western Europe (Armitage, 1976; Scullion *et al.*, 1982; Scullion, 1983; Henricson and Müller, 1979). It is only when other factors such as discharge are altered that major changes are seen. An altered flow regime together with reduced summer and increased winter temperatures in Aurlandselva, Norway, gave greater densities of mayflies and stoneflies, but a reduction in biomass (Raddum, 1985). This was due to a shift to smaller mean individual size, probably caused by the drift of the largest individuals out of the area. Penaz *et al.* (1968) also reported an increase in the number of small animals, especially *Baetis*, below a dam in central Europe.

In continental areas with a highly diverse fauna small environmental changes may have a much greater effect than in oceanic areas due to greater specialization and decreased niche breadth in species-rich areas. Even though the changes in temperature may be just as large below deep release European dams as North American, the effect on species composition are seldom seen when studying the traditional taxa: stoneflies, mayflies and caddisflies. No major differences were recorded in the present study in the River Surna. Changes in oceanic areas may possibly be detected by studying highly diverse taxa such as the chironomids. However, the species composition of chironomids in regulated rivers has been little studied, mainly

Table II. Distribution and abundance of stonefly, mayfly and caddisfly species above and below the power station on the River Surna, western Norway

Taxa	Above	Below
Plecoptera		
Amphinemura sulcicollis	Abundant	Abundant
Capnia atra	Abundant	Abundant
Leuctra fusca	Abundant	Abundant
Leuctra hippopus	Abundant	Abundant
Diura nanseni	Common	Common
Protonemura meyeri	Common	Common
Amphinemura borealis	Common	Common
Amphinemura standfussi	Common	Rare
Siphonoperla burmeisteri	Rare	Rare
Taeniopteryx nebulosa	Rare	Rare
Brachyptera risi	Rare	Rare
Nemoura avicularis	Absent	Rare
Capnopsis schilleri	Absent	Rare
Leuctra nigra	Absent	Rare
Isoperla grammatica	Absent	Rare
Nemoura cinerea	Rare	Absent
Ephemeroptera		
Ameletus inopinatus	Abundant	Abundant
Baetis rhodani	Abundant	Abundant
Ephermerella aurivillii	Common	Common
Siphlonurus lacustris	Absent	Rare
Baetis niger	Absent	Rare
Centroptilum luteolum	Absent	Rare
Heptagenia sulphurea	Absent	Rare
Leptophlebia marginata	Absent	Rare
Heptagenia joernensis	Rare	Absent
Heptagenia dalecarlica	Rare	Absent
Trichoptera		
Rhyachophila nubila	Abundant	Common
Polycentropus flavomaculatus	Common	Common
Limnephilidae	Common	Abundant
Hydroptilidae	Absent	Rare

due to the taxonomic difficulties. In addition, the ecological requirements of chironomids are poorly known.

In the River Surna five chironomid species were common or abundant below the power station, but either absent or rare above. This is probably due to their cold stenothermal requirements. These include *Macropelopia* sp. and *Prodiamesa olivacea*, which are both moderately cold stenothermic (Lindegaard-Petersen, 1972; Fittkau and Roback, 1983). They are often found in fine sediments in cold localities such as springs and small streams, where together with *Micropsectra* species they form a typical community (Thienemann, 1954; Fittkau, 1962). The supply of colder water and the fluctuations in discharge due to the activities of the power station will probably create a situation similar to a small headwater stream. *Synorthocladius semivirens* requires running water and is common in springs and rivers (Cranston *et al.*, 1983), where it lives in gelatinous tubes on the tops of stones (Lindegaard-Petersen, 1972). It is also probably moderately cold stenothermic. *Heterotrissocladius marcidus* was one of the most abundant species below the power station, whereas it was rare above. The genus *Heterotrissocladius* consists of cold stenothermic species and *H. marcidus* is not found in Europe in localities where the temperature exceeds 18°C (Sæther, 1975). Above the power station temperatures fluctuate more than below, often exceeding 20°C in the summer. Below the power station temperatures were always well below 15°C.

Among the chironomid species decreasing slightly in abundance below the power station, there are some species which are generally adapted in cool waters. These include *Diamesa* (Oliver, 1983) and species in the genus *Micropsectra* (Pinder and Reiss, 1983).

Five taxa were abundant above the power station and rare below. *Eukiefferiella* and *Tvetenia* are both eurythermic and occur primarily in running waters (Cranston *et al.*, 1985). It is not known why they are rare below the power station. Similar observations were made by Armitage and Blackburn (1990). They found that *Eukiefferiella* and *Tvetenia* were sparse in a regulated river directly below a dam supplying colder water, but were abundant further downstream. In contrast, Spence and Hynes (1971) found no reduction in *Eukiefferiella* below a hypolimnion release dam. In the River Surna the genus *Rheosmittia* was abundant above the power station but was rare below. *Rheosmittia* is a psammophilic genus, typically of shifting sand areas (Soluk, 1985). On sandy areas further downstream in the River Surna it was common. This suggests that sand and silt do not accumulate below the power station, probably because of fluctuations in discharge.

