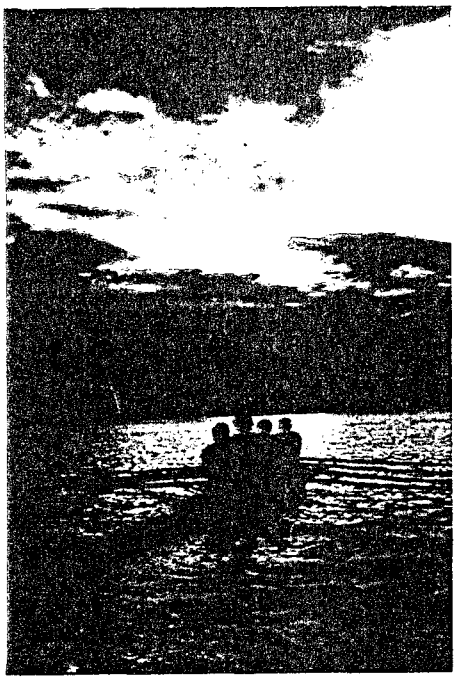
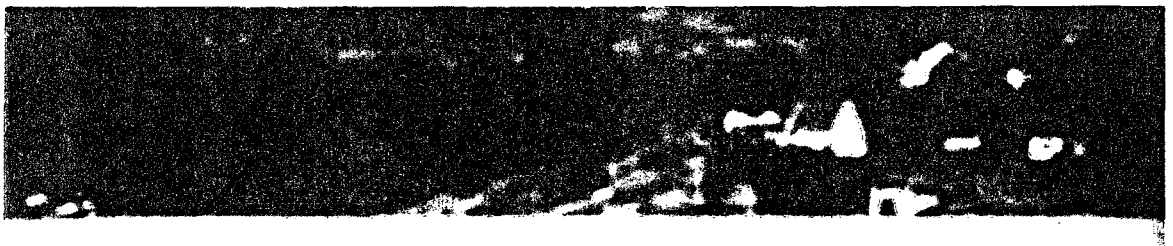
ENVIRONMENTAL EFFECTS OF ESTABLISHING TRAINING- AND RACING-AREAS FOR WATER COMPETITIONS

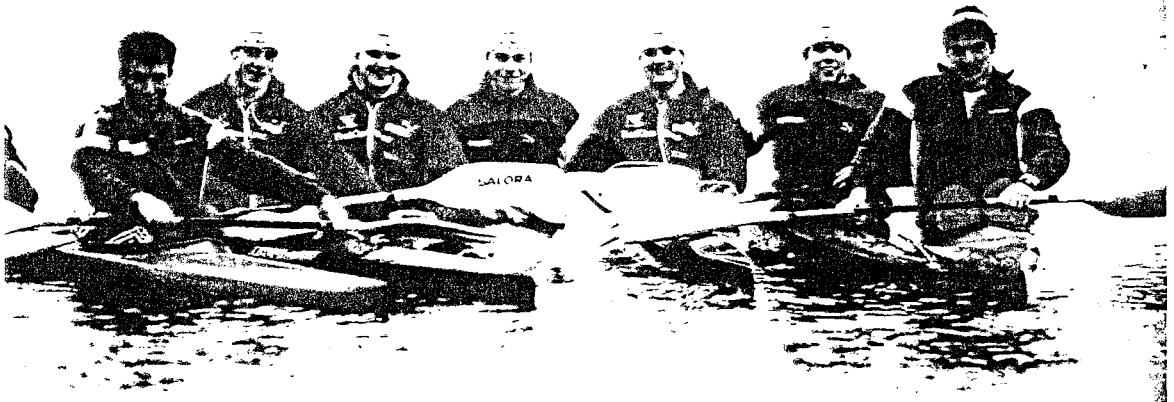
NORGES VANNSKIFORBUND



NORGES ROFORBUND

NORGES KAJAKK- OG KANOFORBUND





INTRODUCTION

This study was initiated by the Norwegian Rowing Association (Norges Roforbund) in close collaboration with the Norwegian Water Ski Federation (Norges Vannskiforbund) and the Norwegian Kayak- and Canoe Association (Norges Kajakk- og Kanoforbund). The ultimate goal was to examine to what extent rowers, water skiiers and kayakers have an effect on the environment or more specifically on the training- and race areas and courses for the three disciplines on selected lakes in Norway.

