How to Become a Marine Mammal Scientist

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Learning Goals

- Become aware of different working prospects in science, technology, engineering and mathematics.
- Understand how careers in different fields can lead to a job in marine mammal science and research.
- Learn how researchers with diverse backgrounds became marine mammal scientists.

1 Introduction

There are many ways to become involved working with marine mammals as a professional career. You can become a zoologist, marine or population biologist, oceanographer, veterinarian, ecologist, physicist, engineer, underwater photographer, technician, national park ranger, naturalist, professional scuba diver, digitalisation expert, science communicator, project assistant at an institute studying marine mammals or a combination of several of these. Scientific working with marine mammals is transdisciplinary and encompasses various academic disciplines, such as biology, chemistry, physics, mathematics and engineering. An interest in topics relevant for today's environmental challenges (e.g. climate change, pollution, decrease in biodiversity, renewable energy, natural disasters and food security) can lead to studies of marine mammals. Marine mammals have a fundamental role in many marine ecosystems.

2 Marine mammal career opportunities

If you plan to become a marine mammal scientist, it will require your full devotion, time, energy and creativity. Practical field work outdoors can be equally part of a researcher's job as working on the computer or performing meticulous laboratory work. Try to find a good place to gain experience in your field of interest and a team that will give insights into their daily work. Volunteering can be important to gain knowledge and experience for a future career. If you are unsure about a certain job or work field, receiving practical insight often helps to make the right career choices for your future. For example, you could utilise your holidays to familiarise yourself with an occupation of interest, like participating in aquatic animal censuses, rehabilitation or education programmes.

There are thousands of students who want to work with marine mammals. Since you are not alone in your passion, you have to be unique in some relevant way. You can achieve this by learning certain technical skills, such as computer coding, equipment repair, or by acquiring a scuba certification, a boat handling licence or a permit to fly drones or radio control aircrafts. It is also important to educate yourself by reading specialised and scientific literature. You can read about marine animals that interest you, but also about your specific field of interest, such as diving physiology, acoustics, diseases, social behaviour, prey species and food availability.

2.1 Prerequisites learned in school

Most research positions have an academic background, so achieving good grades especially in the natural sciences, technology and mathematics is important for being accepted into a university to study your field of interest. It is important that you are proficient in English. You can improve your language skills through training courses. Scientists regularly present their research at international conferences or meet during different assemblies to exchange knowledge, project ideas and research outcomes. Meetings are almost always held in English. You report your study results in scientific publications, written in English to reach a large audience.

In some parts of the world, many people you meet are not comfortable speaking English, so you also want to pick up other languages. Latin is not a requirement, but numerous scientific terms like taxonomy or anatomical structures are Latin for global standardisation.

3 How to become a marine mammal scientist

There are many university programmes preparing you for a career in science, some of which will be touched on in this chapter. Also, non-academic professions can lead to an active career in marine mammal science and research. Scientific groups rely on employees with many practical and administrative backgrounds, such as laboratory technicians, secretaries, communication specialists, public relations managers and animal trainers.

3.1 How to become a marine biologist

Marine biologists study marine organisms, which may include either microscopic beings such as plankton, or larger animals such as marine mammals. If you want to study these organisms you may either observe them in the field (that is, in the ocean), or you can collect some individuals and bring them into your laboratory. In the laboratory, you can investigate a certain scientific question, for instance whether a certain species can survive summer heat waves, by simply increasing the temperature of the water simulating a heat wave event. During field studies, you may investigate if marine mammals are more present in pristine areas than highly human impacted areas.

To become a marine biologist, you need to gain knowledge in a broad range of disciplines. These mainly constitute the subjects of biology, chemistry, geology, physics and mathematics. Being engaged and achieving good grades in secondary school is important. Marine biology and all related careers are of a high educational level, which means you likely need to obtain a degree from a college or university to become a competitive candidate for a job.

First, you likely will need to get a university degree, which is often a *Bachelor of Science* in biology or any other natural science. There are different university programmes, like environmental sciences, marine geosciences, bioinformatics, etc. The duration of a Bachelor's programme is usually three or four years (six to eight semesters). After obtaining your degree, you can choose a field of special interest and deepen your knowledge by entering a *Master's programme* to study and specialise in, for example, marine biology, marine environmental sciences or biological oceanography.