Species whose abundance did not change were usually species adapted to lotic habitats, either living in moss, such as *Conchapelopia* (Fittkau and Roback, 1983), or in crevices between stones such as *Corynoneura* sp. (Cranston, 1982), where they are less exposed to changing conditions.

In conclusion, lower benthic densities were found immediately below the power station on the River Surna, but except for the Chironomid fauna no major differences in species composition were recorded. In species-poor, oceanic areas the effects of river regulation on stoneflies and mayflies are seen in differences in abundance, size and growth patterns rather than in species composition.

ACKNOWLEDGEMENTS

Thanks are due to Åge Brabrand for constructive comments, to Per S. Nielsen and Erland Røsten for the computer analyses, to Finn Smedstad for help during fieldwork and to Randi Pytte Asvall, Norwegian Water Resources and Energy Administration, for providing the temperature data. Financial support was given by the Norwegian State Power Board (Statkraft).

REFERENCES

Armitage, P. D. 1976. 'A qualitative study of the invertebrate fauna of the River Tees below Cow Green Reservoir', *Freshwater Biol.*, **6**, 229–240.

Armitage, P. D. and Blackburn, J. H. 1990. 'Environmental stability and communities of Chironomidae (Diptera) in a regulated river', *Regul. Riv.*, **5**, 319–328.

Bækken, T., Fjellheim, A., and Larsen, R. 1984. 'Benthic animal production in a weir basin area in western Norway' in Lillehammer, A. and Saltveit, S. J. (Eds), *Regulated Rivers*, Universitetsforlaget, Oslo. pp. 233–245.

Brittain, J. E. and Saltveit, S. J. 1989. 'A review of the effect on river regulation on Mayflies (Ephemeroptera)', *Regul. Riv.*, **3**, 191–204.

Brittain, J. E., Lillehammer, A., and Bildeng, R. 1984. 'The impact of a water transfer scheme on the benthic macroinvertebrates of a Norwegian river' in Lillehammer, A. and Saltveit, S. J. (Eds), *Regulated Rivers*, Universitetsforlaget, Oslo. pp. 189–199.

Cranston, P. S. 1982. 'A key to the larvae of the British Orthocladiinae (Chironomidae)', *Sci. Publs. Freshwater Biol. Assoc.*, **45**, 152 pp.

Cranston, P. S., Oliver, D. R., and Sæther, O. A., 1983. 'The larvae of Orthocladiinae (Diptera: Chironomidae) of the Holarctic region—Keys and diagnoses', *Ent. Scand. Suppl.* **19**, 149–291.

Fittkau, E. J. 1962. 'Die Tanypodinae (Diptera: Chironomidae). Die Tribus Anatopyniini, Macropelopiini und Pentaneurini', *Abh. Larven-system. Insect.* **6**, 1–453.

Fittkau, E. J. and Roback, S. S. 1983. 'The larvae of Tanypodinae (Diptera: Chironomidae) of the Holarctic region—Keys and diagnoses, *Ent. Scand. Suppl.* **19**, 33–110.

Fjellheim, A., Håvardstun, J., Radum, G.G., and Schnell, Ø. A. 1993. 'Effects of increased discharge on benthic invertebrates in a regulated river', *Regul. Riv.*, **8**, 179–187.

Frost, S., Huni, A., and Kershaw, W. E. 1971. 'Evaluation of a kicking technique for sampling stream bottom fauna', *Can. J. Zool.*, **49**, 167–173.

Gore, J. A. 1977. 'Reservoir manipulations and benthic macroinvertebrates in a prairie river', *Hydrobiologia*, **55**, 113–123.

Gore, J. A. 1980. 'Ordinational analysis of benthic communities upstream and down stream of a prairie storage reservoir', *Hydrobiologia*, **69**, 33–44.

Henricson, J. and Müller, K. 1979. 'Stream regulation in Sweden with some examples from Central Europe' in Ward, J. V. and Stanford, J. A. (Eds), *The Ecology of Regulated Streams*, Plenum Press, New York. pp. 183–199.

Hynes, H. B. N. 1961. 'The invertebrate fauna of a Welsh mountain stream', *Arch. Hydrobiol.*, **57**, 344–388.

Lillehammer, A. and Saltveit, S. J. 1984. 'The effect of the regulation on the aquatic macroinvertebrate fauna of the river Suldalslågen, western Norway' in Lillehammer, A. and Saltveit, S. J. (Eds), *Regulated Rivers*. Universitetsforlaget, Oslo. pp. 201–210.

Lehmkuhl, D. M. 1972. 'Changes in the thermal regime as a cause of reduction of benthic fauna downstream of a reservoir', *J. Fish. Res. Board Can.*, **29**, 1329–1332.

Lindegaard-Petersen, C. 1972. 'An ecological investigation of the Chironomidae (Diptera) from a Danish lowland stream (Linding Å)', *Arch. Hydrobiol.*, **69**, 465–507.