Before this more extensive study, only a few limited analyses had been performed in Norway. In one case the Norwegian Water Skiing Association initiated a literature research (1980) concentrating on the pollution effect of the use of small speed boats in connection with water skiing. The conclusion - based primarily on available literature from USA - was that the pollution effect was supposed to be minimal.

In another analysis (1984) the Norwegian Water Skiing Association initiated a theoretical study of two small lakes in the eastern part of Norway. The goal was to examine the possible content of heavy metals - especially lead - and to which extent the use of small speed boats would increase the natural lead content.

In the present study the activity has been concentrated on three lakes - two in the southern part of the country near Oslo (Nøklevann and Årungen) and one lake in central Norway close to Trondheim (Jonsvatnet). Årungen - the national rowing arena - and Jonsvatnet have both been used for rowing activities for decades. Rowing activities started at Nøklevann, however, after this study was finished. Jonsvatnet and Nøklevann are drinking water reservoirs both with exceptionally good water quality. Årungen is, however, to a large extent polluted as a result mainly of supplies from the surrounding agricultural activities.

STRATEGIES AND METHODS USED

The present study combined different methods for environmental analysis. Three main areas were focussed on;

A. *Biological analysis*
B. *Analysis of pollution from speed boats*
C. *Noise-studies and health risks connected to water skiing*

The **biological analysis** were performed through a theoretical study of the possibility of transfer of unwanted or non-endemic species (algae, fresh-water plants, plankton, fish and parasites) from one lake to another. In addition, a theoretical analysis of the possible changes in the composition of the plant- and zoo-plankton-species as a result of the sport activities, were performed by making a comparison of the established flora and fauna as recorded over years - with changes occurring during one season. A simple practical toxicity analysis of the effect of petrol on selected species of crustaceans was also performed. A more extensive microbiological analysis of coliform bacteria was also included.

It is expected that the main **pollution source** connected to water sport is the use of coach-boats in rowing and the **towing** boats used in water skiing. This aspect was specially foccused on and the main pollution components can be petrol, spill oil, hydrocarbons and other combustion products. Due to limited economical resources for the project this analysis was made as a theroretical evaluation of other studies without basis in a practical experimental set up in the present study.

It is generally expected that water-skiing might give rise to **noise-problems and health risks**. National authorities have specially focussed on noise problems connected with the use of high-speed boats. In addition, water skiing activities represent a potential conflict with other groups using the same lake areas e.g. for recreation activities (bathing) and fishing. It has also been claimed that the waves caused by the high-speed boats in small lakes can increase erosion in the beach area.

Due to the potential conflicts between the different user groups and the performers of water sport actvities, this study has performed an extensive evaluation and statistical analysis based on personal interviews and questionaires.

SUMMARY OF THE RESULTS OBTAINED

As a part of the **biological anlysis** in this study, plant-zoo-plankton and animals from the bottom of the lakes in Årungen and Jonsvatnet have been collected, in order to determine which species can be transferred through water sport activities or will be affected by pollution. Of the species examined *Daphnia cucullata* is found in Årungen but not in Jonsvatnet. The main dominating blue-green algae *Oscillatoria* found in Årungen is also found in Jonsvatnet. It is not possible to evaluate if the different species in the two lakes can be transferred and establish populations since environmental

requirements and competitions will interfere. Problems connected to transfer of vira, bacteria and fungi via crustaceae and bottom-animals are not examined in this project.