A Master's programme usually lasts four semesters (two years) or in some countries three years. The final year or semester is dedicated to your Master's thesis, for which you choose a research topic that interests you and that you would like to focus on in your future career. Keep in mind that almost everything in the marine environment is connected and therefore of relevance, from the tiniest plankton to the largest animals on Earth, and a solid basis of knowledge is needed to understand them and any threats they face.

After completing a Master's thesis, you may continue to pursue a doctoral degree, which will give you the opportunity to develop your own research questions, and then by performing experiments or field surveys, write scientific publications and thus become a part of the scientific community. This last phase of higher education usually lasts at least three to four years, sometimes longer.

3.2 How to become a veterinarian

If you would like to become a veterinarian, you should have a general understanding of mathematics, physics, chemistry and biology. You should be interested in domestic animals, animal health, microbiology, diseases, food safety and hygiene. If you want to become a wildlife veterinarian, you should also be interested in wildlife, environmental protection, animal welfare and conservation.

To be accepted by a veterinary university, you usually need to have good grades in secondary school, especially in the natural sciences. Often, a letter of intent and an aptitude test are also required. The educational system differs depending on your country of residence, but it usually takes some 11 semesters (5.5 years) of study, including compulsory practical internships. You learn about zoology, botany, chemistry, physics, biochemistry,

embryology, pharmacology, as well as more specialised topics in anatomy, physiology, pathology, animal welfare, internal medicine and surgery. You also learn about food and meat production and hygiene.

Depending on the university, you may specialise in a certain animal species during the course of study. Even so, with a veterinary degree you have a broad training and can work in many different fields. You can work in a veterinary clinic, in the food production and hygiene sector, pursue research, sell veterinary supplies, or work for the pharmaceutical or another industry. Unfortunately, there is usually little university training in topics of interest for wildlife veterinarians. You need to gain experience through internships and postgraduate studies to specialise in fields like wildlife biology, zoo animal and wildlife health, animal welfare and conservation.

As a veterinarian you are expected to see the larger picture by connecting fragmented information to form a diagnosis, to function in unfamiliar situations, to work reliably under stress and to quickly familiarise yourself with new situations and areas of work. You need to be attentive and creative, because regardless of whether you are treating a mouse, horse or elephant, you have to find a solution for each animal and situation. In addition, you can specialise in clinical fields such as reproduction, *ophthalmology* or dentistry rather than in an animal species. If you desire to work with marine mammals, you should try to engage in as many practical experiences as possible. Volunteer wherever you can and participate in relevant internships. This is a highly competitive field with very few paid positions. Therefore, you should be determined and excel at your profession to succeed in the long run.

In rehabilitation or permanent holding facilities, the veterinary care team obtains regular hands-on experience with the animals they care for. Veterinary specialists are often called in for their expertise to assist the head veterinarian with clinical cases (such as dental reconstructions, or *osteosynthesis*). For some wildlife veterinarians, marine mammal research often involves little hands-on work with the animals, as much of the work focuses on population levels or the pattern of spreading of a disease. One should be prepared for working many hours on a computer or in a laboratory. Still, working as a veterinarian is highly rewarding, whether it is helping individuals in a clinical setting or performing wildlife research on a broader scale, as in this profession you can usually see the results of your devotion and you can do a lot of good.

3.3 How to become an engineer

Advice from Principal Research Fellow Mark Johnson, PhD in electronic engineering, Scottish Oceans Institute and Marine Bioacoustics Group, University of St Andrews, and Aarhus University, Denmark.

Working on engineering methods to study marine mammals is incredibly rewarding and challenging. Most marine mammals spend little time at the surface, so much of what we know about their behaviour and capabilities comes from using electronic data loggers (records data over time and/or in relation to location). To learn something new in this highly specific field, you have to develop a logger capable of measuring something different or invent a way to analyse the data that the loggers collect, and this often requires engineering knowledge. Engineering is both a set of skills and a way of looking at problems. Engineers use maths and physics to understand how things work or to build new things. In animal biology, engineers invent ways to find out where animals are, what their environment is like, how many of them are there, and what they are doing. Some biologists working with animals take an engineering approach, for example, by applying physical models to explain how animals move or how the sounds they make radiate into the environment. Either way, the key is to look at problems from an engineering perspective and acquire enough knowledge in maths, physics, and engineering to develop the mechanical or electronic systems you need.

