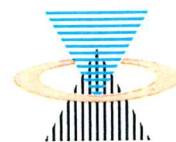
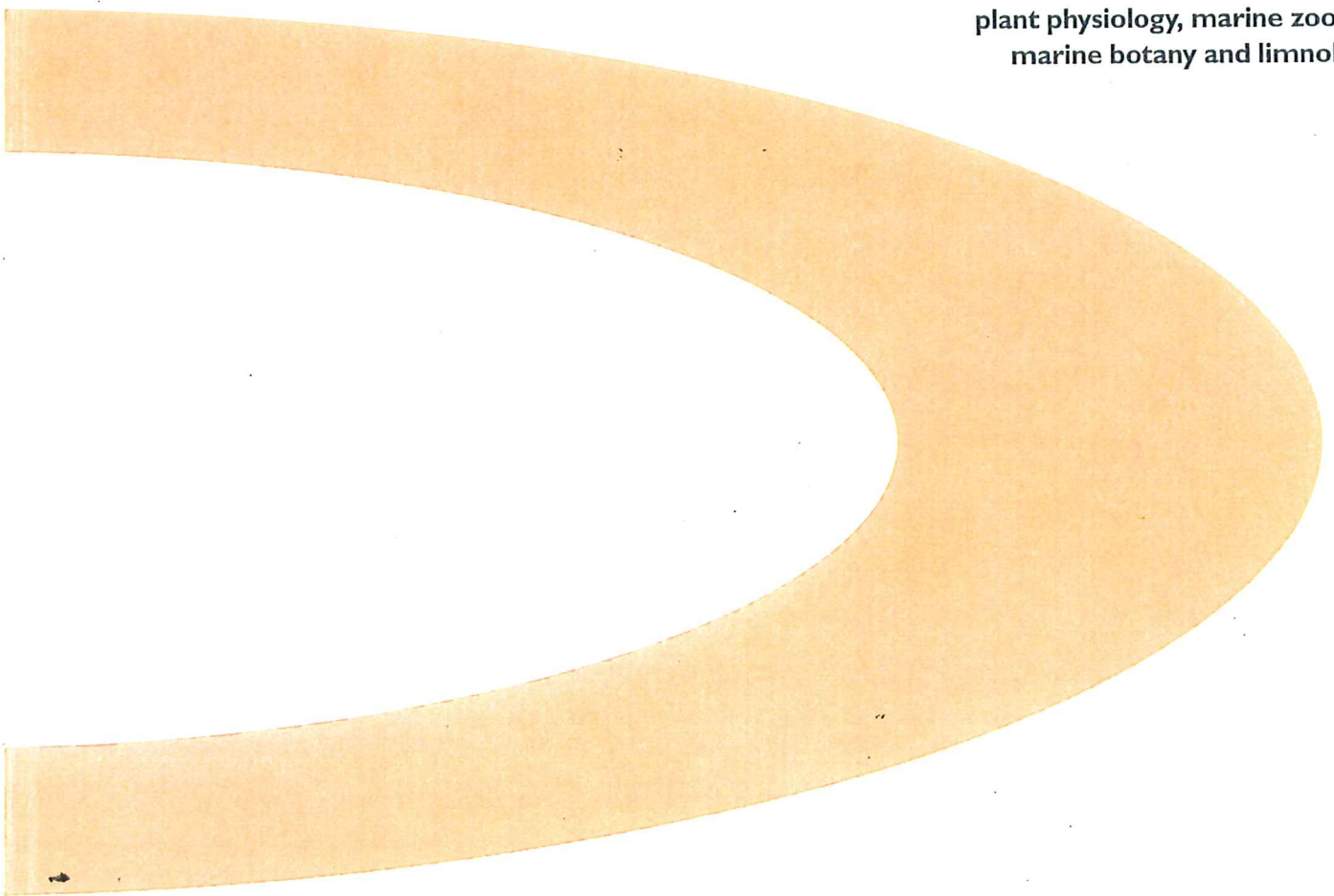


# Research in Biology and relevant areas of Biochemistry in Norwegian Universities, Colleges and Research institutes

*A review*

*Panel I*

(Zoology, botany, ecology,  
plant physiology, marine zoology,  
marine botany and limnology)



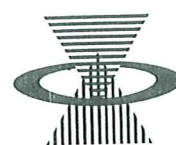
The Research Council  
of Norway

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*Panel I*

(Zoology, botany, ecology,  
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marine botany and limnology)



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of Norway**

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## Preface

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In 1999 and 2000 the Research Council of Norway carried out a comprehensive review of Norwegian basic biological research, including biochemistry and biotechnology at Norwegian Universities, Colleges and Research institutes. The review covers research groups in the natural sciences, medicine, agriculture, fisheries and environmental disciplines.

Because of the large number of scientific groups and disciplines involved in the review, three different international panels of experts were established, each of which reviewed one of the following subfields:

- Panel 1 - zoology, botany, ecology, plant physiology, marine zoology, marine botany and limnology
- Panel 2 - physiology, neurophysiology, neurochemistry, anatomy, toxicology and pharmacology ,
- Panel 3 - microbiology, molecular biology, cell biology, genetics, biochemistry, immunology and biotechnology

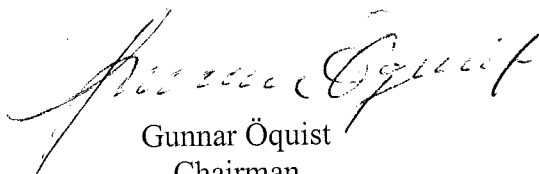
This is the report of the international expert panel formed by the Research Council of Norway to review the research in zoology, botany, ecology, plant physiology, marine zoology, marine botany and limnology.




## To the Research Council of Norway

The members of the Review Panel for Research in Biology and relevant areas of Biochemistry at Norwegian Universities, Institutes and State Colleges submit the following report.

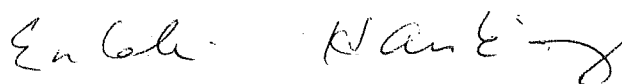
The views expressed in this report are the consensus views of the Panel. The members of the Panel are in collective agreement with the assessments, recommendations and conclusions presented.



Gunnar Öquist  
Chairman




Paul H. Harvey



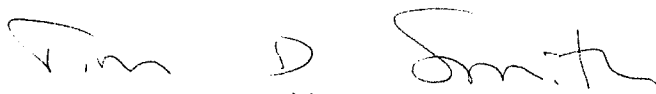
Erkki Haukioja



Bo Barker Jørgensen



Franz Oberwinkler



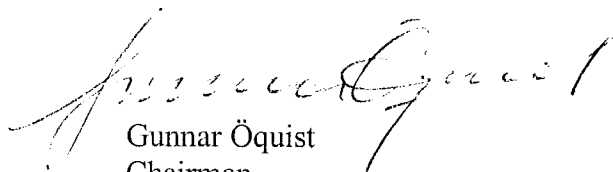
Tim D. Smith

## Acknowledgements

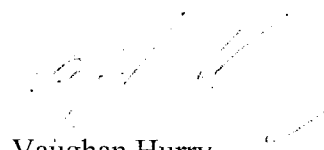
This report has been prepared at the request of The Research Council of Norway. Its preparation has only been possible thanks to the excellent and thorough work of an independent Panel of eminent persons representing different scientific, national and institutional backgrounds. We thank the Panel for their work during the review process and especially for their help in developing the broad conclusions that are the keystone of a report such as this.

We thank all the staff and students from the University Departments, Research Institutes and State Colleges who prepared the detailed written submissions that provided the basis for this review. We would like to particularly thank those who traveled to Gardemoen for their valuable oral presentations and for being open and helpful during the discussions that followed. Without this contribution a wide-ranging review of this nature would not have been possible.

We would also like to acknowledge the exhaustive work of a number of people at The Research Council who were involved in compiling the background material and organizing the week at Gardemoen. We thank in particular: Dr. Tone Vislie, Ms. Malena Bakkevold and Mrs. Signe Urbye for their help throughout the review process.



Gunnar Öquist  
Chairman



Vaughan Hurry  
Executive secretary

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# Introduction

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The evaluation Panel's mandate from the Research Council of Norway was to review the overall state of basic research in the biological and relevant biochemical disciplines in Norwegian universities, colleges and research institutes. The specific directives from the Research Council were:

1. To offer a critical review of the strengths and weaknesses of the scientific quality and organisation of basic research, both nationally and at the level of individual research groups and academic departments.
2. To identify research groups that maintain a high international standard in their research, or who have the potential to reach that level.
3. To enable the Research Council to determine whether there are significant differences in the quality of individual sub-fields or areas of research.
4. To identify areas of research that need to be strengthened to ensure that Norway possesses the necessary scientific competence in fields that are of importance to the nation. As one aspect of this, the evaluation is to assist the Research Council to evaluate the impending situation regarding recruitment in important fields of biological research.

Norway is a highly educated, developed and wealthy nation with a distinguished tradition of scientific research. The Panel therefore assessed the research groups covered in this evaluation by the highest international standards, taking into account Norway's relatively small population, the scientific problems associated with its geographic location and the need to develop regional centres of expertise. While it is difficult to formulate a uniformly accepted definition of what constitutes 'basic scientific research', the Panel defined basic research, for the purpose of this review, as *research in which the principle aim was the development of new understanding, comprising not only specific factual information, but also conceptual insights*. The ranking of the various projects was thus dependent on the conceptual value of the discoveries, rather than the generation of descriptive data. Accordingly, the various groups were graded using the following scale:

Outstanding: research at a very high international level; of great international interest with broad impact and with publications in internationally leading journals; the researchers are among the leading in the field

Very good: research at a high international level; of international interest with impact within its sub-fields and with publications in internationally leading journals; the researchers are among the leading in the sub-field

Good: research at a good international level with publications in internationally well known, specialised journals; the researchers have a good international reputation within their sub-fields

Fair: research that is only partly of a good international standard and only partly published in well known international journals

Not acceptable: research of insufficient quality; without international interest and with only limited national significance

The evaluation procedure included the review of a large volume of pre-prepared documentation. Unfortunately much of the information provided prior to the review was of an administrative nature and of limited value in an evaluation of basic research. Additional documentation was also available during the review, but given the time restraints imposed there were limited opportunities for reading the reprints provided. Therefore the evaluation, with some exceptions, could not get to the level of the individual researcher, but remained at the level of the department or research group. The principle indicator of the scientific performance of these groups was the quality and number of peer reviewed papers published in international journals in recent years. In addition to the documentary information each group had the opportunity to update the Panel on recent developments, to present the most important recent scientific findings and to present their strategy for future development.

As stated above, the primary goal of this evaluation was to provide a comprehensive overview of diverse research groups, from different research sectors, with different institutional mandates. Within such a review it is important to recognise that applied research can also give rise to new directions for basic research, such as the development of new theoretical approaches being made possible through the collection of large data sets during routine monitoring programs. Therefore applied research was also evaluated, but only in the context of its contribution to basic knowledge, as assessed by its publication in internationally peer-reviewed journals. Furthermore, all research groups evaluated during the review were ranked using the same scale, with the same emphasis on basic research, irrespective of their institutional mandate. The Panel did not evaluate purely applied research because this fell outside its mandate. However, it should be acknowledged that in a basic research context a ranking of “fair” might actually be assessed with higher scores in an applied context.

With this emphasis on basic research, it was felt that it was not appropriate to rank the state colleges who participated in the evaluation, as they did not constitute research communities in the context of national basic research, as judged by international standards.

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## General conclusions

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### Overview

As a Panel we found the presentations by the representatives of the research units and the following discussion to be very valuable complements to the written reports. The discussions were very open and it was the general feeling among the Panel members that these hearings helped not only to assess the performance of the different research units but they also gave us good opportunities to reflect on the functioning of the Norwegian research system as a whole.

The Research Council initiated this evaluation in order to get advice on how to formulate future research strategies. In this respect the Research Council has asked much the same question asked by other national funding bodies. This means that the evaluation, although it has the primary objective to assessing Norwegian basic research, is likely to have broader implications and it will become part of the ongoing international discussion on how to foster competitive basic research at the highest possible level. The Panel members, representing different fields of biology and with experience from various national and international research systems, therefore want to congratulate the Research Council for initiating this evaluation and as a Panel we feel very privileged to have been able to be part of this important process.

Before summing up the general conclusions of the evaluation we would like to underline a number of very important trends that we see in the international development of biology, to which Norway has to relate. These include the development of *technologically driven* tools including genomic analysis, complex systems analysis and computer methodologies (e.g. geographical information systems), and *conceptually driven* questions related not only to the advancement of biology as a science but also to various issues arising from human influence on the environment (e.g. ecosystems dynamics, management of human activities and the effects of climate change on organisms and their ecosystems).

Technological tools such as large scale DNA sequencing are spawning major research programs with an enormous range of application. The genomic programs currently underway are accumulating more and more DNA sequence data for an increasing number of organisms. This development is now reshaping not only molecular biology but also the various fields of more traditional organismal biology and ecology. Increasingly, research approaches similar to those used in genomic sequencing can now generate knowledge about functional aspects of this genetic information. This development is often called “functional genomics” and it is expected to open totally new opportunities for the study of complex biological phenomena (development, stress, adaptation, metabolism, interactions, diseases etc) at various levels of organisation from the molecule to the ecosystem. New emerging technologies such as proteomics (large scale protein analysis) and metabolomics (large scale analysis of metabolic products), linked to advances in bioinformatics, are set to not only continue this revolution in the way biological questions are addressed, but will increase the pace of change.

Similarly, technology driven advances in computer hardware and software such as geographic information systems are increasing our data collection capabilities and our data analysis requirements. One important application that is transforming ecological research is analyses of spatial patterns and relationships, where increased capabilities for data acquisition is allowing a new suite of questions to be addressed in both terrestrial and marine ecosystems.

Concept driven questions are increasingly commanding the attention of the international research communities and in the struggle to address these questions, many of the new technologies are being called into play. It is now necessary to organise research to gather together the necessary knowledge and technologies to make use of the opportunities that lie in the combination of global databases and large-scale analytical techniques, all combined with strong computational and mathematical support. With this development, biology enters a new era to which the academic systems in every country need to adapt.

The interaction between conceptually driven questions and technological drive tools has been perhaps most evident in the realm of marine biology, and are of increasing importance in Norway. This is especially so in the arena of fisheries, and these developments will require increased investment within the institute and university sectors if Norway is to stay current and internationally competitive.

The new technological tools, and questions generated by changing societal concepts, are having an enormous effect on the opportunities and progress of basic biological research, with major biological discoveries arising at an increasing rate. Being at the forefront of international biological research means participating in the development and elaboration of these new biological discoveries. To be able to conduct and support research at the leading edge increasingly requires the training of scientists capable of using, and at times developing, these new and rapidly evolving technologies. It also requires a research environment that is able to maintain both broad disciplinary excellence and focus on the evolving concept driven questions.

When discussing the research system of a small, but highly educated and developed nation such as Norway, one must be aware of the fact that research in basic biology is international and that a small country can not make a major contribution from a quantitative viewpoint. Nevertheless, with a research system that produces results of high quality, as measured in an international context, small nations can make very significant contributions, including defining research directions, and in this way become integral partners in major international developments in science. In this way global advancements in science, which would otherwise be far beyond the level of national investment, can be fully accessible to small countries. This is of great importance for small nations who want to be at the forefront of the present strong development towards a knowledge-based society.

For Norwegian scientists to become actively engaged in developing and exploiting these new opportunities in biology will require significant national investment and co-operation between researchers from traditionally disparate fields. Support for basic science to create the knowledge structures on which the societies commercial



enterprises can develop new goods and services, while managing resources in a way that does not over-exploit the environment, will therefore become an increasingly important strategic national investment. The government has a special responsibility to support these new developments in basic research because if this support is not forthcoming it will not be possible to create optimal opportunities for the successful exploitation of new discoveries for the benefit of the nation.

Another strong trend in biology is the increasing involvement of commercial interests. This is not a new phenomenon since fisheries, agriculture, forestry and horticulture all have a long tradition of developing in close interaction with science. However, the new developments in biology have resulted in a proliferation of new opportunities, resulting in the development of various types of partnerships between industry and academia, such as we are now seeing between the pharmaceutical industry, information technology and academia. All these changes in biology, ecology and biotechnology, as put in the context of the development of knowledge based economies, must be taken into serious consideration when formulating future research strategies at governmental, Research Council and departmental levels.

## **The Research Units**

These general conclusions, by their very nature, contain a synthesis of the data and impressions gathered during the evaluation. We are conscious of the fact that these comments are generalisations and therefore that they will not always apply to all institutions, departments or research groups evaluated. However, we feel that the conclusions set down below represent a fair picture of the current state of the research groups and institutions we had the opportunity to meet during this evaluation.

## **Organisation, management and leadership**

At the level of individual departments there has been a strong move away from the traditional organisation based on individual senior professors, toward a more democratic model. Unfortunately, a similar move to a democratic model does not seem to have occurred vertically within the universities, and the administrative decision-making processes have not been transparent at the department level. Furthermore, while the democratic model sounds attractive, at the department level this model has frequently resulted in a lack of scientific leadership. International experience has shown that the most accomplished scientists within the departments should lead. These leaders should have the responsibility to develop research strategies for the department and the authority to promote these strategies vertically within the university administration. The current practice of giving elected members 3-year administrative leadership roles is not encouraging the development of effective research strategies.