Oliver, D. R. 1983. 'The larvae of Diameinae (Diptera: Chironomidae) of the Holarctic region—keys and diagnoses', *Ent. Scand. Suppl.*, **19**, 115–138.

Penaz, M., Kabicek, F., Marvan, P., and Zelinka, M. 1968. 'Influence of the Uir River Valley reservoir on the hydrobiological and icthyological conditions in the River Svratka', *Acta. Sci. Nat. Brno*, **2**, 1–60.

Pinder, L. C. V. and Reiss, F. 1983. 'The larvae of Chironominae (Diptera: Chironomidae) of the Holarctic region—keys and diagnoses', *Ent. Scand. Suppl.*, **19**, 292–435.

Raddum, G. G. 1985. 'Effects of winter warm reservoir release on benthic stream invertebrates', *Hydrobiologia*, **122**, 105–111.

Roen, S. 1980. 'Temperaturforhold i Surna. En utredning til Nordmøre herredsrett i forbindelse med Trollheimsreguleringen', *Report*, 10 pp [in Norwegian].

Saltveit, S. J. 1990. 'Effect of decreased temperature on growth and smoltification of juvenile Atlantic salmon (*Salmo salar*) and brown trout, (*Salmo trutta*) in a Norwegian regulated river', *Regul. Riv.*, **5**, 295–303.

Saltveit, S. J., Brittain, J. E., and Lillehammer, A. 1987. 'Stoneflies and river regulation—a review' in Craig, J. F. and Kemper, J. B. (Eds) *Regulated Streams. Advances in Ecology*. Plenum Press, New York, pp. 117–131.

Scullion, J. 1983. 'Effects of impoundments on downstream bed materials of two upland rivers in mid-Wales and some ecological implications of such effects', *Arch. hydrobiol.*, **96**, 329–344.

Scullion, J., Parish, C. A., Morgan, N., and Edwards, R. W. 1982. 'Comparison of benthic macroinvertebrate fauna and substratum composition in riffles and pools in the impounded River Elan and the unregulated River Wye, mid Wales', *Freshwater Biol.*, **12**, 579–595.

Soluk, D. A. 1985. 'Macroinvertebrate abundance and production of psammophilous Chironomidae in shifting sand areas of a lowland river', *Can. J. Fish. Aquat. Sci.*, **42**, 1296–1302.

Spence, J. A. and Hynes, H. B. N. 1971. 'Differences in benthos upstream and downstream of an impoundment', *J. Fish. Res. Board Can.*, **38**, 35–43.

Stanford, J. A. and Ward, J. V. 1984. 'The effects of regulation on the limnology of Gunnison River: a North American case history' in Lillehammer, A. and Saltveit, S. J. (Eds) *Regulated Rivers*. Universitetsforlaget, Oslo. pp. 467–481.

Sæther, O. A. 1975. 'Nearctic and Palaearctic *Heterotrissocladius* (Diptera: Chironomidae)', *Bull. Fish. Res. Board Can.*, **193**, 1–67.

Thienemann, A. 1954. '*Chironomus*. Leben, Verbreitung und wirtschaftliche Bedeutung der Chironomiden', *Binnengewasser*, **20**, 1–834.

Vannote, R. L. and Sweeney, B. S. 1980. 'Geographic analysis of thermal equilibria: a conceptual model for evaluating the effect of natural and modified thermal regimes on aquatic insect communities', *Am. Natural.*, **115**, 667–695.

Ward, J. V. 1974. 'A temperature-stressed stream ecosystem below a hypolimnial release mountain reservoir', *Arch. Hydrobiol.*, **74**, 247–275.

Ward, J. V. 1976. 'Effect of flow patterns below large dams on stream benthos: a review' in Osborn, J. S. and Allmann, C. H. (Eds), *Instream Flow Needs Symposium*, Vol. II, American Fisheries Society, pp. 235–253.

Ward, J. V. and Stanford, J. A. 1979. 'Ecological factors controlling stream zoobenthos with emphasis on thermal modification of regulated streams', in Ward, J. V. and Stanford, J. A. (Eds), *The Ecology of Regulated Streams*. Plenum Press, New York and London. pp. 35–55.

Ward, J. V. and Stanford, J. A. 1982. 'Thermal responses in the evolutionary ecology of aquatic insects', *Ann. Rev. Entomol.*, **27**, 97–117.

Young, W. C., Kent, D. H., and Whiteside, B. G. 1976. 'The influence of a deep storage reservoir on the species diversity of benthic macroinvertebrate communities of the Guadalupe River', *Texas J. Sci.*, **27**, 213–224.

Zimmermann, H. J. and Ward, J. V. 1984. 'A survey of regulated streams in the Rocky Mountains of Colorado, U.S.A.' in Lillehammer, A. and Saltveit, S. J. (Eds), *Regulated Rivers*. Universitetsforlaget, Oslo. pp. 251–259.