Many universities offer Bachelor's degrees in engineering in which you usually have to select between mechanical or computer and electronic themes. Some universities offer

more cross-disciplinary themes such as industrial design or biomedical engineering which may also give you useful skills for developing systems to study marine life. A more practically oriented diploma in computer engineering may also be a possibility to help you add engineering skills to your biology training (e.g. as an evening class). There are few research groups actively working on engineering applications in marine biology, and you may need to persuade researchers across departments at your chosen university to create a cross-disciplinary opportunity for postgraduate study. However, there is such a powerful need for people with engineering skills in marine biology, that you may find that researchers are keen to create such opportunities.

Strangely, many university engineering courses do not teach you how to build electronic devices. They teach you about the theory and less about the practice. Most engineers learn about designing and building by trial and error or by working with other engineers. Some companies employ interns and this can be a good way to learn how to proceed. Another way is to reverse engineer: see how other people have designed equipment and try to adapt their work. There are a lot of hacker and engineering communities on the web that can help with advice (albeit of varying quality). But ultimately, the way to learn is to build things, test them and find out what breaks, repeatedly.

3.4 How to become a mathematical biologist

Advice from Dr. Benno Wölfing, formerly responsible for statistics and modelling at ITAW, now working in the division for Management and Monitoring of Marine Protected Areas of the German Federal Agency for Nature Conservation, Isle of Vilm, Germany.

In his autobiography, Charles Darwin 'deeply regretted that [he] did not proceed far enough at least to understand something of the great leading principles of mathematics; for men thus endowed seem to have an extra sense'. This *extra sense* has facilitated great scientific discoveries in life sciences in recent years. On the one hand, mathematical models are excellent tools for studying complex systems such as the evolution and spread of new traits in a population or the spread of disease. On the other hand, statistical methods are essential for quantifying the evidence in favour or against a scientific hypothesis and thus form the foundation for inference. The great majority of contemporary publications in the biological sciences draw on mathematical tools. To fully appreciate the evidence underlying a scientific statement, mathematical knowledge is required and every scientist should know a basis of statistics and programming. But don't worry: while statistics use mathematical concepts, they require a different set of logical thinking, and you don't have to be a mathematician to be a great statistician and vice versa. If mathematics is not your strongest suit, you can still get an understanding of statistics and be an excellent scientist, while for the more comprehensive studies and models, an interdisciplinary approach including statisticians, mathematical biologists or bioinformaticians is usually the way to go.

The requirements: Mathematical biologists are working in a field that spans disciplines as diverse as mathematics, biology and bioinformatics. Bachelor's degrees in biomathematics, biology, bioinformatics, statistics, applied mathematics or physics can all be good starting points for a career. In the end you want to achieve both a good knowledge of the biological system you are studying and a thorough understanding of the mathematical toolset. During your studies you may achieve this by participating in courses of other university departments, by selecting or suggesting cross-disciplinary assignments and research projects and by working in cross-disciplinary research groups. Programming experience is an essential skill. For graduate students and postdocs, experts in specific tools or analysis methods often offer internationally advertised courses.

Most research questions in the life sciences can only be answered in collaborative efforts. Fruitful collaborations between researchers of different disciplines require a mutual understanding of basic principles and a shared vocabulary. Mathematical biologists can be viewed as working in a continuum between

mathematics and biology. You can select where to specialise on this continuum based on your personal interests and talents. If your prime interest is in developing mathematical tools, in abstraction or in exploring systems, you may choose to study theoretical physics or applied mathematics. Bioinformaticians typically focus on the analysis of data acquired in the field of molecular biology as well as genetic and genomic data. Statisticians are trained in experimental design and the analysis of experimental data. Biologists receive an in-depth training in the methods and concepts of their discipline enabling them to identify research questions from which their discipline will profit. Efforts to acquire a good knowledge in related disciplines will be important throughout your career.

4 Accounts of different career paths

Interview with Professor Dr Ursula Siebert, Director of the Institute for Terrestrial and Aquatic Wildlife Research (ITAW), Germany

Prof Dr Ursula Siebert is a wildlife veterinarian who specialises in marine mammals. She studied veterinary medicine at the German Justus-Liebig-University Giessen and the Ecole Vétérinaire de Nantes in France, before conducting her doctoral thesis on 'Impact of mercury pollution on cetaceans from German waters' in Brussels, Belgium and Giessen, Germany. In 2007, she finished her habilitation in zoology at the Christian-Albrechts-University Kiel and has been the Director of the ITAW since July 2011. She is a Diplomate of the European College of Zoological Medicine (ECZM) in Wildlife Population Health and a Certified German Veterinary Specialist in wild animals.