University hiring policies, which have given highest priority to covering teaching needs, have fostered the creation of many small research groups with limited

connectivity, effectively fragmenting department research profiles. This has frequently resulted in single person groups that are too small to be productive and certainly can not be competitive internationally. The seriousness of this problem is demonstrated by the exceptions, those outstanding groups in Norwegian institutions that have managed to develop a critical mass through strong intellectual leadership and judicious use of external funds.

The fragmentation of department research profiles, resulting in part from the teaching oriented hiring policies, have resulted in a lack of flexibility and departments are now unable to respond effectively to rapid developments in their research fields. Clearly, 'teaching need' should not be used as the sole determinant for hiring policy and the department's long-term research strategy must become an important component of the hiring policy in the future. This policy has also lead to duplication between institutions, and the current interest in the development of state colleges into universities would only exacerbate this problem. The fact that block funding to departments from the University is tightly coupled to student numbers has no doubt contributed to these policies. Norway has only a small population base and it is not practical for all institutions of higher education to attempt to be broad-based traditional educators.

What we saw as missing is the formation of regional research 'groups' that should be co-operative rather than competitive in order to create the critical mass needed to develop a high ranking research environment, and to generate competitive grant funding. Co-operation of this sort would inevitably also lead to the development of a very high standard of both undergraduate and graduate training, but as a product rather than as a design requirement. The development of such regional groups, determined by need and common goals, could then be used to guide revising departmental structures, not only by amalgamation as appears to have been a major recent occurrence, but also by functional connections that would, in part, minimise duplication of function and expertise.

Norway has a very strong institute sector that responds to the needs of the various Ministries and that also conducts important basic research. The problem of balancing applied and basic research in mission-driven institutes is of course not new and we identified several good examples of how this can be addressed by strong collaboration between institute staff and their academic counterparts. Such collaboration serves many positive functions, including helping institutes maintain a significant focus on basic research, ensuring that university research addresses contemporary issues and helping university researchers to obtain significant external funding. The balance between institutes and universities is especially important in marine science because of the very high infrastructure costs of owning and operating ocean-going vessels, and it is therefore important to ensure that projects that obtain ship time are of the highest quality. To make the most of the infrastructure for promoting basic research, and for ensuring that applied research has the best possible basis in the future, it will be important for marine science research to be organised jointly by the leading scientists from many disciplines and from both institutes and universities. That is to say, university faculty should be full partners with their institute colleagues and not, as has been so often the case, only involved in a piggyback capacity or on a 'not-to-interfere' basis.

## **Research strategies and priorities**

Few departments or research groups presented a strategic research plan. It is important for researchers to recognise that transparency must go both ways – not only must scientific administrators and funding agencies be transparent in their objectives and expectations, but researchers must also clearly formulate and present their future research objectives and the strategies they plan to adopt to achieve them. Groups from the university sector frequently commented on the importance of their democratic model and of individual academic freedom. However, this development in democracy and individual academic freedom, coupled to the lack of unified departmental research plans, has occurred as university administrations have become involved in management at a level that should be controlled by the department. This micro-management, which may be responsible for the weakened departmental structure, could be more easily resisted if the departments developed clearly formulated strategic plans.

Given the government's goal to increase funding in the future, the general lack of forward planning at all levels that became evident during the evaluation was striking. It is hoped that this report can act as a stimulus for the development, in the very near future, of strategic plans for both university departments and research institutes, taking into account the steps that need to be taken to develop competitive biological research for the future.

## **Recruitment policy**

It is clear from the material provided that many university departments and research institutes have age profiles biased towards tenured staff approaching retirement. This provides these departments and institutes with the opportunity to develop research strategies now that can form the basis of their hiring policy during the next 5 to 10 years. However, if such strategies are to be successful it will also be essential to implement a program of start-up funding for new staff. This is especially important for people recruited to develop new sub-fields. It became apparent during the course of the evaluation that many of the new staff hired during the last 5 years had failed to develop the promise shown by their early careers. In many cases this could be directly attributed both to their isolation as single-member 'research groups' and to the fact that no funding was provided for them to establish their research. Many of the groups interviewed also noted that it was difficult to attract top international candidates because of the limited funding available for start-up. If suitable start-up funding is made available, the current system of hiring new staff on permanent posts could also be re-evaluated and serious thought given to introducing a tenure-track system. Lastly, the time taken to hire new staff needs to be drastically reduced. Many groups mentioned that by the time this process was completed the top candidates were often lost because they had been offered positions elsewhere.

## Training and mobility

The general impression of the Panel was that Cand. scient. and Dr. scient. training was of an international standard. However, many groups expressed the opinion that to get an externally funded Dr. scient. position it was necessary to have a highly qualified candidate named in the application. The Panel felt that it would be far more appropriate for the projects to be evaluated independently, and that successful research groups should then be free to advertise available positions nationally and internationally. This would facilitate the movement of students between universities and institutes and enable the research groups to attract the best candidates.

Under the current Dr. scient. program, students have only 3-4 years of guaranteed funding. For these graduates to develop the competence necessary to lead research groups that compete at an international level it is *essential* that they have the opportunity to undertake prolonged post-doctoral studies abroad. At present there appear to be very few such opportunities. Most departments have a limited number of university funded (GUF) post-doctoral positions, many of which are filled by their own recent graduates. This situation is counterproductive to a goal to generate highly skilled internationally competitive scientific researchers. We identified several possible solutions to the current situation. One might be to take the funding for the GUF positions away from the universities and give it to the Research Council to develop a program of competitive post-doctoral grants, open to all recent Dr. scient. graduates, both nationally and internationally. Ideally the successful national candidates should be encouraged to take these positions abroad for 2 to 3 years (or 2 years abroad with one year of funding available upon return to Norway). An alternative solution might be to develop the post-doctoral program into two streams. In one stream, the Research Council should generate funding from the various Ministries for a competitive grants program open to all Norwegian graduates for post-doctoral studies abroad. In the second stream, the universities should use their GUF positions to target foreign post-doctoral candidates who could introduce new methodological and theoretical approaches to the Norwegian groups. Such a dual program would have the advantages of creating more post-doctoral positions within the university sector, of introducing new and competitive technologies to Norway and of enhancing the experience, competitive ability and international stature of Norwegian graduates.

## Publication strategies

From the publication data provided it appears that Norwegian botany and zoology publishes quite well per capita in international journals, while Norway scores low in fields listed as "biology and biochemistry", and "molecular biology and genetics". When it comes to the assessment of impact parameters Norway generally scores low in an international comparison and falls behind the other Nordic countries. Again botany and zoology score better than other fields of biology.

In our assessment of publication we found that the publication strategies were heterogeneous, but there was generally a strong tendency to publish in traditionally

safe, mid- to lower-level international journals. Not enough groups were targeting the leading journals in their fields. Targeting of such journals should be encouraged, if for no other reason than because simply aiming for such journals lifts the standard of the experimental and theoretical approaches taken. However, publication in such journals does take more effort and it will naturally lead to a reduction in the quantity of publications. The importance of this shift from quantity to quality needs to be recognised by the funding agencies so the researchers are confident that they will not be punished for attempting to reach the higher standard.

The Panel noted that there were exceptions where this approach was not appropriate and was very careful not to simply use indicators such as 'impact factors' when assessing the quality of the publications. For example, publications such as systematic monographs may represent very important basic research but it is not appropriate to publish them in 'high impact' journals. Such publication efforts were therefore assessed according to their individual merits. In addition, the Panel noted that Norway has a large number of local journals that Norwegian scientists feel an obligation to support. As a consequence, many publications do not achieve sufficient international distribution and impact and avoid a critical international peer review. A different balance needs to be struck between support for these national journals and publication in the leading international journals in the different fields.

## **Attitude**

The research groups generally appeared to be frustrated and resigned to the current administrative and funding situation. They appeared to have little trust in the funding agencies and to feel that initiatives on their part were ignored by the administration of their home institutions. The groups identified a strong hierarchical or 'top-down' management style within the university and institutional sectors with little transparency in the decision making process. Most important, it appeared that many groups had no plans for working around these problems and were being paralysed by them. The source of such a desperate situation may lie in the transition from block funding to a competitive grants system, with an associated loss of confidence in the funding system. This breakdown in confidence may have its roots in the heavy earmarking of funding to prioritised areas that are defined by the Ministries. The frustration over the funding situation that was evident during the interviews may also reflect a failure of researchers to adapt to the changing research funding procedures, as suggested by the fact that some found ways to work within the system and did not necessarily share this negative outlook. Regardless of its origin, steps need to be taken at a national level to reverse this development, and the Panel hopes that this evaluation may act as a catalyst for this.

## **Equipment**

The time limits imposed by the structure of the evaluation process made it impossible for the Panel to make site visits. This made it difficult to evaluate the suitability of the facilities available to the different groups. Nevertheless, the general impression given

by the groups during the interviews was that the level of support for large equipment was adequate. However, without site visits it was not possible for the Panel to judge if this was due to funding being adequate or to low ambition on the part of the researchers, and whether more competitive research might have resulted in an increased demand for equipment to establish new technologies.

Concern was expressed that there were problems with getting funding to replace small to medium priced departmental equipment. In addition, there were several instances where funds had been made available for major equipment purchases, but no allocation was made to fund the necessary support staff. Frequent concern was also expressed about the reduction in funding for technical support in both the university and institute sectors. This problem is not unique to Norway and in most countries permanent research technicians have generally been replaced by short-tenure post-doctoral positions. Modifications to the post-doctoral funding system in Norway, along the lines suggested above, might go some way to alleviating the worry about the reduced support for research technicians expressed during the evaluation. However, it will not address the problem of funding major new equipment initiatives without also funding an appropriate level of support personnel. This is an issue that the Research Council will need to address in the near future, perhaps in collaboration with the universities or institutes supporting the applications for these major new initiatives.

## **Collaborative networks**

In general most groups presented clear evidence of collaborative links. International links were particularly well developed in most research groups. National links were also strong and the only real weakness was at the regional level. As mentioned earlier, given Norway's geographically scattered museums, universities and research institutes, and small population and funding base, it is essential that regional groups from different departments and institutions form strong collaborative units within which the research links are transparent and effective. Some mention was also made during the week that the emphasis on links to large EU programs had resulted in a weakening of regional collaboration. It is essential that this situation is reversed and that stronger regional research co-ordination help the universities and institutes to function as single units wherever this is practical.

## **Balance between fields**

This was difficult to assess because many of the university departments and research institutes had sections that went before different panels, or were not reviewed at all. However, in general within the biological sciences there appears to be a strong emphasis on marine biology. While Norway's geographical location and long history of dependence on the sea might justify this emphasis, it has the potential to lead to duplication of effort at the expense of other research fields. This is particularly critical because internationally competitive research programs increasingly must draw on diverse disciplinary knowledge. Therefore mechanisms for maintaining a wide range of disciplinary knowledge must be built into any national science policy that would

promote specific areas such as marine biology.

We identified much strength in marine biology in the universities and institutes and there is great potential for renewing and further developing Norway's traditional strength in basic as well as applied marine research. In addition to the disciplines of marine biology, such as fishery biology, we were able to identify many good to very good research groups covering microbiology, biology and zoology, but we also found groups that were not performing well despite the Norwegian emphasis on marine research. Furthermore, several key disciplines that are necessary in support of marine studies, such as taxonomy, were weak and this will need to be addressed if Norway is to maintain its strength in marine biology.

On the background of the traditional strength in marine research, the field of limnology appears to have a decreasing priority in Norway. While a few groups are conducting very good research in freshwater biology, the efforts are geographically dispersed and insufficiently co-ordinated. It is important for Norway to reconsider how research in limnology will be maintained at an international level in the future.

Some of the strongest groups met by the Panel were working with ecological questions, both terrestrial and marine. However, their work covers only relatively narrow fields, especially relating to population dynamics and the evolutionary ecology of mammals and birds. These groups have educated a large number of competitive scientists, who have often continued studying similar questions, even when employed by institutions that should work with other problems and that have additional obligations. The academic freedom being exercised by researchers in such positions has indirectly led to a shortage in taxonomic and ecological studies concerning other important terrestrial groups, such as insects.

Lack of taxonomic expertise is now a problem in all countries, in spite of an increased demand for this expertise. Because the number of taxonomic groups clearly exceeds the possible number of experts in a small country such as Norway, the Panel saw a need for joint Nordic programs that could utilise the expertise in neighbouring countries. However, it should be noted that the formation of such networks will not correct the current imbalance unless those researchers with the responsibility to curate and study particular taxonomic groups concentrate their efforts on this task.

The situation is different in botany where systematics covers a large number of taxonomic groups. Classical taxonomy of plants and fungi (including lichens) has been complemented by additional methods, especially molecular techniques, to suggest new phylogenetic hypotheses. However, in contrast to this diversity in botanical taxonomic expertise, there is a severe shortage of scientists involved in hypothesis testing in experimental plant biology and ecology. In view of the rapid international development in experimental plant science, based on the use of model plants and the rapidly increasing availability of genetic information, we feel that steps need to be taken to strengthen plant physiology at the organismal and cellular levels. Steps should be taken to introduce, and make use of, the new technologies that are emerging in the fields of genetics and molecular biology. Without such efforts there is a clear risk that experimental plant science will dwindle over time and that Norway will not be able to develop international competitiveness in plant biotechnology.

## The funding system

One of the questions covered by the Panel's mandate was to assess whether the research groups being evaluated were in a position to answer "tomorrow's questions". While this is a very important aspect of a review such as this it avoids the critical issue, which is that unless there is long-term support for basic, curiosity driven research, few groups can be expected to be in a position to recognise "tomorrows questions" when they arise, much less provide answers for them. The current emphasis on program directed research, motivated by applied needs, has forced both university and institute scientists to focus on solving "today's problems", with little time or funding to ponder tomorrow's. The strong dependence on EU projects in some research units further emphasises this dependence on external money motivated by relatively short-term needs. This situation has created two principle strategies from individuals who are motivated to maintain their basic research programs. A few scientifically outstanding individuals manage to cope with this system of financing by applying for and receiving a large number of relatively small grants. However, the majority of scientists are pushed to diversify in order to attract whatever money is available. The effect of both strategies is a loss of focus and a fragmentation of the research effort of the individual groups.

Basic research in science operates with two principal driving forces. One derives from the curiosity of individual scientists, searching for an understanding of nature for the sake of understanding, and the second from practical needs that motivate a systematic search for knowledge, with the aim of solving a particular problem. Very often, and some would say ideally, the two driving forces interact and should not be separated. This is often true in the short-term perspective. However, we must be aware that curiosity driven research can address questions well beyond our current understanding of nature, while research motivated by utilitarian needs has less freedom to explore and is restricted by the need to solve a particular problem. This means that curiosity driven and utilitarian driven basic research often ask different questions and operate over different time scales.

We would argue that both facets of basic research need adequate support in a society that wants to build on knowledge, and neither curiosity driven nor utilitarian driven research can develop without the support of the other. Therefore, too much emphasis on motivating basic research from an applied or strategic viewpoint will not maximize the potential of research to produce utilitarian results for the society because in the long-term, progress in applied research inevitably springs from a strong base of fundamental knowledge. The one structural entity within a society that can support and foster curiosity driven, competitive research is the government. This is not the role of industry, and it is not the role of special interest groups within the society. It is quite clear to the Panel that if Norwegian biology is to be able to increase in international significance and become a strong force for social and economical development, Norway has to strengthen curiosity driven basic research at the universities and institutes.

The question the Research Council must now ask is if their present strategy for



funding is appropriate for fostering new and innovative basic research in the university and institute sectors, where block grants are tied up by long-term commitments to salaries and maintenance of the local research infrastructure. We feel that with the present strong emphasis on directed research through the various programs, Norway will have difficulties to foster the type of academic excellence that is the prerequisite for the creation of basic biological science of high quality. One strategy to correct this development would be to change the balance between curiosity driven and program directed research. Increased emphasis should be given to curiosity driven research developed through a rigorous international peer review, based more on the scientific quality of the proposals than occurs at present. If such a step were taken, while at the same time improving dialogue between the university and institute sectors and various sectors of the society, Norway would be able to make better use of its research investments than can be achieved by the present system of strongly directed science.

These important aspects need to be considered when formulating the national long-term policy for funding competitive basic research in natural science. It is the view of the Panel that a coherent and transparent single science policy needs to be developed for Norway so that science funding can be used more efficiently. This policy needs to be developed in consultation with active research scientists from both the university and institute sectors and these researchers must have a strong voice in the policy that is developed by the Research Council and presented to the government.

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## Recommendations

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As stated in the preceding sections, during the course of this evaluation we have noted a number of structural weaknesses that reduce the competitiveness of Norwegian science in the fields of biology and the relevant areas of biochemistry. If Norway wants to become more competitive in basic scientific research at an international level then the balance between problem driven and curiosity driven research needs to be changed. To this end we recommend:

### 1. Modifications to the funding system

- The Research Council should revise its funding systems in order to improve its procedures to include less bureaucratic control and more input from leading scientists, and to improve the transparency and accountability in the review processes used.
- The Research Council should work to increase the availability of funding for basic research, with grants assessed by a rigorous international peer review system, in order to find a more optimal balance between curiosity driven research and research driven by utilitarian needs.
- The institutes should work to include researchers from the university sector as full partners when developing research programs so as to more effectively utilize their funding and their large investments in infrastructure.
- For Norway to increase its basic scientific competitiveness will require substantial new investment in emerging technologies such as, but not limited to, genomic analysis and bioinformatics.