In principle it is to be expected that increase in the frequency of transport between fresh water lakes increases the potential for unwanted distribution of species and parasites/infections in the fresh water flora and fauna. On this basis care has to be taken moving race- and training boats from one rowing course to another. This is specially the case when e.g. a transport occurs from a heavily polluted and eutrophic lake like Årungen to water reservoirs like Nøklevann and Jonsvatnet. It is therefore highly recommended that the boats be cleaned using pure water and thoroughly dried after they are brought on land. It is expected that this could be a part of the ordinary maintenance of the boats.

The effect of **oil-mixed petrol** was in this study tested on the crustaceae *Gammarus lacustris* in an experiment in a closed system during a 24-hour period. The results indicate that low concentrations of oil-mixed petrol (<0.01 ml/l) have an inhibiting effect on the movements of the animal. Concentrations >1.0 ml/l killed all the animals in the test system. This simple experimental system indicates that low concentrations of oil-mixed petrol immobilize *Gammarus lacustris* in closed systems. It is to be stressed that these are preliminary results and in order to obtain more reliable results experiments have to be run in paralell with relevant controls. In addition field studies would also have to be performed.

The goal of the experiments performed and similar experiments is not to get an indication of the effects of different hydrocarbons on the growth and reproduction capacity of the animals. It is, however, possible to test for immobility/mortality at the different developmental stages.

The **bacteriological measurements** are based on the distribution of coli-like bacteria. The results from Jonsvatnet are consistent with similar measurements of the total amount of *E.coli* performed by Trondheim county council (Technical Division). An increase in coli-like bacteria has not been recorded either in Jonsvatnet or Nøklevann as a result of sports activities on the lakes or as a result of establishing rowing courses.

The **chemical analysis** of the water quality samples taken in Jonsvatnet at the end of the rowing season 1987, gave values in the same range as measurements performed by Trondheim county

council. It can therefore be concluded that the water sport activities on Jonsvatnet in 1987 and the establishing of an Albano-system the same year, apparently do not influence the water quality.

Both the bacteriological and chemical analysis of samples taken from Nøklevann, Årungen and Jonsvatnet, indicate that water sport activities performed on the respective lakes do not to a detectable extent cause a change in the water quality. It is assumed that pollution from the agricultural activities from areas surrounding the last two lakes, pollutes the water to a larger extent.

On a theoretical basis the **potential pollution** of the lakes from **outboard motors and other boat engines** has also been evaluated. Different types of engines and their respective characteristics in the context of pollution are dealt with. The leakage of combustion components like carbon monoxide and hydrocarbons and their toxicity are also discussed. In addition the effect of wind, waves, evaporation, bio-degradation, streams, photo-oxidation, adsorbtion and sedimentation of these pollutants are also considered. To quantify the extent of pollution as a result of the use of outboard-engines, references are given to experiments from Germany and tests performed at The Institute for Engine Combustion at the Technical High School, University of Trondheim. It is realistic to expect that when used within a sensible range outboard motors will not have a negative effect on the water quality. More specifically it is concluded that if the boat activities on Jonsvatnet which are limited to afternoons and weekends, are kept to the present level, this will not have any effect on the water quality. However, accidental spillage of oil, petrol etc. may give local pollution effects.

Noise measurements have been performed using two types of boats on Jonsvatnet and Nøklevann. A specially constructed boat for water skiing (MasterCraft, 255 hp) and two coach boats for rowing with a 10 hp and a 20 hp outboard motor were tested. Both the maximum noise level and the normalized equivalent level per accident were measured. Since Norway does not have limit values for recreation boats, in this study the values for road, aircrafts and industrial activities were used as standards. The values measured for the different boats did not give a noise level exeeding 55-60 dB which is the recommended value for domestic areas and 50-55 dB for recreation areas. The coach boats for rowers with a 20 hp outboard motor was the only one to approach the maximum level. However, speed-boats used for the judge in rowing-regattas with e.g. 70 hp outboard motor did exceed the recommended values (>65 dB).