What is your main research focus?

'In my research, I mainly focus on wildlife biology and wildlife health. I supervise terrestrial and aquatic research working groups at the institute; thus, I am involved in everything the institute conducts: health monitoring on live and dead animals, acoustics, animal counts, telemetry, wildlife diseases/parasites and population decline investigations. To protect marine mammals in particular, it is necessary to know how they live and what effects human activities have on them. Only the interdisciplinary work of several research groups and professions (zoologists, veterinarians, chemists, physicists, statisticians, etc.) and the joint evaluation of data and information lead to insights into the status of a population or species. Over the past years, human threats to marine mammals have increased dramatically and researchers need to find out how the animals react to changing living conditions, form conservation management strategies, and propose protected areas. Advising politics and stakeholders is also a main part of my work'.

How did you become a scientist working with marine mammals?

'I was conducting a part of my veterinary studies in Nantes, France, where I lived close to the seaside and started to work on marine mammals. From that point on, I followed this path and kept educating and specialising myself in marine mammal science and pathology'.

What does a typical day as a research institute leader look like?

'The head of a research institute has to look after everything that happens at the institute, for example, the research projects, proposals, contracts, master and doctoral students, building and facilities, as well as everybody's safety and security. I have to keep contact with funding agencies and stake holders to inform them about the progress and outcome of our research, and recognise what type of work or project are needed next to preserve marine mammals in German waters. Because I am involved in so many different working aspects, I regularly meet with ministries, contracting authorities, working groups, national and international colleagues and potential collaborators; have to read and respond to a huge amount of emails per day; write and check scientific papers and reports; and keep an overview of everything that is going on at the institute'.

What was your best experience working with marine mammals?

'The best working experience concerning marine mammals is to teach and train people in different countries about them, including

preparing young scientists for future research and protection of marine mammals. To see the excitement and interest in their eyes during a lecture or a practical class is always rewarding for the hard work we are doing'.

Interview with Associate Professor Magnus Wahlberg, Head of the University of Southern Denmark (SDU)'s Marine Biological Research Center in Kerteminde, Denmark

Prof Magnus Wahlberg is originally from Sweden and studied physics and biology at the Universities of Lund and Gothenburg. He worked with fish telemetry and sound production for the National Board of Fisheries in Sweden before starting a PhD at the University of Southern Denmark, developing acoustic localisation methods for deep-diving cetaceans, focusing on the sperm whale. As a post-doctoral researcher at Tjärnö Marine Biological Laboratory, Sweden, and Aarhus University, Denmark, he continued measurements on deep-diving cetaceans, including bottlenose whales. In 2006, he was appointed chief scientist at Fjord&Bælt, focusing on studies of harbour porpoise biosonar and hearing. He was appointed Associate Professor at SDU in 2012, and in 2015 he became Daily leader of SDU's Marine Biological Research Center in Kerteminde. His current research focuses on the hearing abilities and behaviour of marine mammals and birds.

What is your main research focus?

'My main research area is underwater hearing and underwater sound production in marine animals, especially marine mammals. I studied how fish respond to sound, how marine mammals interact with fishing gear, and also how especially porpoises find food by using echolocation. I work a lot with underwater sound, which means I am working very interdisciplinary. Acoustics by definition is a topic in physics. You need physicists to understand acoustics and you also need skilled engineers to build the equipment that you need for the measurements. We often work with engineers in our research'.

How did you become a scientist working with marine mammals?

'I started my career studying physics, actually. Then I got interested in biology and I switched to biology. But I was mainly interested in underwater sound, how animals respond to it and how they use sound underwater. For many years, I was working on different projects related to these questions. I also had a passion for marine mammals. I worked with many different scientists on some bycatch projects, I was a whale safari guide (naturalist) and very often, I helped other colleagues with their research projects just because I thought it was fun. I never ever thought I could make a career out of this passion. But I was lucky and motivated, so one thing led to the other, until I got a job at the Swedish fishery institute working with fish and seals. Later, I started my graduate work with toothed whales, and eventually ended up in Kerteminde and have continued my career here. For me, one thing has just led to the other very much by coincidence rather than following a planned career path. And I think especially in some scientific fields you have to be flexible and have very many hooks out in the sea of opportunities and then you may get efficient, competent or lucky so that one of the hooks is the big catch and then that's the way you go. In my opinion, you cannot sit down and plan your life a certain way, because the next opportunity is maybe in Canada or in Australia, or in a completely different field or with another species, you never know'.