For any changes in funding to be effective in enhancing the competitiveness of Norwegian science, they must be linked to structural changes, especially changes that encourage strategic planning, the development clear departmental and institutional research profiles and changes that enhance the quality of research leadership.

### 2. Creation of more focussed research strategies

- University departments and institutes need to clearly formulate their scientific priorities. Their strategy should be to develop distinct research profiles in the national context, with the aim of creating national centres of excellence.
- The Panel strongly recommends that the current practice, in the university sector, of giving departmental members 3-year administrative leadership should be abandoned in favour of the appointment of senior departmental chairs, perhaps for periods of 5 to 6 years. The departmental chair should be chosen from among the leading scientists within the department. These leaders should have both the responsibility and the authority to formulate

departmental research strategies and to vigorously promote these strategies vertically within the University and funding administrations.

- The age profiles of most research groups in Norway are biased towards late career scientists, and most university departments and institutes will need to hire a number of new staff over the next 5-10 years. Therefore university departments and the institutes should develop hiring policies based on forming strong competitive research units with a clear research agenda.
- If a hiring policy biased towards the development of a specific research profile is implemented, it is also essential that there is a policy of supporting new positions. This should include adequate start-up funding and adequate access to peer reviewed competitive funding, perhaps for an initial period of 5 years. Without such support newly hired persons have a high risk of failing to develop their potential. With a more favourable environment being created for early career scientists, it would also be useful to reconsider the introduction of tenure-track or a 5-year review system for new appointments.

### **3. Improving training and mobility to increase the competence and international competitiveness of the next generation of Norwegian scientists**

- The current trend for students to remain at the one institution throughout their training does not optimise training and is detrimental to the development of innovative basic research in Norway's universities and institutes. Training opportunities could be improved if Dr. scient. positions were awarded to researchers on the basis of competitive, peer reviewed grant applications, with the successful research applicant then being free to advertise positions nationally and internationally.
- The post-doctoral system needs to be overhauled if Norwegian graduates are to develop the competence necessary to lead research groups that compete at an international level. Funding urgently needs to be allocated so that Norwegian graduates can apply for competitive grants to undertake prolonged post-doctoral studies abroad. The universities, institutes and the Research Council should actively discourage the current trend for new graduates to stay at the institution where they were awarded their Ph.D.

### **4. Publication strategies**

- All research groups should place an increased emphasis on publishing in the very best international journals available. This development needs to be supported by the Research Council by increasing the proportion of funding being awarded on the basis of competitive peer-reviewed grants, where there is a clear emphasis on the scientific quality and significance of the proposed work.

## 5. Making use of Norway's unique opportunities

- The research policy of Norway is directed to making good use of the unique opportunities offered by its geographical location, e.g. its marine and sub-arctic to arctic environments. However, the Panel would like to emphasise that such priorities should not be pushed too far. Such a strong focus on limited fields can lead to losing competence in other areas of research, resulting in opportunities for cross-fertilisation from other research fields being missed as these fields advance internationally.
- Marine science is a strongly prioritized research field in Norway. Marine science is a broad field and we have not been able to review the balance in the different aspects of it within the university and institute systems. In addition, while this review has focused on the quality of basic biological research, we have not been able to assess the entire scope of marine biology, let alone marine science. Furthermore, we identified a serious lack of strategic planning in both the university and institute sectors. This suggests that a review of all marine science programs would be helpful in developing a balanced national research program. We suggest that marine science would benefit from an in-depth international evaluation aiming at defining priority areas and, more specifically, at identifying areas of existing strengths and weaknesses.

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## Review of individual research groups

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### University of Oslo

#### Botanical Garden and Museum

*Overall Ranking: Good*

The Botanical Garden and Museum are now part of the new unit "The Natural History Museums and the Botanical Garden", which is directly under the University board. Overall, there are 8 permanent academic staff, whose duties include curating the museum collections (including the living collections in the Botanical Garden), teaching at the University of Oslo, supervising graduate students, conducting research in different fields (mainly or partly based on the collections), and taking care of public relations and information. Museum researchers have successfully supervised 23 Cand. scient. students and 1 Dr. scient. student since 1994. External funding accounted for 14% of total available funds in 1998.

At present there are three research groups:

- a) Taxonomy, biosystematics and evolution of vascular plants
- b) Taxonomy of fungi and lichens
- c) Vegetation ecology

#### ***Taxonomy, biosystematics and evolution of vascular plants***

Five professors and three doctoral students are integrated in research dealing with Norwegian, Scandinavian and circumpolar, as well as Macronesian, flora. The studies are based on the living collections available through the Botanical Garden and on herbarium material stored in the Museum. Important results include a revision of the Norwegian flora, comprehensive contributions to the flora of Macronesia, diverse contributions to systematics and phytogeography of critical taxa of Norway, Scandinavia and the boreal, subarctic and arctic regions. This research is ranked as good.

#### ***Taxonomy of fungi and lichens***

Two permanent scientific positions are available for curating the fungal and lichen collections. Studies by three students (1 Cand. scient. and 2 Dr. scient.) have recently been completed. Research is based on the collections of the Museum and focuses on the worldwide taxonomy, ecology and phytogeography of fungi and lichens. Museum researchers have published important contributions on the lichen and fungal flora of Norway. These studies are based on comparative light microscopy and also include chemical analyses as well as ultrastructural and molecular data. Ecological studies deal mainly with the conservation of fungi and lichens as indicators of pollution. Considerable time has also been spent on the national database project, which includes the Museum collection. Though there is heterogeneity within the group, this research is ranked as good.

### *Plant ecology*

This is a group run by a single permanent member of staff, supported by research students. There is a long tradition of floristic and taxonomic research covering Norwegian, Scandinavian and circumpolar floras, as well as Macronesian flora and some taxa on a global scale. Researchers have expertise in all terrestrial plant groups and in classical and modern techniques. Their work is facilitated by the availability of large collections and a comprehensive up to date library. The taxonomic expertise on mosses and higher plants is used as a basis for ecological studies, with the main emphasis on forest understory vegetation, boreal swamps, bryophyte population biology and the effects of nitrogen deposition on mire vegetation. These studies are mostly descriptive, but they also include experimental aspects. The studies focus on Norwegian boreal forests, arcto-alpine and coastal ecosystems (including mires and agricultural landscapes). In most cases the research groups consist of one person in a permanent position and a variable number of students. However, the number of students is very low and this is considerably hampering the research. This sub-optimal situation is also documented in several cases by low publication rates in international journals. The results are ranked fair to good.

In general, it is important to further integrate the scientific activities of the Museum and the Botanical Garden with the biological education and research of the Faculty of Science, University of Oslo, as well as other institutions dealing with taxonomy and ecology of terrestrial organisms in Norway. The collections of the Museum have been gathered over a long period and represent a valuable archive of biodiversity for those regions from which they have been collected. This archive is a unique resource for modern systematics, based on molecular techniques. The collections should be used as much as possible for research and for the education and training of students in floristic, taxonomic and vegetation studies. In this new structure, it is important that the mission of the museum is clearly defined. A new 6-year strategic university program application is being prepared and this represents an ideal opportunity to lay down the Museum's future plans, however, the strategic plan that was presented for the future development and use of the collections was not at all convincing.

It is recommended that the effectiveness of the Museum and the Botanical Garden's public information systems be strengthened, especially in the fields of biodiversity, and in local and global ecological problems.

## Zoological Museum

*Overall Ranking: Good*

As with the Botanical Garden and Museum, the Zoological Museum is also now part of the new unit "The Natural History Museums and the Botanical Garden", administered directly by the University board. The museum includes five professors who work in the fields of parasitology (3), behavioural ecology (1) and walrus/polar bear field studies (1). These groups collaborate mainly with the Department of Biology at the University of Oslo, although there is some international co-operation on the walrus/polar bear research. External grants account for approximately 60% of the funding for the Museum.

The staff devotes approximately 50% of their time to research, the rest being spent on administration and curatorial duties. Scientific activity varies considerably among the different groups in the museum but generally it is high in the field of behavioural ecology and fair to good in other areas. The balance between theory and experimental approaches is good in behavioural ecology but for other areas observational studies predominate. The methods used included an increased emphasis on the use of the DNA laboratory but the questions to be tackled utilising this technique are often unspecified and no clear picture emerged on how the different groups planned to benefit from this new technology.

Generally, the research groups are very small, except for parasitology. Therefore the groups need to better combine and co-ordinate their activities with the Department of Biology at the University of Oslo. The Museum groups also need to do more teaching and attend combined seminars with the Department of Biology. This increased co-ordination would benefit both institutes.

There is clear duplication of activity between the behavioural ecology activity at the Museum and at the Department of Biology. The Panel felt that Lifjeld would benefit from being moved from the Museum to the University as his work in behavioural ecology is not related to the function of the Museum and his research would strengthen the zoology division at the University of Oslo. There is equally clear complementarity (and an obvious need to pool resources) for mammology.

The project leaders are capable, but the 3 professors working in parasitology are nearing the end of their careers. In the past, research topics were chosen for historical reasons, relating to the personal preferences of the professors, although there was some evidence of direction coming from program topics. For the future, the Museum needs to develop a clear strategic plan and a coherent hiring policy to cover these positions, as they become vacant. No such plan was presented during the evaluation.

Finally, most of the research at the Museum could be done anywhere, it is not museum related and the low activity of classical systematics is a concern.

# Department of Biology

## Division of Botany and Plant Physiology

*Overall Ranking: Good*

The Division of Botany and Plant Physiology has a total of 12 permanent academic staff with a broad range of competence covering important aspects of plant and fungal biology. The laboratories are mostly well equipped and 37% of total funding came from external grants in 1998. There are many candidates with final degrees, but recently the number of students has been fallen sharply. Though there are several very well organised research groups, some groups appear to be sub-critical, and there is not enough effective co-operation between the groups.

At present there are three broad research groupings:

- a) Taxonomy, biosystematics and evolution of fungi
- b) Taxonomy, biosystematics and evolution of vascular plants
- c) Molecular biology and plant physiology

### ***Taxonomy, biosystematics and evolution of fungi***

Taxonomy of fungi is well represented with three professors leading research as well as 10 students. The group working on Ascomycetes has worldwide expertise in systematics, evolution and ecology. Molecular work is used to complement traditional comparative morphology and has led to progressive hypotheses in phylogenetics of Ascomycetes. The work on taxonomy of the Basidiomycetes is of high quality and the flora of Corticiaceae of Northern Europe is now a standard work in its field. A new edition will cover all of Europe. This flora has stimulated international taxonomic studies in lower Basidiomycetes. It is an excellent example of optimising research through intensive co-operation over a long period of time. In addition there are many original publications dealing with the taxonomy of tropical Homobasidiomycetes. The focus is on Cortinarius, the largest genus of ectomycorrhizal fungi. Molecular data now make possible the development of phylogenetic hypotheses in Cortinarius. The population genetics of fairy ring mushrooms and the fungal tolerance of toxic elements are also being investigated. The research of the mycology group is ranked as very good.

### ***Taxonomy, biosystematics and evolution of vascular plants***

The research focuses on three aspects; (i) taxonomy and biodiversity of tropical Africa, (ii) taxonomy of arctic and alpine plants, and (iii) population ecology of coastal and oceanic plants. This group has published major contributions for regional African and Nordic flora as well as critical systematic revisions of various taxa. The group uses both traditional taxonomic and new molecular methodologies. Several national and international collaborative studies document the effective and very good research of the plant systematics and evolution group.



### ***Molecular biology and plant physiology***

Two staff members in plant molecular biology have been recruited during recent years to complement the plant physiology work of the department. Conceptually this has been a good strategy for the department, but the development so far is not at all satisfactory. The two competent researchers with a background in molecular biology appear to be poorly integrated into the department. This is regrettable in view of the important role that molecular biology plays today in experimental plant biology. The dependence on building the necessary technology platforms, and the required skill and knowledge to address physiological questions at a competitive, mechanistic level, is likely to increase rapidly with the accumulation of sequence data for *Arabidopsis* and other plant species. Together with the steadily improving abilities to study global gene expression governing complex physiological processes, we are entering a new phase in the search for a better understanding of complex physiological processes.

The ability of the two molecular biologists to build competitive research groups has also been severely hampered by a lack of resources and productive collaborations with other plant physiologists. It is time for the department to stop viewing molecular biology just as a tool, and to support and fully integrate those researchers with the ability to apply new technologies in an innovative fashion. During the evaluation we were pleased to learn that steps have now been taken to integrate molecular biology and plant physiology into a new division of molecular biology. We endorse this development very strongly and recommend that all staff members working on experimental plant biology at the department support this step. If the Department of Biology wants to be competitive in the search for a better understanding of plants at the organismal, cellular and molecular levels it needs to take urgent steps to give this new division adequate resources so it has a fair chance to develop in a satisfactory way. Overall, the scientific productivity in molecular biology and plant physiology is, at present, unacceptable, with the best groups being fair.

This division presented no clear strategy on how they will use retirements to develop their research profile.

### **Division of Limnology**

*Ranking: Unacceptable to Very good*

This division has 5 permanent members of academic staff, whose research covers several important areas of limnology, including lake water chemistry, element cycling, productivity and biology of phytoplankton, effects of UV radiation, planktonic food web structure, and diversity of benthic invertebrates. Members of the division teach a broad range of courses in general limnology and freshwater biology. Thus, only at the University of Oslo may students of biology take a Cand. scient. or a Dr. scient. degree in limnology, which is taught as an interdisciplinary science involving aspects of biology, chemistry, geology and geography. In recent years the division has overall obtained 52% of total budget of its funding through external sources. The graduation of Cand. scient. candidates has been good and of Dr. scient. candidates very good.

Although limnology is an ecosystem-defined discipline, which should promote integrated and co-operative research, the division has been characterised by individualistic projects. This has obviously been a weakness and may be part of the reason why the overall quality and productivity of research is very heterogeneous. On the background of rather weak contributions from groups representing classical limnology within the division, ranking from fair to unacceptable, the excellent and highly productive studies in freshwater biology stand out and are at the highest international level. Thus, the group working on aquatic ecology and planktonic food webs represents 75% of the scientific publications in international journals. This group has a clear focus on important research problems as well as a broad perspective, ranging from cell biology to ecosystem function. The group also has good national and international collaborations.

Within the next three years, three of the five permanent scientific positions within this division will become vacant due to retirements. It is now important for the Department of Biology to carefully consider the future of limnology at the University of Oslo. If limnology is to continue as an independent discipline in teaching and in research, the division must maintain sufficient positions in this field in order not to fall under a critical mass. In that case, the Panel recommends that the discipline of limnology is rebuild using the freshwater biology group as a nucleus. An alternative, which was suggested by the division, is to restructure the department and to establish a Division of Biogeochemistry, including limnology and marine chemistry. However, given the present personal resources of the department, the Panel considers a Division of Freshwater Biology as potentially more promising, but does not see this as the only constructive solution.

## **Division of Marine Botany**

*Ranking: Good to Very good*

There are 4 permanent faculty members in the division, studying the biology, ecology and physiology of marine phytoplankton and benthic macroalgae. The division has very good support through external funding, which provided 53% of the total budget in 1998. However, the group says it finds it difficult to obtain funds from the Research Council because much of their research does not fall within defined strategic programs. The rate of graduation of Cand. scient. and Dr. scient. candidates is, at present, low.

The division maintains collections and taxonomic information on a range of algal species, which are important in relation to harmful algal blooms and eutrophication. The division considers its special expertise on algal taxonomy and ecology unique in Norway and stresses that their maintenance of a museal collection of these organisms is a national responsibility. The research of the division covers important aspects of marine botany. There is currently a special emphasis on bloom forming, toxic algal species that are of significance for coastal ecosystem management. The group currently works only in coastal waters and has stopped earlier international activities in biological oceanography, partly due to lack of funding and access to ocean-going research vessels.

Biodiversity is an important aspect of the research, and the division is increasingly using the facility of the DNA laboratory for sequencing. It is important that the department establishes sufficient capacity of the DNA laboratory to ensure its future service function for this and other divisions. However, in addition to the phylogenetic work the division should establish closer collaborations with other groups in northern Europe who do excellent research in this area. Another facility used intensively by the division is electron microscopy, and the use of stable carbon isotopes as a tracer for marine benthic food chains will be done through collaboration outside the department.

Within the next 7 years, three of the four permanent scientists of this division will retire. It is important that the Department of Biology considers well in advance how to fill the positions so that these and other concurrent retirements are used to ensure a strong and consequent structure. The Panel finds that the subject of marine botany will continue to fill an important function in the future research spectrum of the Department of Biology. However, a sound strategic plan needs to be developed so that potential new appointments will be able to integrate developing technologies into the department without causing fragmentation of the division and a dilution of its research effort.