The measurements performed demonstrated that MasterCraft with an inboard 255 hp engine, did not exceed the 60 dB level - even when run at maximum speed. Based on these analysis, limiting water skiing activities on lakes due to noise problems is not a relevant argument.

An extensive evaluation and statistical analysis **to study potential conflicts** between recreation users of the lakes, inhabitants living near the lakes etc. and the performers of water sport activities was made. In this context 87 persons living close to Jonsvatnet and 103 persons regularily using Nøklevann for recreation activities were interviewed and/or asked to fill in a questionaire. The analysis demonstrated that the majority of the persons interviewed accepted that organized rowing and kayaking can be permitted in recreation areas. A certain reservation was made to the use of coaching boats making noise - restrictions should therefore be applied in the evenings and weekends.

The persons interviewed had a more negative attitude to water skiing. This seems to reflect more personal individual experience and associations related to the unorganized activity performed by water skiiers on Jonsvatnet where the analysis was performed.

RECOMMENDATIONS

Based on the results obtained in this study the following recommendations are given in order to help the planning and development of training and race-course for water sport activities;

* establishing an Albano-system on a fresh water lake has no effect on the water quality. When planning a water sport plant where a training or race-course will be placed for longer periods of time on the lake, the organisation (club, association) should acquire information from the supplier about the chemical/physical characteristics connected to the hardware - in case the water quality may be affected.

* conventional and normal training and competitions through a season for a number of rowers and kayakers equivalent to an average Norwegian club, does not give detectable changes in the water quality. The figures and results in this report, should be the basis for potential discussions with official authorities where there are relevant problems on these lines.

* transport of boats from one lake to another may represent a potential infection source. Special care must be taken when

moving boats from eutrophic lakes (e.g. Årungen) to drinking water reservoirs. It is therefore recommended that the boats and equipment are cleaned in pure water before transport to other water sources.

* reasonable use of coach boats for instruction of rowers and kayakers, is assumed not to give detectable effects on the ecosystem in lakes like Jonsvatnet due to dilution and degradation. Accidental spillage of oil, petrol etc. may give local pollution effects. Care has therefore to be taken when tanking and repairing the engines when still on the water.

* the noise level caused by coach boats for rowers with a 20 hp outboard motor run at low speed did not exceed the maximum values for living and recreation areas. Speed-boats used for the judge or for referee functions in rowing-regattas did exceed the recommended values. Organizers of regattas should take this into consideration when planning the event.

* water-skiing with specially constructed and certified boats does not create noise- or pollution-levels higher than other water sport activities. Since the public attitude to water skiiers is more negative than to rowers and kayakers, planning and construction of water skiing plants may create conflicts. In order to minimize such potential problems, it is recommended that the Norwegian Water Skiing Association concentrate on giving relevant and objective information about water skiing - especially in connection with applications for establishing new arenas.

* when planning training and race-courses on lakes located in recreation and touring areas, the clubs and other associations should as early as possible contact official authorities to clarify potential user conflicts. Specialist support can be given by the respective water sport associations.

LIST OF PARTICIPATING INSTITUTIONS AND CONSULTANTS

Institute	Contact person	Task
Department of Botany, University of Trondheim N-7055 Dragvoll	Tor-Henning Iversen	Bacteriological analysis
Department of Zoology, The Museum, University of Trondheim	Jo Vegar Arnekleiv	Biological analysis (zoo-plankton)
The Maritime Center, SINTEF	Olav Vadstein	Biological analysis (plant-plankton)
Institute of Marine Machinery NTH	Terje Almås	Boat engines
Noise Technical Center, ELAB, NTH	Kjell Skaalvik	Noise measurements
Food Control, Trondheim County Council	Arne M. Jensen	Water quality
Psychological Institute, University of Trondheim	Tor E. Larsen	User conflicts