What does a typical day as a researcher look like?

'There are no typical days for researchers. Every day is different, and I think you have to be very open minded and adaptable. We call it 'expect the unexpected'. You should always try to find out if there is something new and interesting in what you are doing; that's sort of what we are mainly focusing on. On the other hand, you have to be very meticulous, because it takes a lot of discipline to formulate good ideas for projects, plan the projects, and get funding to conduct them, and also to collect and analyse the data, and finally writing it up for a scientific publication.

Natural scientists are trying to figure out the unknown, how issues are connected or how biological life systems function. Our work is trying to find new things. And how do you do that? Well, it's not necessarily like an 8:00 am to 4:00 pm kind of job. The days usually

start more or less in the same way as they do for most people: we are starting our computer and go through our emails to see if there is an immediate problem from colleagues or students that needs our attention. But otherwise every day can be very different. Sometimes we are running experiments, we have to fix technical problems, we may have some issues that we have to solve in terms of understanding an experimental result or we go out in the field to measure sounds from the wild and we have to either prepare field equipment or actually go out and take the measurements. Often, we dive into our computers to analyse the data and also write up papers and reports. On top of that, we are also teaching and supervising students at different levels. Finally, we have some administrative work to do. Basically, every day looks very different'.

What was your best experience as a marine biologist?

'I have many fantastic experiences from field work with whales and seals but maybe the best one I can think about is one in the Azores, which are some beautiful Portuguese islands in the Atlantic where a lot of whales congregate. We had been out there for several weeks listening for and also tagging sperm whales from a sailing boat. During our last night, when all tags were retrieved, we had to finish up and eventually get all the equipment back into the boat, which actually took the whole night. It was already in the early morning hours when we had everything organised. I had been able to sleep a little bit during the night whereas the rest of the crew was completely exhausted. So, I was the only one who was sort of fresh enough to sail. There I was, sitting all alone while the sun was rising, and right beneath the stunning volcanic landscape of the Azores, quietly sailing the boat back to the harbour—that was a fantastic experience!'

Interview with Professor Eric Parmentier, Director of the University of Liège's Functional and Evolutive Morphology laboratory, Belgium

Eric Parmentier is a fish and 3D-modelling expert who graduated from the University of Liège's animal biology department before studying Carapidae, a sound producing fish family whose members infiltrate invertebrates. With the aim of carrying out comparisons, his research expanded to other fish families capable of acoustic communication.

What is your main research focus?

'I like to work on different subjects. In the lab, we work mainly on the acoustic communication of fish. We try to understand which messages fish send, how they produce their calls and how we can use these calls to monitor the environment. If fishes are able to send sounds, they should also be able to receive them, meaning that we are also working on their hearing abilities. Additionally, we examine the feeding modes of different fish species. Being able to feed on different prey and food items means that you are able to share the same environment and different niches. This way, we can explain the biodiversity of fish in the same habitat. Our latest project in the lab concerns marine mammals. They have different sizes, anatomies and physiologies, and do not all live in the same parts of the ocean. Using the vertebrae of the backbone, we try to explain how they evolved and adapt to different environments. Our work slogan could be: show me your backbone and I will tell you where and how you live'.

How did you become a scientist working with aquatic animals?

'I simply like to be in the sea. So, I suppose, it is easy to understand that I also like to understand how creatures of the sea are living. How they communicate, how they adapt to changing situations and how they thrive. The most obvious way to find answers to these questions was to study them—so I became a biologist'.

What does a typical day as a researcher look like?

'It depends on the day, because I am a professor and I also have to teach. However, much of my time is spent in a lab, working with bones, graphics and animations. But right now, while answering these questions, I am in Guadeloupe (in the southern Caribbean Sea) for one month with my research team and it is 6 am. In twenty minutes, we go to sea. We will probably swim four to five hours to collect different fish species we suspect to be vocal. Once we catch them, we place them close to the beach in shallow water and use hydro-

phones to record their sounds, if possible. We also take small tail samples for genetic studies. After sampling, some fish are set free immediately, while others are kept longer for morphological studies. If the fish is vocal, we can go back to the sea to place other hydrophones allowing us to follow the fish's sonic activity for longer times. We can also use cameras to explain fish behaviour through videos. This kind of fieldwork is always very exciting, but can also be strenuous and exhausting work. Once we are home, we have a huge amount of data that needs to be analysed and interpreted, so when we leave the field the work is by no means done'.