The quality of research is generally good to very good in all the working groups. Publication is steady and mostly in leading international journals.

### **Division of Marine Zoology and Marine Chemistry**

*Ranking: Not acceptable to Very good*

The division employs six permanent faculty members, whose research activity has focused on the ecology of large vertebrates and their parasites, on plankton and planktivorous fish, on benthos sediments, and on the biology of copepods that parasitise fish. The division has graduated a good number of Cand. scient. students and four Dr. scient. students since 1994. In 1998, 42% of the divisions funding came from external grants.

The research of the division has been pursued in four rather separate groups, with a wide range of accomplishment. The research questions in both the plankton and benthos research projects address issues of great scientific interest. The plankton project makes use of unique deep sea research opportunities near the University, and uses state of the art acoustic techniques to describe the nature of the vertical overlap and interactions of plankton and various planktivorous fish over diel cycles. The benthos studies have also used acoustic techniques, establishing gradients in sediment biodiversity along latitudinal and depth gradients. The strength between these two groups in using acoustic techniques is great, and there is the potential for these techniques to be applied to other scientific questions, including freshwater systems. The results obtained by the benthos and the plankton research were very good.

The other two research areas were not competitive. However, there is applied interest in some of those studies for addressing some aquaculture disease problems, and for documenting regional pollution levels in marine food chains, especially in seals.

These projects suffered especially from low rates of publication, restricting their impact on their sub-fields.

The Panel did not rank or comment on Marine Chemistry as it is not a viable group and we assume that when the position becomes vacant it will not be refilled.

## **Division of Zoology**

*Ranking: Outstanding*

The division employs 6 professors and 2 associate professors with excellent records of external grant funding, resulting in 68% of total expenditures in 1998 coming from external sources. Training between mathematics and biology is excellent for both sides. The division has graduated a large number of Cand. scient. and Dr. scient. students.

Research in the Division of Zoology focuses on population and behavioural ecology and evolutionary biology. This division has a superb publication record and there is ample evidence that the groups work together in harmony, bringing in international collaborators to fill gaps in their own expertise as required. The methods used are a fine blend of theory, experimental, observational and comparative approaches. Of the different groups, Stenseth, Ims and Slagsvold are each world leaders in their own fields. The research problems are well chosen and are clearly developed in consultation with the international research community. The division has a good age structure, though Stenseth needs a junior, scientifically robust, permanent colleague. The division has exemplary local, national and international collaborators. From the Panel's perspective Lifjeld would be better transferred from the Museum to join this division in order to provide a better environment for his research. During the interview the division representatives presented clear research plans for future developments within their fields. The overall quality of research in this division is outstanding. There is clear potential for this division to develop into a centre of excellence.

# University of Bergen

## Department of Botany and Bergen Museum

*Ranking: Very good*

According to the present organisation, the Department of Botany, the Arboretum and the Botanical Garden at Milde belong to the Faculty of Mathematics and Natural Sciences. The Bergen Museum is administratively a separate institution. However, there are several cross-linked activities and responsibilities by leading staff members in two of the three units, which unite them as a coherent and scientifically strong unit. Together, these units employ 14 permanent faculty. Botanical research in Bergen has a long tradition with a high international standard in plant systematics, plant ecology, and vegetation history and pollen analysis. The wide range of research activities is internationally based and often published in international, peer-reviewed journals. The Department of Botany and the Museum has graduated of 36 Cand. scient. and 6 Dr. scient. students since 1994 and in 1999 received 34% of its funding from external sources.

### *Plant systematics and ecology*

Research in experimental taxonomy, phytogeography, physiology, and population biology focuses on Nordic taxa including South West Coast invaders. Biometric variation in Himalayan *Rhododendron* species is studied and molecular techniques are applied for a better circumscription of the genus *Rhododendron*, i.e. to clarify whether *Ledum* also belongs to the genus. It is tempting to include the large collection of *Rhododendron* species of the Milde Arboretum in further studies of these ericaceous taxa. Through the expertise of C.C.Berg the tropical diversity of the Moraceae, Cecropiaceae and Dorsteniaceae has been elucidated considerably. Monographic contributions to neotropical and palaeotropical floras have been published or are under present study. An important collection of *Ficus* species is cultivated in the greenhouses at the Milde Arboretum. This research is ranked as very good.

### *Lichen research*

The Lichen research group in Bergen benefits from a successful tradition in systematic research. A comprehensive collection of samples from Norway has been placed in a computerised database. These data are now available free on the Internet and provide a valuable resource for mapping the distribution of lichens in Norway. The Norwegian Lichen Database is also an important tool for biogeographic research, for developing strategic plans dealing with endangered species, and for environmental monitoring in general. Taxonomic and phylogenetic studies include morphological, chemical and molecular data and focuses on Lecanorales and Micaraceae. Biogeographical and autecological investigations are carried out in lichens of Scandinavia, the Arctic region, Western North America, Australia and the Antarctica. The application of molecular methods has made it possible to trace the historical dispersal of lichens within Northern and Western Europe and Europe and North America. Phylogenetic studies are also successfully using molecular data, e.g. for elucidating the Bacidiaceae and Pannariaceae. The group is aware that maintaining a

high competence in organismic and morphological knowledge is their main strength. The results are very good. There is a potential to be outstanding if given adequate support.

### ***Vegetation ecology, history and pollen analysis***

Research activities include quaternary pollen analysis, quantitative paleoecology, paleolimnology, community plant ecology, plant geography, and bryology. Vegetation ecology studies on Calluna heath started with a multidisciplinary project 1971. Research in this field has been continued and finally led to the development of the Calluna heath Centre at Lindås. Late-quaternary vegetational and environmental history is studied in northern Europe, the Alps and in North America. The studies include pollen mapping and research on lake acidification and heavy metal pollution. Numerical methods are used for the quantitative reconstruction of past environmental changes and for the analysis of plant geographical data in the Northern hemisphere. These studies are headed by H.J.B. Birks and include efficient national and international co-operation. A large number of publications in international, peer reviewed journals document outstanding research in several fields.

Overall, the permanent staff of this unit is ageing and several new staff will need to be recruited in the next 5-10 years. In addition, it became clear during the interview that much of the research was being done by externally funded researchers. For this unit to be able to maintain the existing quality of research, a strategic plan needs to be developed identifying areas of strength and future development so that the University can implement a program of early replacement of retiring staff. This would minimise the risk that this productive unit will collapse.

## **Department of Fisheries and Marine Biology**

*Ranking: Fair to Very good*

The department employs 20 permanent faculty, divided into 7 different research groups. Panel 1 evaluated four of these, covering the research efforts of 14 of the permanent faculty of the department, whose work focuses on the study of free living marine populations. These included the Benthos (3) and Plankton Ecology (3) groups, the Resource Biology group (6), and the Systems Ecology group (2). These groups vary greatly in size, focus, and research productivity. Since 1994 the department, as a whole, has graduated 55 Dr. scient. and 169 Cand. scient. students. The department received 49% of its funding from external grants in 1998.

### ***Benthos***

The Benthos group has focused on descriptive work, and appears to have archived useful samples of infauna over a range of diverse habitats. However, insufficient attention has been given to how to use these data to address specific ecological hypotheses. Research productivity of the three permanent staff, as reflected in the CV's reviewed, is low and the work has been published in a limited range of journals. However, the group mentioned that others had published a larger set of papers based

on data from the benthos mapping work. Overall, the research quality of this group is fair.

### ***Plankton Ecology***

The Plankton Ecology group has focused on the structure and function of planktonic ecosystems and on copepod taxonomy. The research productivity of the three members ranged from good to very good. Work on planktonic ecosystems had addressed a number of important research questions, and had mostly been presented in leading international journals. There is great potential for extending this research using the department's remotely operated vehicle but strategic planning on its implementation, including the selection of acoustic and other sensors and the provision of additional support funds to maintain and operate the vehicle, is needed.

### ***Resource Biology***

The Resource Biology group has focused on testing basic elements of fish population dynamics, especially identifying relationships between population processes and biological and physical processes. The group has a goal of contributing to improving the scientific basis for management of fishery resources, resulting in an emphasis on applied research. However, the overall research productivity of the group has been modest and the quality of the basic research done has been fair for most group members. Very good basic research on larval ecology has been published in a range of international journals.

### ***Systems Ecology Research***

The research by the Systems Ecology Research group has been guided by a clear research agenda and this agenda has been strategically implemented. The basic research productivity and quality of the group has been very good, with a high rate of production of papers published in a wide range of the leading international journals. The methods and results have been path breaking basic research and are being further developed, in collaboration with the Institute of Marine Fisheries, for use in a more applied setting in fishery management. This is a small group that is quite young and with further investment by the department it has the potential to improve its performance to an outstanding level. There is potential for this group to become a centre of excellence, in conjunction with the Institute of Marine Research.

Overall the department's strategic planning is not sufficiently developed. Consolidation of some of the smaller research groups and the implementation of more specific research plans would facilitate the development of a stronger and more focused research effort. The Systems Ecology Research group's modelling work suggests a variety of experimental questions that could provide the basis for such planning. The department has established very good international collaborations and their research links to the Institute of Marine Research are an important way for their more basic results to be utilised in an applied context.

## **Department of Microbiology**

*Ranking: Very good*

The department employs 7 permanent faculty, who are divided into 5 research groups. Panel 1 evaluated only four of these; Marine Microbiology, Molecular Ecology, Algal Physiology and Fungi. Unfortunately, this Panel did not evaluate the research group studying anaerobic microbiology, so we do not have a complete picture of the department. The department covers a broad field of general microbiology including ecology, physiology and molecular biology. The main focus is on the planktonic marine environment, but work is also done on sediments and soils. The department teaches a wide spectrum of courses, covering relevant aspects of microbiology at all levels. Only at the University of Bergen can students take Cand. scient. and Dr. scient. degrees in microbiology and the department has graduated 9 Dr. scient. and 38 Cand. scient. students since 1994. The external funding to the department provided 73% of the total costs in 1998.

The Panel found the choice of research topics generally to be very good. The department has been very successful in attracting international funding from the EU, which provided many contacts to research groups in other countries. However, the department pointed out that the former intensive national collaborations had suffered from this dependence on EU funding. The marine research projects require access to research vessels of the University or other institutions, but the group found that this was not a limitation for their work.

A scientist position is presently vacant and within the next 3-5 years another two positions will become vacant. The department presented a plan for filling these positions in the fields of general microbiology, microbial genetics, bacterial physiology and protist physiology. The Panel fully supports this plan as it will strengthen microbiology and ensure the broad coverage of this discipline in the future. The quality of research in microbial ecology is of the highest international standard and is rated as very good to outstanding. Geomicrobiology is also strong and of international standard, whereas the research on algae and fungi is fair and not productive. Given the awareness of quality and the clear strategy for future development of the research groups, the Department of Microbiology has the potential to become outstanding and if given the resources, perhaps a centre of excellence.

## **Department of Zoology**

The Department of Zoology employs a total of 21 permanent faculty and 2 adjunct professors. The researchers are divided into 6 sections (including LFI) covering anatomy, environmental physiology, parasitology, systematic zoology and ecology. Panel 1 only evaluated the parasitology, systematic zoology and ecology sections, and therefore was not able to get a clear overall picture of this department. The Department of Zoology, as a whole, reported 35% of total expenditures coming from external grants in 1998.



## **Parasitology section**

*Ranking: Good*

The Parasitology section has two permanent faculty members and is very vulnerable, with a low level of overall activity. Training by this section has been poor, with only one Dr. scient. student registered and no graduates since 1994. Numbers of Cand. scient. students were not provided. The evidence from student numbers suggests that external funding for this section is below average for the department.

The methods used are experimental and observational, using theory developed elsewhere. Skorpning, who has recently been hired, works at a good to very good international level on a variety of host-parasite systems. Although his work is international and is often published in good journals, it has not been path breaking and his plans for the future appear to be poorly developed. Organisationally, the section has no strategic plan and their facilities generally seem to be poor. Collaboration at the national level is low, but at an international level it is outstanding. This section has the potential to be of high international standard, but the Panel could see no evidence that there were plans to make it one.

## **Systematics section**

*Ranking: Fair to Good*

The Systematics section has eight permanent members of faculty and one adjunct professor. It has graduated 3 Dr. scient. students since 1994 and currently has 1 student registered. As with the other sections, the numbers of Cand. scient. students were not provided. From the number of students graduated it seems likely that the proportion of external funding for this group is also below average for the department.

The section has expertise on two taxonomic groups; flat backed millipedes and chironomids. The work ranges from traditional systematics through to cladistics, but there are no clear plans for molecular systematics. The level of research activity for the different groups ranges from very good for Sæther to fair or poor for the others in the section. On the whole, this section is doing good research, or taken in its own cladistic or classical systematic terms it is very good. The methods used are good for the morphological characters that they use. However, there is no strategy for improving research quality or for incorporating more modern techniques. Theory is poor in this section and it is unclear why particular problems were chosen. The only explanation provided during the evaluation was that the individual researchers supervisor had suggested working on a particular taxon, often decades ago. Organisationally the section is not at all impressive, members of the section do not collaborate and they generally work alone, with people carrying their old studies forward without developing any context within which to work.

## **Ecology section**

*Ranking: Fair*

The Ecology section is a typical unit with normal and diverse teaching responsibilities. The section listed the production of an avian ecologist from the Bergen Museum and accommodates a freshwater and inland fisheries group (LFI) as well as projects relating to the Norwegian Environmental Education Network, including training and research in tropical zoology in Bangladesh and biological inventories of forests. The section has been productive in teaching, and was responsible for the majority of the Dr. scient. degrees in the Department of Zoology during the last few years. This would suggest that this section maintains a level of external funding above average for the department. The section has also recently obtained external funding for a plankton simulator, opening up new experimental possibilities.

The section listed nine current research themes, ranging from chemical communication to grazing and mating systems. The leading theme had an evolutionary perspective, but the staff did not identify any specific leading themes for the whole section. The lack of cohesion is obviously a reflection of the history of staff recruitment, directed at covering diverse teaching fields. Furthermore, the staff members clearly appreciated their independent rights to choose what they wanted to study. Even though this is often desirable, from a scientific viewpoint, the lack of strategic planning that has resulted greatly weakens the research carried out within the Ecology section. Publishing activity was uniformly low, ranging from fair to not acceptable, and it was not clear from the information provided whether the students they were graduating were publishing their thesis work.

## **Laboratory for Freshwater Ecology and Inland Fisheries**

*Ranking: Not acceptable to Fair*

The Laboratory for Freshwater Ecology and Inland Fisheries (LFI) is closely associated with systematics and ecology research groups of the Department of Zoology. It is administratively connected to a foundation associated with the University of Bergen, allowing it the ability to adjust its applied mission rapidly, as is often required. LFI staff estimated that 10-15% of its budget is applied to more basic research, primarily in the form of additional analyses of the long data series that are being collected.

Although the basic research results were of course limited by the requirements of other duties performed by the staff, this research, by the best people in the group, could only be judged to be of fair quality. However, the data collected and archived LFI in the course of its applied studies have considerable potential for use in basic research. The strengths appear to be long time series (10-20 years), with collections focusing especially on acid rain effects. To realise that potential, it would be invaluable to make the data available to other scientists who may be addressing more basic ecological questions. Making the data available on the Internet, perhaps on a restricted basis, by following the approach taken by the Bergen Museum, would facilitate this. However, the Panel recognises that it is important in such

collaborations that appropriate professional credit is given to those involved in the data collection. Further, greater collaboration with other researchers studying limnology, freshwater ecology and inland fisheries would help the group realise its full potential. It is important that a policy on collaborations is developed to encourage those involved in data collection programs to establish appropriate liaison with other researchers who can demonstrate the ability to make better use of such long term data series in analyses.

In supporting the long term monitoring program by LFI, Norway has created an invaluable ecological monitoring program. However, one serious weakness of this program was that there did not appear to be significant strategic or long term planning about what aspects should be given priority for continuing support.

# Norwegian University of Science and Technology

## Department of Botany

*Ranking: Fair to Very good*

The department employs 13 permanent faculty, divided between seven research groups covering biodiversity, a dendrochronological laboratory, environmental toxicology, marine aquaculture, molecular biology, plant cell biology and plant physiology, and terrestrial plant ecology. The department has recruited three new professors from abroad to meet the demands of a previous evaluation (1988) for more process-oriented research. This has strengthened research, especially in the areas of biodiversity, which utilises diverse evolutionary and ecological approaches. Research groups in these fields have been successful in obtaining external funding. The department also has new facilities, finally making it possible for most of the groups to be housed in a single building. This will hopefully lead to better unification of the department and to the development of internal collaborations. The department has graduated 19 Dr. scient. and 134 Cand. scient. students since 1994, with the highest rate of examination in biodiversity research.

The Plant Biology group and the PLA2-group of the Department of Botany are presently located at the UNIGEN Centre for molecular biology. This is within the Medical Technical Research Centre, where a technological and scientific environment for molecular biology has been created at the Norwegian University of Science and Technology (NTNU). The work of the PLA2-group does not fall within the field covered by Panel 1 and is therefore not evaluated. The work of the Plant Biology group deals mainly with cellular and molecular aspects of plant defence. The group is rather small but quite active and with a publication record that is good to very good.

The Department of Botany also has the Plant Biotechnology Centre, built around cell biology, plant physiology and molecular biology, with a focus on agricultural science and space biology. The research group is relatively large and built around two permanent staff members. The Centre appears to be well equipped and has recently received a major EU project grant, which is co-ordinated from the Centre, to work on strawberry resistance to grey mould. Space biology primarily deals with the effect of microgravity on plant cell regeneration and a new project is planned to study the effect of gravity on gene expression. The group seems to have a good ability to attract Cand. scient. students. However, publication activity is relatively low and from a basic scientific viewpoint the research activity of the Centre is ranked as fair.

The Panel is concerned about the strategy for the future development of experimental plant biology (molecular and cell biology, plant physiology) at the department. The Plant Biocenter seems to have developed into a biotechnology centre motivated by applied problems, while the Plant Biology group forms the core of competitive basic research in the department. This group therefore represents a very strategic unit for the future development of experimental plant biology at the Department of Botany

and the Plant Biology group should be further strengthened. The Panel endorses strongly the decision to appoint one more professor in plant molecular biology. Regarding the future location of the Molecular Biology group, for the long-term development of experimental plant biology and botany it is very important that it becomes physically integrated with the rest of the department. This opinion is based on the view that science, in the long run, must be question rather than methodology driven. UNIGEN and the Department of Botany could form a joint strategy on how to develop a unit of shared core facilities enabling NTNU as a whole to acquire the modern technologies needed for genomically based research in biology.

Representatives of the department met by the Panel regarded the number of small projects/groups to be too high but they did not present a clear strategic plan for how to deal with this issue. However, these representatives were very positive towards ideas of an amalgamation of the relevant sections of the botany and zoology departments, and those of the museum. They preferred an organisation based on ecology, physiology, taxonomy etc rather than the traditional division of botany and zoology. However, the Panel was not convinced that this was the only constructive solution and felt that further open discussion, at both the department and faculty level, was required to formulate an optimal configuration of the different groups in the Department of Botany.

## **Department of Zoology**

*Ranking: Very good*

The Department of Zoology has built a very strong group in ecology, behaviour, and evolution and organismic biology. The department has 16 professors and 5 associate professors. All aspects of mobility and training of students and staff are excellent. The department has a high level of student enrolment and graduates an impressive number of Cand. scient. and Dr. scient. students. The department generated 42% of its funding from external sources in 1998.

The level of scientific activity is impressive, as is the integration of the different researchers, who clearly work well together as a unit. The overall quality of the research is very good. The research groups publish regularly in leading journals in their field. The methods used are a good balance between observation, experimental (laboratory and field) and theory. The ability of the leaders and staff is excellent. Organisationally this department is very strong, and they have clear plans for their future development. These plans are contingent on the replacement of positions as retirements make them vacant and the Panel strongly recommends that these positions be refilled. International and national collaborations are excellent and fruitful. This department has a fine future, and both the University and the Research Council must support them. This department is nearly outstanding and could become a centre of excellence.

## **Department of Natural History**

The Department of Natural History employs 15 permanent faculty in the sections of Botany (5), Zoology (6) and the Trondheim Biological Station (4). The faculty is responsible for a broad range of activities including curating collections, disseminating information to the public, administration, teaching and research. Research at the department focuses on botany, zoology and marine biology with a major emphasis on boreal and alpine-arctic areas and taxa. Since 1994 the department has graduated 16 Dr. scient. and 63 Cand. scient. students. Overall the Department of Natural History received 62% of its funding from external sources in 1998.

### **Botany**

*Ranking: Good*

The Botany section covers 5 permanent faculty who divide their research activities in terrestrial botany between (i) bryophyte systematics and evolution, (ii) vegetation and population ecology, (iii) floristic geography. Co-operation between scientists of the Museum is common and often concentrated on bryophytes. Since 1994 the Botany group has graduated 8 Dr. scient. and 11 Cand. scient. students.

#### ***Bryophyte systematics and evolution***

Systematic and evolutionary research in mosses, especially in *Sphagnum*, includes traditional taxonomy, molecular techniques, population genetics and theoretical approaches. Twelve new taxa of *Sphagnum* have been described over the last 15 years. Relationships between taxonomically difficult species complexes have been elucidated, allopolyploids identified and morphological variation along ecological gradients was studied for the purpose of species delimitation. Studies in population genetics have given insight into the balance between mutation rate and random genetic drift. The lack of the latter primarily determines the genetic structure of populations of *Sphagnum* species. Bryophyte systematics and evolutionary biology of this dimension is unique in Norway and is of a good international standard.

#### ***Vegetation and population ecology***

Research activities concentrate on biodiversity and plant-cover in boreal and alpine-arctic regions with special emphasis on cultural landscapes, forests and vegetation types in Norway. Results are of importance in landscape management, population monitoring and biodiversity conservation. "Vegetation types of Norway" and "National Atlas of Norway: Vegetation" are comprehensive compilations based on long lasting original research. This research is of a good standard nationally, but the group has too strong an emphasis on publishing reports and popular articles that are not peer reviewed and that have limited international significance.

#### ***Floristic geography***

The long tradition of the Museum in fieldwork documentation and distribution studies is a good basis for further contributions to plant geography. Bryophytes and vascular plants are the main objectives of ongoing research. The mapping of alien species

spreading in Norway will continue. The group produces good work within their field of research.

## **Zoology**

*Ranking: Fair*

The relatively small staff is divided into three areas: freshwater biology, herpetology and population ecology and social systems in birds. The groups do not have much in common, although some co-operation exists between the herpetology and freshwater groups. The groups emphasise work on databases making museum collections more easily available, e.g. via the Internet. However, the research concentrates mainly on faunistics and more general ecological problems that do not belong to the core functions of a museum. The reason seems to be the demand for applied studies about influences of humans, especially in the freshwater ecology. The ornithological group has the best publication record, but altogether the scientific output is meagre.

The groups are scattered in their interests and do not present strategic plans for the future. The freshwater and ornithology groups have local co-operation. The scientific output would probably benefit if the staff were relocated in the relevant university departments or institutions, instead of a museum.

## **Trondheim Biological Station**

*Ranking: Good*

The Marine Research Unit comprises four groups of which three work mostly at the Trondheim Biological Station. The staff is partly shared among the groups and comprises 4 permanent scientists. The Marine Research Unit is very active in seeking international collaborations and projects and has been most successful in obtaining external funding. Thus, a major part of the external funds of the whole Department of Natural History comes from the many EU-projects of this Unit. The Marine Research Unit has been successful in attracting many students, both at the Cand. scient. and Dr. scient. level.

### ***Marine Zoobenthos***

The Marine Zoobenthos group studies biodiversity in Norwegian coastal waters with the main emphasis on mapping and long-term monitoring. The group participates in the Nordic BIOFAR and BIOICE projects and has contributed to a larger monography on the distribution and taxonomy of marine fauna. Although the Panel recognises the importance of this traditional type of biological monitoring and the value of long time series, more emphasis should be given to the analytical synthesis of the results and their publication in the international literature. The quality of research is good and the productivity in terms of international publications is fair.

### ***Planktonic Food Web***

The Planktonic Food Web group studies important and relevant questions concerning the growth and productivity of fish stocks and aquaculture. The work is generally productive and the quality good to very good.

### ***Phytoplankton Photobiology***

The Phytoplankton Photobiology group is a small, but very active and internationally highly respected group. They have taken a methodologically and conceptually broad approach to the regulation of marine photosynthesis that has generated important results. The quality and productivity of the work is very good. The Phytoplankton Photobiology group is also very active in the organisation of international meetings and the management of research.

### ***Population Genetics***

The Population Genetics group is studying rather classical population biology of fish and marine invertebrates. The quality of the research and the productivity are good.

The strategy to combine opportunities in marine science and marine technology takes advantage of the local opportunities in Trondheim and is endorsed by the Panel.



# University of Tromsø

## Department of Biology

The department has 14 permanent faculty divided into an Ecology/Zoology group (4), a Plant Ecology group (3) and a Microbiology and Plant Physiology group (7). Since 1994 the department has graduated 13 Dr. scient. students and 64 Cand. scient. students. Relative to the size of the staff, the graduation of Cand. scient. and Dr. scient. students has been good compared to other departments within the Faculty of Science. External funding accounted for 30% of the departmental budget in 1997.

The department has made the logical decision to concentrate on studies of the Arctic and northern regions. They have defined ecology and molecular biology as the main areas of development. They also try to combine applied and basic research, which has led to emphasis on five areas: biodiversity, conservation biology, global change, the effects of UV radiation and the effects of grazing. However, rather than generating true research programs this division into separate research areas has simply led to the projects and groups being classified under different headings. More active co-operation between the existing groups is essential. The sabbatical system is very well organised and utilised, offering all scientific staff a sabbatical year every fifth year, paid jointly by the Faculty and the Research Council. However, the department stressed the need for more travel money to develop collaborative links within Norway and to be able to invite leading scientists to give seminars and to participate in courses. The Panel would like to see a strategic plan developed aimed at improving biology interactions across different departments and institutes in Tromsø, including UNIS.

### *Ecology/Zoology*

*Ranking: Fair*

The zoological research group in the Department of Biology is made up of 1 professor and 3 associate professors. This group has diminished in size and quality in recent years, leaving just 1 internationally active researcher who is able to plan for the future. The department urgently needs to strengthen zoological research with new appointments. The group must be ranked as fair, but this does not do justice to the high quality and productivity of Folstad's work, which has an international profile. Folstad may be an anchor around which to develop a re-invigorated Ecology/Zoology group. This group's external funding remained high in 1997.

## ***Plant Ecology***

*Ranking: Fair*

The Plant Ecology group consists of four staff members, although one has not been filled for various reasons. The fields of the researchers fall into two streams, geobotany/vegetation ecology and vegetation history/paleoecology. Researchers seem to function independent of each other. As the result of the previous evaluation (1988), the Plant Ecology group decided to emphasise ecophysiology/population biology. However, the implementation of this strategy has not been very successful. The publishing activity of the scientific staff in the main field defined by them is not higher than fair. This strongly contrasts their extensive knowledge of the studied systems. The group leader has utilised this knowledge in floristic contributions, but such publications do not promote new research directions. This work would fit better into the activities of the Tromsø Museum.

## ***Microbiology and Plant Physiology***

*Ranking: Good*

The research group has an ecophysiological profile with studies of plant adaptation to northern climatic conditions combining studies of plant hormones and plant-microbe interactions with studies of plant and microbial adaptation to northern climatic conditions. The group includes 7 permanent faculty (1 vacant) and maintains good external grant funding. This group has graduated 13 Cand. scient. and 3 Dr. scient. students since 1994. The laboratories are well equipped for studies requiring microbiological, physiological, analytical and molecular research, and the facilities include a well functioning phytotron.

### **Microbiology**

The research focuses on the symbiotic interaction between *Rhizobium* and legume plants and includes efforts to characterise the full life cycle of the bacterium under northern climatic conditions. The studies involve both physiological and molecular approaches. Methane oxidising bacteria in the tundra ecosystem are also studied. The biodiversity of the cyanobacterial communities in different ecosystems are studied in relation to grazing and climatic changes. Work is also directed towards understanding carbon and nitrogen cycling in the Arctic. The projects are scientifically sound, but the group is rather small and the Panel is concerned that the increased diversification of the questions being asked will be counterproductive with respect to scientific significance and quality of research. A sign of this is that the Microbiology group as a whole reports a relatively poor publication record that can not be ranked higher than fair to good. The group needs to develop a more focused approach. While it was not clearly so, the Panel was left with the impression that the diversification was driven by the need to get funding and by the funding strategy of the Research Council.

### **Plant Physiology**

The group has major projects on the molecular basis of climatic adaptation in forest trees, hormonal regulation of plant growth and regulation of cold hardiness. The group is internationally well known for their work and the development now is to take

a more molecular approach with an increased use of model plants. This is the right development. The publication record shows that this is a good group by international standards, and with its current leadership, a very good potential to develop its international competitiveness further. We consider this to be a leading plant physiology group in Norway and active steps should be taken to further strengthen it. The strategic plan to further strengthen molecular biology by hiring a new staff member is strongly endorsed. It is important that this group gets access to the newest technologies and are able to acquire the necessary skills to take advantage of the new opportunities offered by functional genomics.

## **University Museum of Tromsø**

### **Department of Botany**

*Ranking: Fair*

The Museum and the Botanical Garden are a separate administrative unit of the University of Tromsø and it employs 5 permanent faculty. Activities at the Museum include curating collections, public information (including exhibitions), teaching, research and administration. The Museum includes experimental work and aims to computerise its collections to optimise accessibility for scientific research. Collaborative work with scientists of the Department of Biology, University of Tromsø, is based on individual activities and is of limited significance. The Department of Botany at the Museum has graduated 1 Dr. scient. and 2 Cand. scient. students since 1995 and receives 7% of its funding from external grants.

### **Botany Department**

Scientific research focuses on biogeography, taxonomy and evolution of arctic plants, mycology, ethnobotany, paleoecology and botanical studies in cultural landscapes. The flora of Finnmark has been critically revised and all data are computerised. Mycological research refers to taxonomy, phylogeny, and ecology of asco- and basidiomycetes with special emphasis on pyrenomycetes. The mycology group in Tromsø has a well-established co-operation with Trond Schumacher, University of Oslo, who helped to develop and improve research conditions, including the introduction of molecular techniques. A fungal culture collection will be built up and a molecular laboratory will be established in the Museum. Ethno-botanical research considers the use of wild plants in the North Norwegian women's tradition and old garden plants in northern Norway. General vegetation history, late glacial aspects and paleoenvironmental studies are part of the paleoecological research at the Museum. Several projects are running under the heading of research in cultural landscapes. They include studies of neophytes and genetic variation of *Knautia arvensis* in relation to management of habitats.

This group is not currently conducting research at a competitive national or

international level. Rather, they considered that their primary task was to communicate to the public through popular articles and museum activities. Such activities are commensurate with the role of a museum and it has important educational value. However, this focus will continue to make it difficult for this group to gain competitive research funding.

## **Arctic-alpine Botanical Garden**

The Arctic-alpine Botanical Garden at Tromsø is a new institution opened 1994. Its budget is now administrated by the Museum. The garden is attractive to the general public and plays an important role in the cultivation arctic and alpine plants. Special collections, e.g. those of *Meconopsis* and *Saxifraga*, are already used for systematic studies. If it is the universities aim to develop this gardens unique potential the level of staffing would need to be increased.

## **Department of Zoology**

*Ranking: Good*

The Department of Zoology employs 4 permanent faculty, who have graduated 1 Dr. scient. and 5 Cand. scient. students since 1995. No external grants were recorded in the fact sheets provided for the evaluation.

By their own admission, the researchers do not work collaboratively within the Museum. However, they are all active in research with about 10% of their research being associated with collections. This is an average and differs among individuals. The research quality is variable, from crucial systematic treatises to minor ecological studies. As far as studies associated with the collections are concerned, it will become vital to computerise the records and plans should have been draw up to do that. The researchers are capable and serious, but do not seem pro-active in bringing the records of the collection up to date or in attracting graduate students. The staff must attempt to attract outside funding for the records work. The activities of the permanent staff appear to have little connection to the museum work, and in the context of museal work their ranking is only fair.

We strongly advise that all the staff take an active part in undergraduate teaching. This would help attract Dr. scient. and Cand. scient. students. There seems to be very little activity that is related to either training or mobility and the recruitment of students is minimal. There is a lot of collaboration on research papers, though it tends to be national rather than international. Organisationally, the researchers do not work as a team and individuals pursue their own interests. These interests differ and result in widely divergent activities varying by taxonomic group, of which the curator is a specialist. There are minimal links with the Department of Biology, and the zoologists within it. Action must be taken to remedy this situation.

## **Norwegian College of Fishery Science**

The College employs 28 permanent faculty divided into three different institutes, of which Panel 1 evaluated the Institute for Marine and Freshwater Biology and the Institute of Aquatic Resources and Environmental Biology. The infrastructure of the College is good, with three well-equipped research vessels, an aquaculture station and a freshwater research station, and with seawater available in the building in Tromsø. The need for a research ship with ice-breaking capability was expressed as a requirement for the work on the biology and carbon cycling at the ice margin. The many facilities bind a significant part of the finances and the College is therefore very dependent on external funding. The external funds are good and covered about half (43-56%) of the total costs of the departments in 1999. Support comes mostly from the Research Council and EU, but also through collaboration with the USA, including from the NSF.

Due to the geographical location of Tromsø in northern Norway, members of the institutes saw a potential danger of isolation and inbreeding of the staff. It was therefore important that good national and international collaborations are maintained and that the students and young scientists are exposed to other research environments through research visits and meetings abroad. The sabbatical arrangement of the College motivates the scientists and promotes national and international collaborations.

### **Institute of Marine and Freshwater Biology**

*Ranking: Good*

The Institute of Marine and Freshwater Biology employs 9 permanent faculty whose studies focus on the ecological basis for fish production in northern Norway, the Barents Sea and at Svalbard. Priority is given to experimental and field studies in lakes, rivers and coastal areas. Scientists from the Institute teach biology at different levels at the University of Tromsø. There are a good number of Cand. scient. and Dr. scient. students and good possibilities of new recruitment. External funding is good, covering about half of the total expenditures.