What was your best experience as a marine biologist?

'There is no best experience, but a lot of nice experiences. Each time we visit a new place or we know we are the first people to observe something, we are excited and happy. For example, during this mission in Guadeloupe, we are the first to record and describe the sounds of ten different fish species! Before us, nobody knew these fish were even able to produce sounds. Isn't that amazing? It is also neat to communicate the experiments we have done and our research outcomes. The description of new fish species was also a great thing. So, there are a lot of nice experiences in my life as a marine biologist'.

■ Interview with Dr. Iwona Pawliczka, Head of Prof. Krzysztof Skóra Hel Marine Station, Department of Oceanography and Geography, University of Gdansk, Poland

Dr Iwona Pawliczka studied marine biology at the University of Gdańsk. She has always been interested in marine mammals but did her master's thesis on fish diet. During her studies she published her first paper on harbour porpoises as a co-author of an international team. After a couple of years spent far from the sea, she got a position at Hel Marine Station University of Gdańsk where she took care of the research and population reestablishment and stabilisation of Baltic harbour porpoises and grey seals. She finished her PhD on the biology, population status and threats to harbour porpoises in the Polish waters of the Baltic Sea. Her current research and conservation work focusses on the biology of and threats to marine mammals. She is a member of different international forums dedicated to marine mammal protection in European waters, including ASCOBANS and HELCOM expert groups.

What is your main research focus?

'Marine biology is a very multidisciplinary science. In our situation in Poland, where there aren't so many marine mammals, and at the same time not so many scientists working on them, it is very important to cover a lot of different issues in this kind of research. At Hel Marine Station the team and I try to cover not only biology, behaviour and monitoring—but also more specific research as toxicology, parasitology and microbiology. We try to find out as much as possible about marine mammal populations that live here in the Baltic Sea. At the same time, we cooperate with a lot of different international teams like the ITAW, which are specialised in their own very specific aspects in the lives of marine mammals'.

How did you become a scientist working with marine mammals?

'From the beginning of my life, I lived at the seaside. I was pretty sure that my professional life has to be connected to the sea, in some way. Growing up, I decided, that the biology of the sea was the most exciting for me. I had the chance to observe marine life from a very young age. I became more and more excited and curious about it, asked myself how marine mammals can live in the water and what adaptations they have to live in the marine environment'.

What does a typical day as a researcher look like?

'I think marine biologists and researchers, in general, are independent workers. It very much depends on how you organise your work in your office and the field. Firstly, you have to find financial support to carry out projects. You have to find co-workers and research teams, often internationally, who are also interested in the same project or research questions. Writing grant and project proposals is a large part of a researcher's life. Then you have to organise your time between fieldwork, office work, conferences, workshops,

and writing publications and project reports. The first stage of almost all projects is dedicated to fieldwork. Sometimes on the ocean, sometimes at the beach, sometimes in the laboratory. Being out on the ocean or working hands on with marine mammals is obviously a prize for every researcher, which is only occasionally awarded. Often, you have to spend a lot of time inside the office or in labs. But you may also have to dedicate your time and your research to working at the university and to education, both academic and public education. It is very important to deliver the most recent data to the public, to politicians and to decision-makers, to take care of the environment and to trigger positive progress'.

What was your best experience as a marine biologist?

'This is very difficult to say. My job and being a researcher have so many facets and so many different days, and you get so many different experiences, that it is very difficult to say which one was the best. But, I would definitely say, that the happiest moments and days are when you can really observe the results of your work out in nature and how the animals live in their natural environment and not in captivity, not in the labs and not in the offices. So those are the best moments in my life as a marine biologist'.

Interview with Dr. Andreas Ruser, Deputy Director and Head of the Bioacoustic Research Group at the ITAW, Germany

Dr. Andreas Ruser is a trained physicist. He graduated from the Faculty of Mathematics and Natural Sciences of Kiel University in 2001. During his doctoral research in biophysics, he focused on analysing chlorophyll-fluorescence to determine marine algae groups and on investigations on natural water samples with flow cytometers. One of his interests focuses on the layout and construction of analogue and digital circuits and he is in charge of the development and improvement of different monitoring-systems (for water levels, currents, waves, underwater sound, animal hearing, etc.).