The research of the department covers a wide range of topics with the basis in the biology of fish populations, but also with a broad perspective on the ecology and nutrient cycling of lakes and coastal seas. The scientific productivity and quality of research was uniformly good in the research groups. The development of new optical instrumentation for plankton studies appears to be promising and the results are soon to be published. DNA-based studies of north Atlantic cod have been successful in discriminating between two populations with strong genetic separation. The department has good national and international collaborations and has been an attractive partner in EU-projects. The balance between applied and basic research in the department appears to be very good and the interactions between the research groups were functioning well. In some cases the number of projects may be too large and a stronger focus on the most important questions could strengthen the research. This balance was particularly good in the Freshwater Biology group. The Panel

endorses the strategy to recruit young scientists prior to the retirement of existing staff.

## **Institute of Aquatic Resources and Environmental Biology**

*Ranking: Good*

The institute employs 9 permanent faculty. Although the institute has responsibility for some applied research, basic biological research is conducted in three of the four groups identified (Marine Ecology, Aquatic Ecophysiology, and Fishery Biology and Technology). Basic research related to aquaculture was included in the presentation of the Aquatic Ecophysiology group, while the Aquaculture group included the applied aquaculture work. The institute has good external funding with 56% of total funding coming from external grants in 1999. There is also a good level of participation in teaching and the institute has graduated 55 Cand. scient. and 6 Dr. scient. students since 1993.

The basic research in the Aquatic Ecophysiology focuses on whole animal studies, and has been reported in a range of excellent international journals and authoritative books over a long period, and is very good. The work by Jobling has defined key aspects of the field, and is very good in productivity and quality. The basic research productivity of the permanent staff in Marine Ecology is good. The work has appeared in leading international journals, and sets research direction in the field. The basic research productivity of the staff in Fishery Biology and Technology has been much lower, and the quality is fair to good.

The institute has used research staff and adjunct positions to effectively enhance its basic research effectiveness and stature and it has good international collaborations. However, in the case of Marine Ecology continued success is critically dependent on research grants supporting the key position of Wassman, who supports a very active research group of high international standard and very good scientific productivity. The Panel was surprised to discover that a scientist of such importance to the department was not a permanent member of staff. In the case of Fishery Biology and Technology, the adjunct positions appear to have been well utilised in developing strong research programs and in periodic short courses and student guidance. However, better use could be made of these individuals by strengthening full time work in this group.

# Agricultural University of Norway

## Department of Animal Science

The Department of Animal Science employs 9 permanent faculty, separated into 4 sections. Panel 1 evaluated only the section for Applied Ethology and the section for Bees and Beekeeping, and was therefore unable to get a general picture of the quality of basic research in this department. As a whole, the department has graduated only 1 Dr. scient. student and 26 Cand. scient. students since 1994. In 1998 the department received 59% of its total budget from external grants.

### Applied Ethology

*Ranking: Fair*

The Applied Ethology section has two Associate Professors whose research is focused on animal welfare components of applied ethology. They are working on welfare because, they say, that is where they can get funding. Teaching, recruitment and mobility seem to be good. The activity of this group is good in terms of enthusiasm and energy, as well as networking with similar units in other countries. The project leader is competent, but needs to develop a clear focus for his research. There is no national duplication of effort, however this group needs to define its international role. Further, the methods used and proposed need to be subjected to rigorous external review because the focus on functional, behavioural ecology was not persuasively related to welfare issues. National collaborations could be improved and if the group intends to continue with the behavioural ecology approach, it should develop strong links with the Department of Zoology at NTNU, which is among the best in the world in this field. Otherwise the group appears to be well organised and the groundwork seems to have been laid for the development of an effective group. The quality of the research is only fair but it could be improved dramatically if the international networking turned into true collaborations.

### Bees and Beekeeping

*Ranking: Very good*

The unit accommodates two scientists, a laboratory engineer and a Dr. scient. student, and there is clear evidence of good external funding for the next few years. The two staff members have very different research profiles, but taken together seem to combine well. They have systems established that make it possible to study honeybees as laboratory animals, and have developed techniques to preserve honeybee germplasm. The development of nuclear transplantation and embryo technologies is in progress. The publishing activity of the group seems to completely depend on Omholt. His close co-operation with mathematicians has been very productive and has led to the development of new mathematical tools for studying complex systems. The articles are published in the leading periodicals of theoretical biology and cover a number of questions ranging from bee husbandry to general problems of bridging

regulatory biology and classical genetics.

## **Department of Biology and Nature Conservation**

*Ranking: Good*

The department has a total of 18 permanent faculty. The permanent staff are split into 3 groups covering botany (7), zoology (4) and nature conservation (7). The department has the responsibility of teaching the main part of basic biology, resulting in a demand for a range of teaching specialities. Since 1994 the department has graduated a total of 15 Dr. scient. and 160 Cand. scient. students. In 1998 the department received 59% of its total funding from external grants.

The recruitment of teachers on the basis of these diverse specialities has led to scattered research topics. Two strong fields (physiological plant ecology and research on brown bear) were formed or strengthened by recent recruitment. The Panel noted that some of the research topics (plant ecology, invertebrate ecology, and restoration ecology) cover research areas that are generally poorly developed in Norway. Mobility of the scientists has been good, and the department has actively recruited scientists from other units. The recruitment of a new generation of plant physiologists, in particular, seems to have been very successful, and this will hopefully enable this department to maintain its strong tradition in this field. However, filling vacant positions was said to be difficult because of budget cuts and also because of limited possibilities to provide research facilities and start-up grants for the new staff. The scientific activity of the department was generally good, without large differences in the average levels of the three fields. The list of periodicals covered most of the leading journals in the field. At present this department can not be ranked higher than good, but the Panel felt that with recent and planned recruitment and the strategic thinking presented during the evaluation, the department has the potential to develop in a very promising way.

## **Department of Horticulture and Crop Science**

*Ranking: Fair*

The department has ten permanent faculty members, split between five groups covering post harvest physiology, floriculture, biotechnology, wheat quality and agroecology. Since 1995 the department has graduated 10 Dr. scient. and 27 Cand. scient. students. The recruitment of students appears to be an increasing problem for the department. The Panel noted the recent recruitment of two new Dr. scient. students. The fact sheet provided by the department did not include information on external grant funding.

In recent years the general emphasis in crop sciences has shifted from increasing crop productivity to improving crop quality, but the Panel was unable to recognise original findings in this field. The representatives of the department listed the general



obstacles for research, including the amount of teaching and administration, shortage of internal funding. The Urban Horticulture and Floriculture group makes good use of physiological knowledge in their work to solve practical questions in horticulture and floriculture. The results of their work are published in refereed journals and from a basic scientific viewpoint the work is ranked as fair, with Mortensen's work being good. The Plant Breeding and Applied Biotechnology group also publish regularly in refereed journals with a fair to good ranking on an evaluation of basic research. The Post Harvest Physiology group appeared to be weakest in their scientific production. The general scientific activity was judged to be fair.

## **Department of Soil and Water Science**

### **Limnological Research**

*Ranking: Fair*

The limnology research groups under the Section of Geology and Water studies lakes, rivers and their catchments with the main emphasis on physical and chemical processes. The staff consists of 6 scientists. The Limnology group has a very high productivity of Cand. scient. students (57) candidates, but few Dr. scient. students (2) since 1994. More Dr. scient. students would help to invigorate research in the group. External funding has been good in previous years but dropped in 1998 to 20% of the total costs.

The research profile of the group comprises aspects of surface water quality such as lake acidification, lake restoration, and soil-water interactions in catchments. The emphasis on the interaction between terrestrial and aquatic processes is a strength. However, the Panel found the concepts incoherent and the research plans and ideas weak. Most of the group is not very productive in terms of publications and much of the work appears only in reports. On this background, the good work of Gunnhild Riise should be emphasised. A new soil chemist in the group, Jan Mulder, has been doing very good work before coming to the Agricultural University of Norway and should be supported in order to improve the general research level.

# University Courses of Svalbard

## Department of Biology

*Rating: Good to Very good*

The University Courses on Svalbard (UNIS) was established in 1993 and is an independent private foundation, financed by the Norwegian Ministry of Education and controlled by a board with representatives from the four universities. The Department of Biology has a scientific staff of four plus two adjunct professors (the latter are not evaluated here). External funding is growing and covered half of the total expenses in 1999.

The scientific staff has time limited contracts of 6 years without the possibility of prolongation. This means that the researchers comprise a dynamic and changing group who have all rather recently been hired on the basis of their scientific merits. It also means that an evaluation of the long-term development of research programs at UNIS is less relevant here. The research themes are partly chosen to cover the wide spectrum of teaching obligations. Since the group is small, it can only have a limited degree of focus and limited possibility to develop a strong research program. The size of the scientific staff is at the lower limit for an Arctic research institute.

The research on reindeer populations and their parasites is very good and is now being published with a high productivity. The work on seals and their physiology and reproductive behaviour is also of very high international quality. The studies on terrestrial vegetation and on marine invertebrates are good, but have so far been less productive or less focused.

UNIS is an internationally unique facility for teaching and research in the high Arctic. It provides an inspiring environment with excellent logistics, which attracts many students and scientists from Norway and abroad. The Panel finds the concept and achievements of this young institute very good and recommends its further development. It is our impression that closer interactions and co-ordination between UNIS and the Norwegian Polar Institute would mutually increase the efficiency of logistics and research in this rather isolated environment. The marine studies of UNIS are very dependent on access to a research ship.

## **Institute Sector**

In the institute sector, the objective of research is to develop various sectors of the society rather than doing ground breaking basic research at an internationally, highly competitive level. The basic research conducted at the institutes is, in most cases, motivated in a utilitarian context and often has the character of expanding existing knowledge to cover particular environments and nationally relevant problems. Such basic research does normally not rank very high in international comparison, but may be highly relevant to specialised fields and for solving the applied problems at a national level. In this evaluation we have chosen to use the same ranking scale for the institutes as for university departments. On this scale, the institutes generally score lower than university departments. However, the Panel is aware of the fact that even if the quality of the basic research may be ranked relatively low it may be highly relevant and appropriate for solving questions of more applied character.

We also found the working situation for the commercially operating institutes quite different from the state institutes with secured block funding. In the former, the operation depended totally on external funding while in the latter external funding paid more for marginal costs, in a manor that was similar to the university sector. High quality basic research depends on long term secured financing in order to build platforms able to ask the most challenge questions, with the concomitant risk of failing from time to time. This type of competitive basic research can not thrive in institutes fully dependent on insecure short term funding, particularly not if the need to find money becomes a significant factor in the priorities of the institutes and time requirements of the staff.

## **Institute of Marine Research**

The written material provided to the Panel consisted of very brief summaries of the purpose and statistics of the institute, supplemented with CVs of the scientific staff of Research Program 2 and 10. The institute has both routine monitoring tasks and basic and applied research. The former is mostly published in reports, the latter in scientific journals. The Panel found that the publication tradition of the institute is poor and should be improved. Results are mostly published in local or lower-quality journals. The institute should motivate the scientists to publish good results in high-quality journals in order to strengthen its international profile and promote international collaborations.

### **Program 2 - Mare Cognitum**

*Ranking: Fair*

An ecosystem study of the Nordic Seas ("Mare Cognitum") has continued since 1995, with plans for the next two years for data analysis and wrap up. As originally conceived, this program was ambitious, with work in ocean climate, resource ecology and carbon cycling. Incomplete funding was obtained, and the implemented program

focused on resource ecology for two or three years and subsequently on physical processes. This program was connected to a multinational Norwegian Sea ocean basin monitoring study that has constrained its focus primarily to data production. There have been few basic research results reported from this study, although a suggestive correlation has been demonstrated between environmental processes, herring growth and zooplankton productivity.

This study was quite expensive, and while the preliminary results are encouraging, data analysis and reporting of even preliminary results has lagged. Overall the basic research productivity of the staff of this project has been fair over the period, and little strategic planning was described about how to improve this performance or how to more fully utilise the potential of these data. The study has the potential for supporting good to very good basic research, but ongoing data production responsibilities of the staff assigned to this project may preclude this potential being reached.

Although the results of this study are still being developed, the preliminary results are being used to suggest a follow-on long-term project focusing on mechanisms coupling climate and fish and zooplankton growth. These are planned using the modelling approach developed by the University of Bergen's Department of Fisheries and Marine Biology's Ecosystem Modelling Research group. These plans are to be encouraged and should be augmented with a stronger connection between the Institute of Marine Research staff and university staff, which would ensure more complete analysis and publication of research results based on the data collected in this program.

## **Program 10. Marine Pollution**

*Ranking: Fair to Good*

The program combines predominantly monitoring tasks with more detailed studies of the mechanisms of incorporation of toxins in marine organisms and of their physiological effects. The distributions of toxins in the marine environment and food chains are investigated in collaboration with oceanographic modellers of the Institute in order to understand contaminant transport. The work is very useful for the understanding of pollution in Norwegian waters and the productivity of the group ranges from modest to very good. However, the poor publication tradition limits the international impact of the results and the contributions to basic biological research are only fair to good.

## **Norwegian Crop Research Institute**

Panel 1 reviewed only the group for Disease Resistance Biology. This group includes 2 associate professors plus the head of the group (Professor Tronsmo), employed by the Agricultural University of Norway.

### **Disease Resistance Biology**

*Ranking: Fair*

The Disease Resistance Biology group has used many plant species (cereals, strawberry) and has decided not to work on typical model species. This means their results have a strong applied impact rather than a basic focus, and it makes it unlikely that they will generate new scientific findings. The work easily drifts into testing known triggers of plant immune systems in a range of different species. The low mobility of young researchers is a problem for the disease resistance group, a fact well recognised by the group itself. The group expressed their interest for a closer co-operation with forestry researchers studying similar questions, for instance stress physiology and cold hardiness. The scientific publishing activity of the group is fair, two younger members reaching or approaching good performance.

## **Norwegian Forest Research Institute**

Five research areas were included in the evaluation, covering biotechnology, forest genetics, plant physiology, pathology and entomology. The institute is like other institute only addressing basic scientific problems in the context of applied needs. This means that the institute does not have specific strategic plans for its basic research activities besides what is needed from an applied viewpoint. Five research areas are included in the evaluation covering biotechnology, forest genetics, plant physiology, pathology and entomology. External funding is 34%.

### **Biotechnology, Genetics, Plant Physiology**

*Ranking: Fair to good*

The Biotechnology group consists at present of 3 senior scientists and 2 students working on i) regeneration of plants from somatic embryos, ii) the development of methods for transformation of gymnosperms, and iii) molecular responses to different forms of stress in gymnosperms. Norway spruce is the main experimental organism used and the laboratory appears to be relatively well equipped. With regard to the ambitious research program, this small group of young researchers is doing remarkably well and they are publishing their results in good international journals. The research is at present ranked as fair to good. With this small group, a more focused approach is needed to become more competitive in their field of research.

The small (2 full time and 2 part time scientists) Forest Genetics group deals with the genetics of Norway spruce in relation to climatic adaptation. The work is published in recognised international journals of good quality. Clearly the group needs to establish competence in molecular genetics and establish stronger links with other plant scientists. The potential appears to be there, but the group will have difficulties to develop further unless the Norwegian Forest Research Institute (NISK) puts a higher priority on forest genetics.

The Plant Physiology group is very fragmented and physiology seems to be more of a tool for genetics, pollution studies, and climate change and soil science. The publication record of the scientists listed is not satisfactory.

If NISK wants to strengthen the quality of the basic research within these three areas it is important to focus the research on a smaller number of key issues and to attract more students. With a more focused research program and with the potential that the senior staff appears to have, they should be able to become more competitive in basic research and in doing so also become a more valuable resource for the applied sector.

## **Entomology and Pathology**

*Ranking: Fair to Good*

The entomological work closely relates to pathology because of a common interest in blue-stain fungi, spread by bark beetles, the main study objects of the forest entomologists. The concentration on bark beetles has helped to create critical mass for these studies. Simultaneously, it has meant that many equally important forest pests, such as voles, have received very little attention, although the pathology and entomology groups both try to cover the whole field. In addition to research on beetle spread fungi, the pathologists have worked with fungal pathogens on trees and seedlings. A more intimate co-operation of entomologists and pathologists with NISK plant physiologists and geneticists would be a natural direction to develop. The publishing activity of the entomology and pathology groups ranges from fair to good, most papers appearing in international periodicals.

## **Norwegian Institute for Nature Research**

*Ranking: Good*

Norwegian Institute for Nature Research (NINA) is divided into 5 divisions covering terrestrial ecology, aquatic ecology, landscape ecology, conservation biology and arctic ecology. There is a total of 102 staff, 47 of who are associate professors. NINA has a small block grant, but also conducts a considerable amount of contract work for the Directorate for Conservation Management (DNM). Basic research funding from the Research Council contributed 19% of the total budget in 1998.

The basic research activity at NINA, which frequently piggybacks on contract grants, is good to very good but this will decline if the present granting situation continues.

Because of the very high over-heads (>100%) charged by the institute, research groups at NINA are placed in an unfair position when competing with university based research groups for basic research grants. The methods used are appropriate for the problems being addressed and there is a good modelling and theoretical base for the observational and experimental work. There are good leaders and staff, but some of the best have left for the university system. An enormous amount of the research staff's time is spent writing annual reports for the DNM contracts and applying for one-year grants to continue the monitoring programs. We recommend that many of the monitoring projects could be granted for 5 years, with short annual reports, which would free the researchers from the burden of administrative tasks and enable them to increase the amount of time dedicated to research. There are no particular problems with training and mobility. Collaborations with University, national and international groups seem to be very good. Given the high administrative load, organisation was good.

## **Norwegian Polar Institute**

*Ranking: Good to Very good*

The Norwegian Polar Institute (NP) under the Ministry of the Environment conducts research, monitoring, environmental management, and mapping in the polar regions. The main emphasis is on Arctic research and NP has good working facilities on Svalbard, where scientists work for limited time periods. Approximately 130 persons are employed at the institute, of whom 9 are researchers in the programs Marine Ecology, Terrestrial Ecology and Ecotoxicology, the activities reviewed by Panel 1. NP was moved from Oslo to Tromsø in 1993, which has resulted in a complete renewal of the scientific staff. The research profile has therefore developed in recent years and further activities are currently being established. Due to the general fascination and interest for the high Arctic, the field-oriented research of NP is very popular among young biologists and there are no problems to find candidates for Cand. scient. projects. In recent years the NP has had only few Dr. scient. students. NP presently covers ca 50% of its expenditures by external funds, mostly from the Research Council and EU.

An important task of the NP is the monitoring of biodiversity and of the environment in relation to climate change and pollution. Given the limited resources and the high cost of working in the Arctic, it is important that the monitoring of carefully selected parameters is based on well-defined research questions and is well suited to provide the answers. The scientific staff of NP is relatively young due to the restructuring and the researchers are generally very active and motivated. The quality of the ongoing research is generally good with several projects being very good. The Panel finds the efforts to establish and maintain a high level of research very laudable. The studies of mammal populations should be strengthened by expertise in ecotoxicology. Expertise in terrestrial plant ecology is lacking. NP scientists have good contacts to Norwegian and international universities and institutes and contribute as teachers at UNIS in Longyearbyen. There is a demand for a new research vessel with icebreaking capabilities, which can be used for research in the ice margin zone. NP has excellent new buildings and facilities in Tromsø within the Polar Environmental Centre,

together with other institutes doing research in the Arctic.

## **Norwegian Institute for Water Research**

*Ranking: Fair*

Norwegian Institute for Water Research (NIVA) is a private, non-profit research foundation that conducts biological research in the fields of taxonomy, biodiversity, physiology, and ecotoxicology of aquatic organisms as well as research on sewage and drinking water treatment. The total staff is 180 of which 80 are researchers. The foundation covers 20% of its total expenses by basic funds, 40% from public funds, 20% from international funds, and 20% from private sources. About 10% come from EU-projects, which provide international co-operation with many other European institutes. The institute is well equipped and the structure of disciplines appears to function well. A number of researchers teach at the universities, which provides contacts to students and colleagues there. However, NIVA currently has only 3 institute-funded Dr. scient. students and thus gives a low priority to research innovation through doctoral projects. The large institutional overhead may counteract an improvement of this situation.

The strength of the institute lies in the broad knowledge base among the staff on taxonomy and aquatic environmental problems and in the ability to manage complex and integrated research projects. Research at the institute is mainly defined through contracts and funded projects for which scientists at the institute apply. By far the most of this research is published in reports and does not appear in the international literature. Generally, researchers are concurrently involved in many projects and these are productive and lead to useful results. The researchers have in average ca 300 hours per year, or 17%, of their working time available for their own research (i.e. not contract defined work). Some are rather active in basic research and publish internationally, others not. Based on the CVs and publication record of researchers from the Departments for Freshwater Ecology, Marine Ecology, and Environmental Technology and Water Resources Management, it is a general impression that basic biological research may not have a high priority at NIVA. The Panel found that NIVA had hired many good and active scientists who over the following years slowed down or even stopped that part of their research activity, which had formerly led to good publications in the international literature. It was not clear whether the lack of sufficient time for the scientists to become more deeply engaged in research questions or the lack of motivation from the leaders of the institute was the main reason for this. The level of basic research was somewhat higher in the Department of Freshwater Ecology than in the other departments. On this background it should be noted that a small number of scientists at NIVA have maintained a long-term research activity and quality which is at the highest international level and which has a significant impact on the reputation of NIVA in the international scientific community.



## **State Colleges**

### **Sogn og Fjordane College**

#### **Institute of Landscape Ecology**

The College is divided into five departments, of which only Landscape Ecology participated in the evaluation. The Landscape Ecology group is small, but very enthusiastic and the researchers had worked extensively to maintain and restore traditional local cultural landscapes, which are rapidly vanishing due to changes in land use practices. They emphasised the multidisciplinary nature of the research, conducted together with social and humanistic scientists. The group had been very active in obtaining financing. From the basic research perspective, the work evaluated belongs to vegetation science and paleobotany. If the outcomes of the basic research activity are evaluated in the same way as in universities, it is fair. However, such a grading does not take into account the heavy teaching load of the researchers, the management type of approach and the production of numerous reports and popular books. The real merits and importance of the work thus fall outside basic research.

### **Bodø College**

#### **Faculty of Fisheries and Natural Science**

The fisheries science program being developed has the potential to contribute to basic biological research. The facilities and setting have much to offer and the staff includes several well-trained scientists. At present research is being conducted on a diverse range of topics. Some financial support has been obtained in recent years from EU grants, but applications to the Research Council have been unsuccessful.

To be more competitive the group needs to improve its publication rate, which was very low in the last two or three years. A high priority should be given to publishing several manuscripts that the groups reported were nearing completion in international journals. Further, to overcome several impediments to research that the group identified, a strategic plan needs to be developed that capitalises on strengths and that identifies approaches for addressing weaknesses. This should include a recruitment plan to increase scientific competitiveness. Stronger connections with researchers in Norwegian universities should be developed, especially to gain from the experience of others scientists in designing research projects and in working with funding agencies. The group puts a premium on free choice of research areas. However, to develop an effective and competitive research program it may be wise to give up some of that freedom and develop a more focused research direction.

## **Stavanger College**

### **Department of Natural Science**

The Panel enjoyed learning about the distinguished systematic and phylogenetic studies that Professor Rognes continues to publish. We hope that a research community can develop that will re-invigorate the research careers of the other members of staff so that they may also go on to publish in refereed international journals.

# Appendices

# Appendix I

## Curriculum vitae of the Panel

### **Gunnar Öquist**

Gunnar Öquist studied chemistry and biology at Uppsala University where he graduated in 1967. He received his Ph.D. in Plant Physiology from Umeå University in 1972. After a post-doctoral period, including stays at Lund University and Oregon State University, he became Docent at Umeå University in 1976 and Professor of Plant Physiology in 1981.

His research field is photosynthesis with particular emphasis on stress and adaptation to contrasting climatic conditions.

At Umeå University he has been Chairman of the Department of Plant Physiology, Vice Dean of the Faculty of Science, and a member of the Board of the University. He has also been a member and Secretary General of the Swedish Natural Science Research Council, a member of the Boards of the Swedish Research Council for Engineering Sciences and the Foundation for Strategic Research. He is currently a member of the Board of the European Science Foundation. He is a member of the Royal Swedish Academy of Science and the Royal Society of Canada.

### **Paul H. Harvey**

Paul Harvey studied biology at the University of York, where he gained a BA (1st class) in 1968 and a DPhil. in 1971. In 1989 he was awarded a D.Sc. from the University of Oxford.

After holding faculty posts at the University of Swansea and the University of Sussex, Paul Harvey joined the University of Oxford in 1985. He has been Head of the Zoology Department since 1998.

His areas of research expertise include evolution, ecology and behaviour. He has most recently been developing and applying methods for the use of evolutionary trees constructed for gene sequence data to answer hitherto untackled questions in biology.

He was elected a Fellow of the Royal Society in 1992. Medals and awards include the Scientific Medal of The Zoological Society of London, 1986, the University of Helsinki Medal, 1994 and the US National Academy of Sciences' J. Murray Luck Award, 1997.

Paul Harvey is the Secretary (constitutional Chief Executive) of the Zoological Society of London. He is a member of the Royal Society Research Grants Board and has just been elected to the Council of the Royal Society. He is a Governor of the Marine Biological Association of the UK. In 1999 he chaired the Science and Management Audit of the Centre for Ecology and Hydrology of the Natural Environment Research Council of the UK. He is a member of the Life and Environmental Sciences Divisional Board of the University of Oxford.

He is co-editor (with Sir Robert May) of the Oxford Series in Ecology and Evolution, and member of numerous Editorial Boards as well as being on the Board of Reviewing Editors for Science.

### **Erkki Haukioja**

Erkki Haukioja studied biology at the University of Turku and completed his Ph.D. in 1970. He was appointed professor in zoology at the University of Turku in 1980. He has been a visiting professor at the University of Alaska (Fairbanks), Michigan State University (East Lansing), University of Queensland (Brisbane) and CSIRO (Canberra).

He started his research as an ornithologist working with questions of life history evolution. In the early 1970's he switched to plant – insect relationships. His main topics today relate to mechanisms of how birch trees develop resistance against defoliating insects.

He is currently on the editorial boards of: Ecology Letters, Ecoscience and Chemoecology.

### **Bo Barker Jørgensen**

Bo Barker Jørgensen studied biology at the University of Aarhus, where he was awarded an M.Sc. in 1973, a Ph.D. in 1977 and a D.Sc. in 1979.

After holding the post of lecturer in the Department of Zoology at the University of Aarhus, he became a Senior Lecturer and then Research Professor in the Department of Ecology and Genetics at the University of Aarhus. Since 1992 he has been the Director of the Max Planck Institute for Marine Microbiology (Bremen), and since 1993 Professor in the Department of Geology, University of Bremen and Adjunct Professor, Department of Biology, University of Aarhus.

His research covers broad areas of marine microbiology and sediment biochemistry, with focuses on element cycling in aquatic environments, eutrophication of coastal marine ecosystems, microbial mats and biofilms and studies of hydrothermal vents.

He was awarded the Friedman Award (Los Angeles, USA) in 1991 and the Körber

Prize (with 6 other European scientists) in 1995.

He has been on the editorial boards of several leading international journals. He has extensive experience as a member of diverse research committees and advisory boards in Sweden, Germany and Denmark, and he has been a member of several evaluation boards for German research institutes.

### **Franz Oberwinkler**

Franz Oberwinkler studied Biology, Chemistry and Earth Sciences at the University of Munich, where he received his Ph.D. in 1965. After a postdoctoral period at Tuebingen University and a one-year research stay at the Instituto Forestal Latino-Americano in Merida, Venezuela 1968-69, he returned to Munich as a lecturer and research scientist. In 1974 he was appointed director of the Botanical Garden and full professor of Botany and Mycology at the University of Tuebingen.

His research field is ecology, systematics, evolution of Basidiomycetes and co-evolution of fungi and plants. Mycological fieldwork, especially in the tropics, has been carried out since 1968 and resulted in the description of various key-taxa of Basidiomycetes.

He was twice Dean of Faculty of Biology and several times director of the Botanical Institute. Over eight years he served as a principal reviewer for the German Research Council. From 1994-98 he was president of the International Mycological Association.

### **Tim D. Smith**

Tim Smith studied biology and statistics at the University of Washington, Seattle, where he received his Ph.D. in 1973. From then until 1975 and again from 1978 to 1985 he worked at the Southwest Fisheries Science Center in La Jolla, California. From 1975 to 1978 he was Associate Professor of Zoology at the University of Hawaii, Honolulu. Since 1985 he has worked at the Northeast Fisheries Science Center, Woods Hole, Massachusetts.

His research has focused on the dynamics of fish and of large mammal populations, especially seals, dolphins, elephants and whales. A principal focus has been developing methods of estimating cetacean population size, which has included fieldwork in the Eastern Tropical Pacific, the Black Sea, the Gulf of Maine and the Barents Sea. He has also focused on determining the effects of by-catch of cetaceans in fishing operations. He has also made major contributions to the history of fisheries science, and more recently has been developing approaches to using the history of fisheries to test theories of the effects of fishing.

In addition to leadership roles within the fisheries laboratories where he has worked,

he has also served on numerous advisory committees, including those of US fisheries management councils, the US Marine Mammal Commission, and the International Whaling Commission.

# Appendix 2

## Mandate

for

## the evaluation panels and the principal evaluation committee

*The Research Council of Norway has decided to evaluate basic research activities in biology and relevant areas of biochemistry in Norwegian universities, colleges and research institutes. The reports of three individual evaluation panels and the summary report of a principal evaluation committee will form the basis for the future strategy of the Research Council.*

### Purpose of the review

The objective of this evaluation is to review the overall state of basic research in the biological and relevant biochemical disciplines in the Norwegian universities, colleges and research institutes. Specifically, the evaluation process will:

- Offer a critical review of the strengths and weaknesses of the scientific quality and organisation of biological research, both nationally and at the level of individual research groups and academic departments.
- Identify research groups which maintain a high international level in their research, or which have the potential to reach that level.
- Identify areas of research that need to be strengthened in order to ensure that Norway in the future will possess the necessary competence where this is of importance for the nation and, as one aspect of this, enable the Research Council of Norway to evaluate the impending situation regarding recruitment in important fields of biological research.
- Enable the Research Council to determine whether there are significant differences in the quality of individual sub-fields or areas of research. It will also enable the Council to compare the overall quality of Norwegian biological research with that of other countries (e.g. in Scandinavia, Europe and the USA).

### Follow-up of the evaluation

The evaluation will provide the institutions concerned with the knowledge they require to raise their own research standards. They will thus be given feedback on the



scientific performance of individual research groups, together with suggestions for improvements and priorities.

The evaluation will improve the knowledge base for strategic decision-making by the Research Council, constitute a platform for future work on developing the disciplines concerned and represent a basis for determining future priorities including funding priorities within and between areas of research.

The evaluation will reinforce the role of the Research Council as advisor to the Norwegian Government and the relevant ministries.

### **Organisation**

Three evaluation panels will be established, each of which will evaluate one of the following subfields:

- Terrestrial, marine and freshwater botany and zoology (including the museums), ecology and plant physiology
- Anatomy, physiology, zoophysiology, neurophysiology, neurochemistry, pharmacology and toxicology
- Microbiology, cell biology (cytology & histology), immunology, molecular biology (including biotechnology), genetics and biochemistry.

In addition to the three evaluation panels, a principal evaluation committee will be appointed, with responsibility for drawing up a summary report based on the reports of the panels and for making an overall assessment of the situation.

### **Background material**

The panels and the committee will be provided with background material which will cover the following points:

- the fields currently represented in Norwegian biological research
- the structure of the academic departments
- the personnel at different levels and its age structure
- the funding of research groups
- the equipment situation
- the situation regarding publication and citations

## **Mandate of the evaluation panels**

Each panel is requested to make use of the background material provided to evaluate the overall state of its subfield, and to produce a report with a set of specific recommendations for the future development of the field. The panels are requested to evaluate scientific activities with respect to quality, relevance and international and national collaboration, bearing in mind the resources available. Specific aspects to be considered include:

### **General aspects**

- Which fields of research have a strong scientific position in Norway? Which have a weak position?
- Is there a reasonable balance between the different fields, or is research lacking in any particular field? On the other hand are some fields overrepresented, in view of the quality or scientific relevance of the research performed?
- Is there a reasonable degree of co-operation and division of research activities at national level, or could these aspects be improved?
- How is the balance between theoretical and empirical studies within the various fields? How does it compare to the situation in other countries?
- Is the biology of today relevant to the needs of Norwegian industry and society? Do the research groups maintain sufficient contact with industry and the public sector?
- Are research groups prepared to solve “tomorrow's problems”, both nationally and internationally?

### **Academic departments/research institutes**

- Are the academic departments adequately organised?
- Is their research carried out as part of an overall research strategy?
- For applied departments and research institutes with groups carrying out basic research: does basic biological research activity form part of the department's research strategy?
- Is there sufficient co-operation related to the use of expensive equipment?

### **Research groups**

- Do research groups have a strategy and plans for the research which they are doing?
- Are the size and organisation of the research groups reasonable?
- Are the results obtained, e.g. number of fellowships awarded and articles published, reasonable in terms of the resources available?
- What role do Norwegian research groups play in international co-operation in individual subfields? Are there significant differences between Norwegian biological research and research in other countries?
- Do research groups take part in international programmes or use facilities abroad, or could utilisation be improved by introducing special measures?
- Is there sufficient contact and co-operation with other research groups at national and international level?
- Are any institutions/research groups candidates for status as “centres of excellence”?

### **Training and mobility**

- Is recruitment to doctoral training satisfactory or should more emphasis be placed put on recruitment in the future?
- Is there a sufficient degree of national and international mobility?
- Are there sufficient educational and training opportunities for PhDs in industrial research?
- Where do the newly qualified candidates go to work?

### **Miscellaneous**

- Any other important aspects for consideration.