What is your main research focus?

'The bulk of my work is in the field of bioacoustics, where I mainly perform research on marine mammals. My working group focuses on underwater noise and hearing of harbour porpoises, harbour seals and grey seals, in particular on the impact of anthropogenic underwater noise. We examine the animals' ears to understand the physical effects of anthropogenic underwater sound on hearing, and also try to investigate how sound affects the distribution of animals within their habitat. To record sounds in the ocean, acoustic recording devices (hydrophones) are stationed underwater. Through their recordings, we can learn how severe the underwater sound input is and can determine its effects on marine animals. By analysing the recordings, we can detect whether animals are present in the vicinity of the hydrophones or not. In addition, we also tag animals with acoustic recording and GPS devices and later try to figure out how an animal behaves when exposed to underwater sound. Through our bioacoustics research, we try to answer questions regarding their normal physiology, anthropogenic influences on behavioural change and the severity of underwater noise pollution effects'.

How did you become a scientist working with marine mammals?

'The career process until I started working with marine mammals was very long. I was always interested in technology and this passion led to the decision to study physics. During my studies, I would have never dreamt of ever working with marine mammals. That was never my plan. However, I always wanted to work in the field of applied physics. Meaning no theoretical research, but something that can be measured or somehow captured and practically implemented. During my university studies, I worked in a very different area, namely in photosynthesis research. During the course of my career, I moved from basic photosynthesis research in terrestrial plants, over investigations of phytoplankton, to research on marine mammals. In fact, my research objects have slowly but steadily increased in size throughout my career. In the end, working with and on marine mammals happened just like that. I always had a natural interest in this subject, but the basis to become a marine mammal researcher was paved very early on by my fascination and orientation for applied physics'.

What does a typical day as a researcher look like?

'This morning, my day started like every other workday. With a rather unpleasant sound: the repeated buzzing of my alarm clock. Like most people working at the institute, I would rather be outside in the field watching and studying marine mammals and recording their call behaviour instead of working in the lab. The step into the acoustic laboratory is sobering; it looks like a NASA control room with banks of computers and boxes filled with equipment such as hydrophones, amplifiers, cables and sound cards. A colleague is staring at the computer screens, but he is actually listening to the sounds of blue whales the team recorded in Iceland. Sound recordings come with a collection of a gigantic amount of data. Each recorded second represents, depending on the sample rate, up to more than 500,000 data points. These huge amounts of data and many hours of recordings require many cups of coffee, the use of powerful software, excellent programming skills and proper data management. The subsequent analysis of sound is diverse and requires more cups of coffee, but statistical programmes allow data organisation, calculation, statistical computing and graphic display of recorded sounds. This means, that we will sit in front of our computers for the rest of the day, analysing the collected data, trying to refine our programmes and change statistical descriptive parameters to improve our results. Often, we let the computers calculate overnight, so that we have the next dataset analysed the next morning and we can continue working on it'.

What was your best experience as a scientist?

'Apart from a very mind-boggling experience with different plankton types during my doctoral chlorophyll-fluorescence research, my best experience as a scientist is the acoustic work with a harbour porpoise. Doing my first hearing tests and auditory experiments with porpoises was my absolute career highlight. For one, the animals are extremely special, all the porpoises I've studied so far have their own personality, which is amazing and relatively unbelievable. They may not look like it, but porpoises are simply highly fascinating, remarkable animals. It is just something completely different to work with a large animal, compared to researching microscopic plankton structures that are barely visible to the naked eye. Moreover, every field investigation is a new challenge, always extremely complicated. You have to think about and consider an incredible amount of possibilities and in the end, everything has to work in the field. Something that is easily done in a lab is usually a challenge on site and fieldwork is always complicated and often nerve-racking. Even if you have tested the entire equipment and the measuring system worked perfectly a few hours ago, the conditions in the field are always different. Suddenly, an electronic system that was previously running flawlessly for weeks in the laboratory shuts down without a reason while you are working on a porpoise. Adrenaline kicks in and you have to find a fast and easy solution to the problem to still get reliable results at the end of the day. That is why a good day out on the water, where everything works and you get good results is so satisfying. When all your hard work is rewarded with aspired data, the whole team is happy, the examined porpoise is healthy, has good hearing abilities and can happily swim off—that is always a great feeling and the best motivation one can think of'.