## **Mandate of the principal evaluation committee**

The responsibility of the principal evaluation committee will be to draw up a summary report based on the reports of the three panels and to offer an overall assessment of the state of biological and relevant biochemical research in Norway, taking into account its quality and relevance in an international context.

The committee is requested to evaluate:

- The scientific quality of Norwegian biological research as a whole in the light of the resources available.
- Which areas of research have a strong scientific position in Norway in a national and international context and which are weak? Is Norwegian research ahead of scientific developments internationally within specific areas?
- In view of the scientific importance of the research performed, is the balance between individual fields of research reasonable?
- Is Norwegian research lacking or under-represented in any particular important area, especially in internationally important fields in which Norwegian groups might be expected to make a significant contribution?

The committee's conclusions should lead to a set of recommendations concerning the future development of research in biology and relevant areas of biochemistry in Norway.

## **Appendix 3**

### **The letter from the Research Council to the Norwegian Universities (in Norwegian)**



**Norges  
forskningsråd**

Stensberggata 26  
Boks 2700 St. Hanshaugen  
N-0131 Oslo  
Telefon 22 03 70 00  
Telefaks 22 03 70 01  
Org.nr. 970141669  
E-post: post@forskningsradet.r

Til institutt/-avdelingsledelsen ved  
institusjoner i følge vedlagte liste

Vår saksbehandler/telefon  
Jarle Nygard/2203 7209  
jn@forskningsradet.no

Vår ref.  
99/01365 JN/sdu  
Deres ref.

Oslo, 26. mars 1999

## **Evaluering av grunnleggende biofaglig forskning**

Det vises til tidligere utsendt brev.

Norges forskningsråd ønsker å gjennomføre en evaluering av grunnleggende biofaglig forskning inkludert biokjemi og bioteknologi ved universitetene, de vitenskapelige høyskolene, de statlige høyskolene samt ved relevante forskningsinstitutter. Evalueringen gjennomføres som et samarbeid mellom fire områder i Forskningsrådet: Bioproduksjon og foredling, Medisin og helse, Miljø og utvikling samt Naturvitenskap og teknologi.

Evalueringen vil bli gjennomført ved hjelp av tre evalueringspaneler bestående av internasjonale eksperter, samt en overordnet evalueringskomité. Vedlagt følger mandat for evalueringspaneler og evalueringskomité.

### Egenrapport fra forskningsinstitusjonene

*Etter anmodning fra fagmiljøene utsettes fristen for egenrapportering fra institusjonene til 15. mai. Rapportering fra institusjonene vil danne grunnlaget for arbeidet i evalueringspaneler og evalueringskomité. Denne henvendelsen sendes til flere organisatoriske nivåer: instituttgruppe-nivå, instituttnivå og til aktuelle avdelinger (i hht. vedlagte liste). Vi ber om at rapporteringen så langt mulig samordnes på instituttnivå eller på annet organisatorisk nivå der dette er naturlig. Ved større institutter der flere avdelinger skal evalueres, bør det leveres rapport både på avdelings- og instituttnivå. I det følgende er "institutt" benyttet som fellesbetegnelse for det som måtte være naturlig organisatorisk enhet i hvert enkelt tilfelle.*

Som angitt i forrige brev er instituttene delt i to hovedgrupper:

*Gruppe 1: Institutter der hele den vitenskapelige virksomheten skal evalueres.*

*Gruppe 2: Institutter der ikke hele virksomheten skal med, men der aktiviteten til enkelte forskergrupper skal rapporteres.*

Fordelingen på "gruppe 1" og "gruppe 2" går fram av vedlagte liste.

Ved "gruppe 2"-institusjonene er det kun den virksomhet relevant for den grunnleggende biofaglige forskningsaktiviteten som skal rapporteres, og institusjonen må selv avgrense hva som er relevant informasjon. I noen av punktene under er dette forsøkt presisert.

Vi ber om å få tilsendt følgende informasjon (10 – 20 sider avhengig av instituttets størrelse) på engelsk både som papirkopi og på diskett innen 15. mai:


- Organisering av instituttet
- Beskrivelse av forskergruppene (gruppe 2-institutter: relevante forskergrupper)
- Vurdering av instituttets styrke, svakheter, muligheter og trusler (gruppe 2-institutter: vurdering i forhold til grunnleggende biofaglig forskningsaktivitet)
- Strategi og framtidige planer (gruppe 2-institutter: Strategi og framtidige planer i forhold til grunnleggende biofaglig forskning)


Vi ber om følgende vedlegg

- Oversikt over vitenskapelig ansatte inkludert stipendiater, angi alder og fagfelt (gruppe 2-institutter: ansatte og stipendiater innen grunnleggende biofaglig forskning).
- CV for alle vitenskapelig ansatte; maks. 2 sider inkludert liste over publikasjoner siste 5 år. Legg ved 2 kopier av de 5 viktigste artikler siste 5 år.
- Liste over større utstyrsenheter (gruppe 2-institutter: større utstyrsenheter relevante for biofaglig forskning).
- Oversikt over større investeringer siste 5 år.
- Annuum-bevilgninger siste 5 år.
- Eksterne forskningsbevilgninger siste 5 år med angivelse av kilde.
- Oversikt over uteksaminerte hovedfags- og doktorgradskandidater med veileder siste 5 år. Angi tittel på doktorgrader.
- Beskrivelse av nasjonalt og internasjonalt forskersamarbeid.
- Beskrivelse av samarbeid med industri og offentlig forvaltning.
- Årsrapporter siste 5 år.

Evalueringsmaterialet fra institusjonene vil bli bearbeidet og oversendt evalueringspanelene før sommeren. Som tidligere nevnt vil møter mellom evalueringspanelene og forskergruppene trolig bli avholdt i Oslo i september/oktober 1999, og evalueringsrapportene vil bli ferdigstilt i løpet av høsten 1999.

Med vennlig hilsen  
Norges forskningsråd

  
Nils Marås  
Områdedirektør  
Naturvitenskap og teknologi

  
Jarle Nygard  
Spesialrådgiver  
Prosjektleder

Kopi: Ledelsen ved universiteter, fakulteter og høyskoler i følge vedlagte liste

## **Evaluering av biofag – oversikt over miljøer i UoH -sektoren:**

Miljøene vil bli delt i to hovedgrupper:

**Gruppe 1:** Institutter der hele den vitenskapelige virksomhet skal evalueres

**Gruppe 2:** Instituttet der aktiviteten til utvalgte forskergrupper skal evalueres

### **Universitetet i Oslo – gruppe 1**

#### **Bioteknologiseret**

#### **Det matematisk-naturvitenskapelige fakultet**

Biologisk institutt

*Avdeling for botanikk og plantefysiologi*

*Avdeling for generell genetikk*

*Avdeling for marin zoologi og marin kjemi*

*Avdeling for marin botanikk*

*Avdeling for limnologi*

*Avdeling for molekylær cellebiologi*

*Avdeling for generell fysiologi*

*Avdeling for zoologi*

Botanisk hage og museum

Zoologisk museum

Biokjemisk institutt

Farmasøytisk institutt

*Avdeling for mikrobiologi*

#### **Det medisinske fakultet**

Instituttgruppe for Medisinske Basalfag

*Anatomisk institutt*

*Fysiologisk institutt*

*Institutt for medisinsk biokjemi*

Instituttgruppe for Oslo kommunale sykehus

*Institutt for eksperimentell medisinsk forskning*

#### **Det odontologiske fakultet**

Institutt for oral biologi

### **Universitetet i Oslo – gruppe 2**

#### **Det matematisk-naturvitenskapelige fakultet**

Farmasøytisk institutt

*Avdeling for farmakologi*

*Avdeling for farmakognosi*



*Avdeling for legemiddelanalyse*

**Det medisinske fakultet**

Instituttgruppe for Medisinske Basalfag

*Institutt for ernæringsforskning*

Instituttgruppe for Oslo kommunale sykehus

*Institutt for medisinsk genetikk*

*Mikrobiologisk avdeling*

Instituttgruppe for laboratoriemedisin-RH/DNR

*Mikrobiologisk institutt*

*Farmakologisk institutt*

*Institutt for immunologi*

*Institutt for patologi*

*Institutt for kreftforskning, Det Norske Radiumhospital*

*Rettsmedisinsk institutt*

Instituttgruppe for klinisk medisin-RH/DNR

*Institutt for kirurgisk forskning*

*Pediatriisk forskningsinstitutt*

**Det odontologiske fakultet**

Seksjon for odontologisk farmakologi og farmakoterapi

**Universitetet i Bergen – gruppe 1**

**Det matematisk-naturvitenskapelige fakultet**

Molekylærbiologisk institutt

Botanisk institutt (inkl. hage og museum)

Institutt for fiskeri- og marinbiologi

Institutt for mikrobiologi

Zoologisk institutt (inkl. museum)

**Det medisinske fakultet**

Avdeling for mikrobiologi og immunologi (inkl. Senter for virologisk forskning)

Fysiologisk institutt

Institutt for anatomi og cellebiologi

Institutt for biokjemi og molekylærbiologi

Institutt for klinisk biokjemi

Pediatriisk institutt

*Fagområdet medisinsk genetikk*

*Senter for klinisk molekylærmedisin*

**Universitetet i Bergen – gruppe 2**

**Det medisinske fakultet**

Institutt for farmakologi

Avdeling for patologi

Senter for internasjonal helse

**Det odontologiske fakultet**  
Fagområdet mikrobiologi  
Fagområdet patologi

**Andre forskningsentra m.m.**  
Senter for miljø- og ressursstudier

## **Norges teknisk-naturvitenskapelige universitet – gruppe 1**

**Fakultet for kjemi og biologi**  
Botanisk institutt  
Zoologisk institutt  
Institutt for bioteknologi

**Det medisinske fakultet**  
Institutt for fysiologi og biomedisinsk teknikk  
*Gruppe for fysiologi*  
*Gruppe for biomedisinsk teknikk*  
Institutt for kreftforskning og molekylærbiologi  
Institutt for morfologi, avd. for anatomi

### **UNIGEN**

**Vitenskapsmuseet**  
Institutt for naturhistorie  
*Botanisk avdeling*  
*Trondhjem biologiske stasjon*  
*Zoologisk avdeling*

## **Norges teknisk-naturvitenskapelige universitet – gruppe 2**

**Det medisinske fakultet**  
Institutt for farmakologi og toksikologi  
MR-senteret, medisinsk seksjon  
Institutt for laboratoriemedisin

## **Universitetet i Tromsø – gruppe 1**

**Det matematisk-naturvitenskapelige fakultet**  
Institutt for biologi

**Tromsø museum**  
Fagenhet for botanikk  
Fagenhet for zoologi

**Det medisinske fakultet**  
Institutt for medisinsk biologi  
*Avdeling for arktisk biologi*  
*Avdeling for biokjemi*  
*Avdeling for bioteknologi*  
*Avdeling for genbiologi*

*Avdeling for immunologi*  
*Avdeling for medisinsk biokjemi*  
*Avdeling for medisinsk fysiologi*  
*Avdeling for medisinsk mikrobiologi*  
*Avdeling for molekylær cellebiologi*  
*Avdeling for virologi*  
*Avdeling for molekylær genetikk*

**Norges fiskerihøgskole**

Institutt for marin biokjemi  
Institutt for marin- og ferskvannsbiologi  
Institutt for akvatiske ressurser og miljøbiologi

**Universitetet i Tromsø – gruppe 2**

**Det medisinske fakultet**

Institutt for medisinsk biologi  
*Avdeling for morfologi*  
*Avdeling for eksperimentell patologi og anatomi*  
*Avdeling for farmakologi*

**Norges landbrukshøgskole- gruppe 2**

Institutt for kjemi og bioteknologifag  
Institutt for biologi og naturforvaltning  
Institutt for husdyrfag  
Institutt for næringsmiddelfag  
Institutt for plantefag  
Institutt for jord- og vannfag  
Senter for internasjonale miljø og utviklingsstudier – Noragric

**Norges veterinærhøgskole –gruppe 2**

Institutt for arktisk veterinærmedisin  
Institutt for biokjemi, fysiologi og ernæring  
Institutt for farmakologi, mikrobiologi og næringsmiddelhygiene  
Institutt for morfologi, genetikk og akvatisk biologi

**Universitetsstudiene på Svalbard –gruppe 1**

*Biologisk avdeling*

**Norges idrettshøgskole – gruppe 2**

Institutt for idrettsfag og biologiske fag

**Statlige høgschooler - gruppe 2**

**Høgskolen i Bodø**

*Avdeling for teknologi og naturvitenskap (forskere innen relevante fag)*

**Høgskolen i Stavanger**

*Forskere innen relevante fag*

**Høgskolen i Sogn- og Fjordane**

*Forskere innen relevante fag*

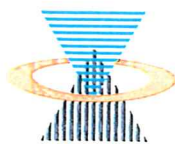
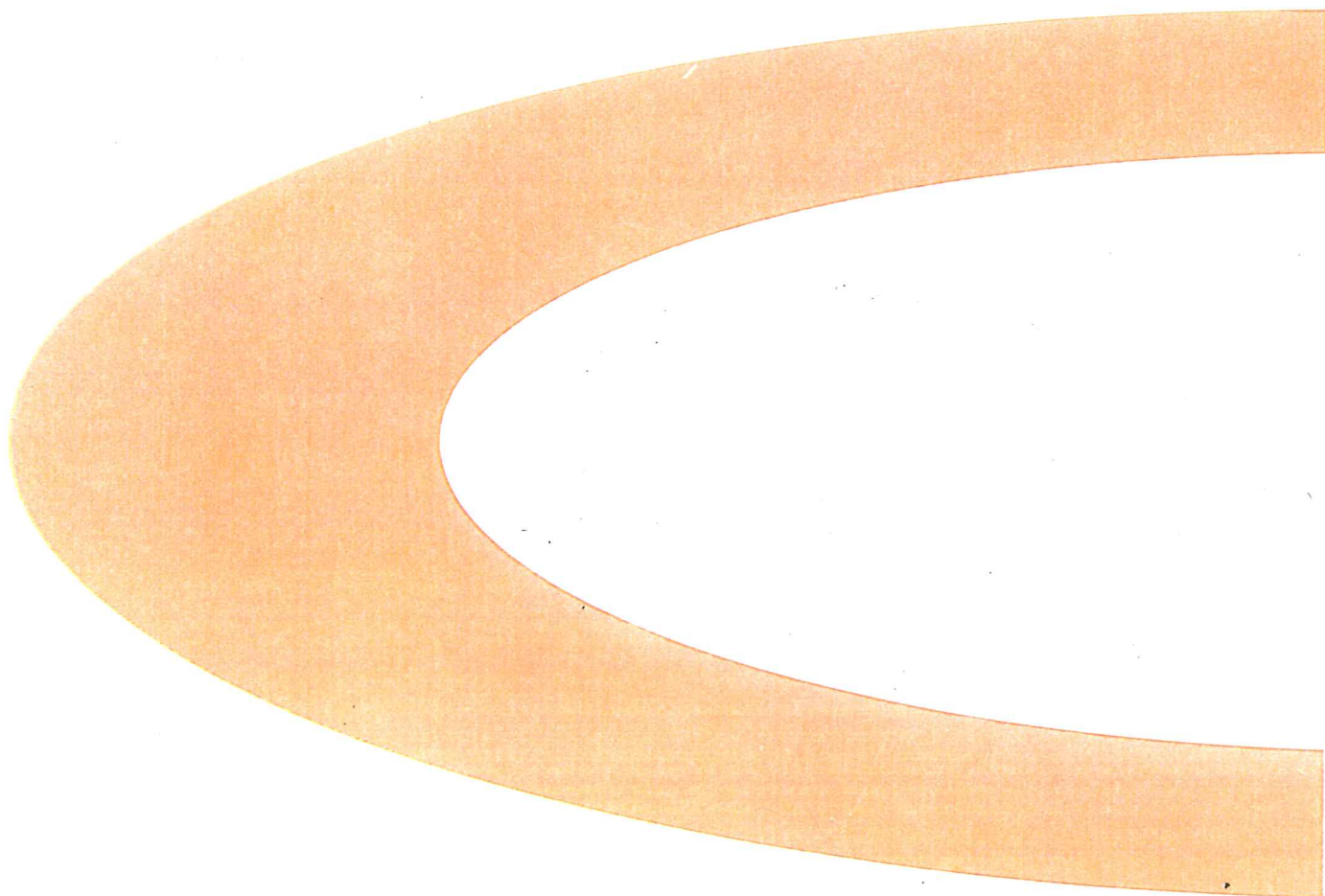
**Oversikt over miljøer i institutt-sektoren:**

Alle miljøene tilhører

**Gruppe 2: Instituttet der aktiviteten til utvalgte forskergrupper skal evalueres**

Fiskeridirektoratets ernæringsinstitutt  
Havforskningsinstituttet  
Akvaforsk  
Norconserv  
Fiskeriforskning  
Matforsk  
Planteforsk  
Norsk institutt for skogforskning  
Veterinærinstituttet  
Statens institutt for folkehelse  
Statens arbeidsmiljøinstitutt  
Forsvarets forskningsinstitutt  
SINTEF/UNIMED  
Norsk institutt for naturforskning  
Norsk institutt for vannforskning  
Jordforsk  
Norsk polarinstitutt

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